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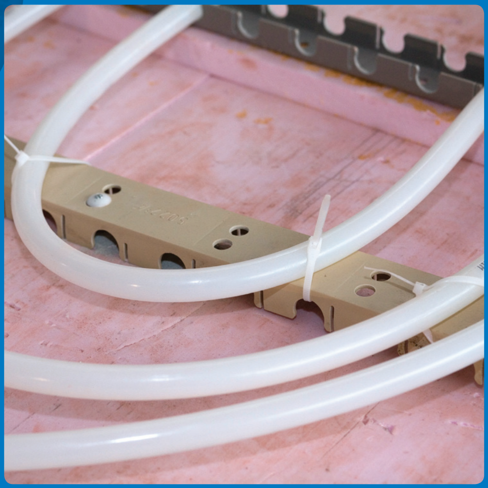
RADIANT
COOLING SYSTEMS

RADIANT COOLING DESIGN MANUAL

Radiant Cooling Design Manual

Embedded Systems for Commercial Applications



Uponor, Inc.
5925 148th Street West
Apple Valley, MN 55124 USA
Tel: 800.321.4739
Fax: 952.891.2008

Uponor Ltd.
2000 Argentia Rd., Plaza 1, Ste. 200
Mississauga, ON L5N 1W1 CANADA
Tel: 888.994.7726
Fax: 800.638.9517

uponor

www.uponorengineering.com

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Radiant Cooling Design Manual (RCDM) First Edition

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is published by

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Foreword

Uponor, formerly Wirsbo, is dedicated to partnering with professionals to create better human environments. As the North American leading manufacturer of Engel-method crosslinked polyethylene (PEX-a) tubing, Uponor provides system solutions that include both the quality products and technical support required to design, install and operate radiant cooling systems.

As part of this technical support, Uponor publishes the Radiant Cooling Design Manual (RCDM) for mechanical engineers, mechanical contractors, architects, building owners, building officials and other individuals interested in hydronic radiant cooling. The RCDM describes Uponor radiant cooling systems, and it assists the reader with specification, design, installation and inspection of Uponor hydronic radiant floor, ceiling and wall cooling systems.

Through their versatility, Uponor hydronic cooling systems are used in a variety of applications. Please direct any questions about the suitability of an application or a specific design to a local Uponor representative by calling toll free 888.594.7726 (United States) or 888.994.7726 (Canada).

In addition to the RCDM, Uponor provides:

- Other design and installation manuals
- Videos
- Case studies
- Training
- Specs and submittals
- CAD details
- Revit® files
- BIM support
- Design services
- Technical support

For information about these support services and tools, please contact your Uponor sales representative or visit **www.uponorengineering.com**.

Note that this manual is available at no charge. To order additional copies, go to www.uponorpro.com/rcdm.

Acknowlegements

Uponor would like to thank Peter Simmonds, Ph.D., and Robert Bean, R.E.T, P.L.(Eng.) for their assistance in bringing this manual to fruition. Their expert knowledge and experience in the radiant heating and cooling sector proved invaluable in creating this comprehensive manual for professionals interested in learning more about hydronic radiant heating and cooling system design.

Chapter 1
Introduction

The goal of this manual is to assist mechanical engineers in designing radiant-based, embedded cooling systems for commercial building applications. Many of the concepts presented can also be directly applied to residential construction. The application of presented concepts for both commercial and residential construction may vary depending on the characteristics of the specific project. It is recommended that the engineer consult a local Uponor representative for additional information and support.

A Brief History of Radiant Cooling

Although many historians cite ancient Rome as the birthplace of radiant heating, evidence from recent archeological digs in Asia and America shows that radiant floor heating systems have actually been used for more than 3,000 years. Inhabitants of the Northern Hemisphere during the Neoglacial and Neolithic period heated their subterranean shelters by drafting smoke from fires through stone-covered trenches excavated into the floor. The warmed stones would radiate heat from the floor into the living spaces, creating relatively comfortable indoor environments in very harsh climates.

Water-based radiant heating systems have been used extensively in Europe for the past century. In these systems, warm water is circulated through a series of piping loops embedded in the concrete floor slab. By controlling the water temperature, the temperature of the slab can be controlled to provide superior comfort. Also, because the heat transfer capacity of water is much greater than that of air, a radiant slab can transfer energy much more efficiently than a forced-air system.

For years, the most common systems were installed using embedded copper tubing. At the time, copper was considered reasonably inexpensive and relatively easy to work with. It was plagued, however, with problems such as kinks during installation, corrosion, pitting and material build-up, which reduced the effectiveness of the system over time and limited its useful life.

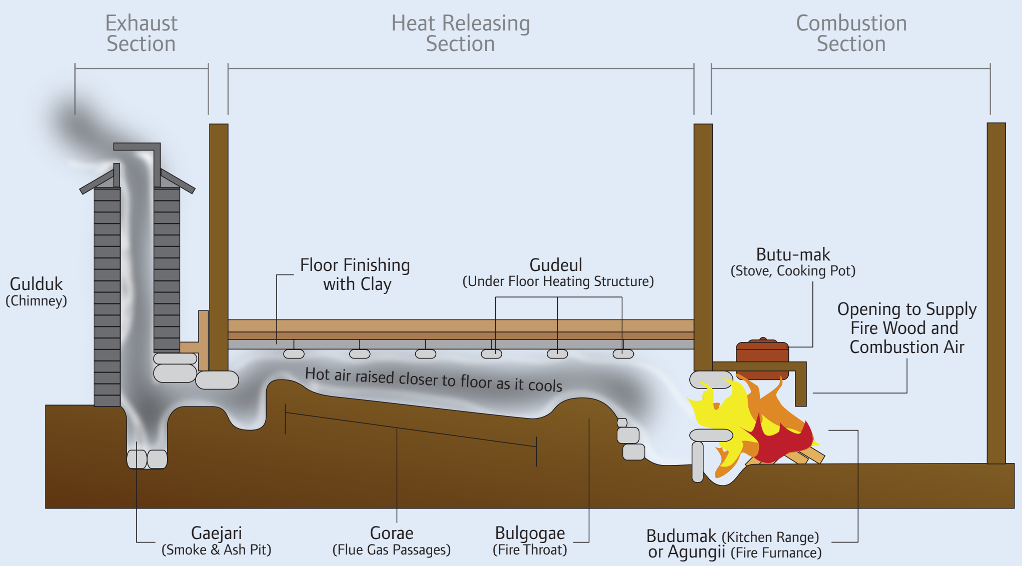


Figure 1-1: An ondol, also called gudeul, in Korean traditional architecture. This type of underfloor heating uses direct heat transfer from wood smoke to the underside of a thick masonry floor.

In 1968, a German engineer named Thomas Engel developed a method to crosslink the oxygen molecules of polyethylene to create crosslinked polyethylene or PEX. The following year, Wirsbo — a Swedish company, refined the manufacturing process for PEX-a using the Engel method, and made PEX-a tubing commercially available. Wirsbo tubing revolutionized the hydronic industry by providing a flexible and durable high-quality alternative to copper.

In 1988, Uponor acquired Wirsbo. Uponor has become one of the worldwide leaders in PEX solutions for radiant heating and cooling, plumbing, hydronic distribution and residential fire protection. Uponor's solutions in North America are manufactured in Apple Valley, Minn.

Over the past few decades, the same principles that were used to design radiant-based heating systems have been adapted to provide cooling as

What is PEX-a?

PEX-a is cross-linked polyethylene tubing manufacturer using the Engel method, offering superior flexibility and kink repair. The other types of PEX are PEX-b (silane method) and PEX-c (irradiation method). For more information PEX-a tubing, see **Appendix B**.

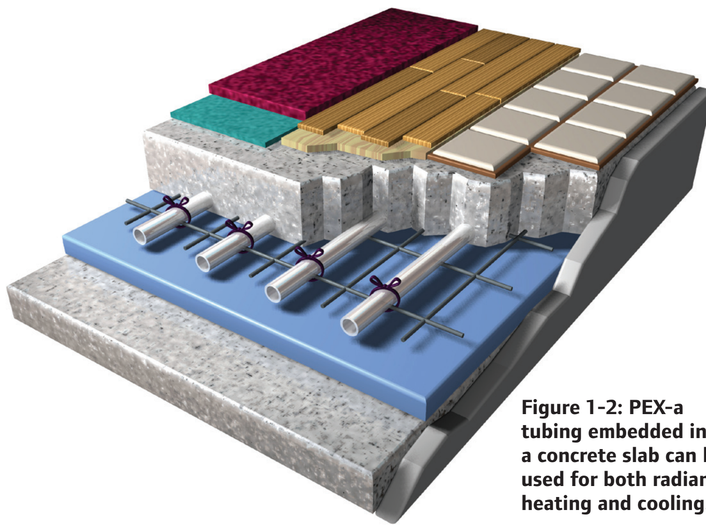


Figure 1-2: PEX-a tubing embedded in a concrete slab can be used for both radiant heating and cooling.

well. By utilizing the same PEX-a tubing embedded in the concrete slab, a radiant cooling system that circulates chilled water can be used as an engineered replacement for forced air-only systems.

More and more jurisdictions and building owners are adopting stringent energy standards and requiring higher building performance ratings to meet the requirements of ASHRAE's Building Energy Label program or the United States Green Building Council (USGBC) LEED® Certification program. Designers are responding with radiant cooling as a cost-effective, energy-efficient solution.

Radiant Cooling Benefits

Over the past decade, the number of radiant cooling systems designed, installed and commissioned in North America has increased dramatically. Radiant cooling systems are gaining exposure and popularity for a variety of reasons:

- Energy efficiency
- Superior comfort
- Greater architectural flexibility
- Reduced operating and maintenance costs
- More effective control of ventilation

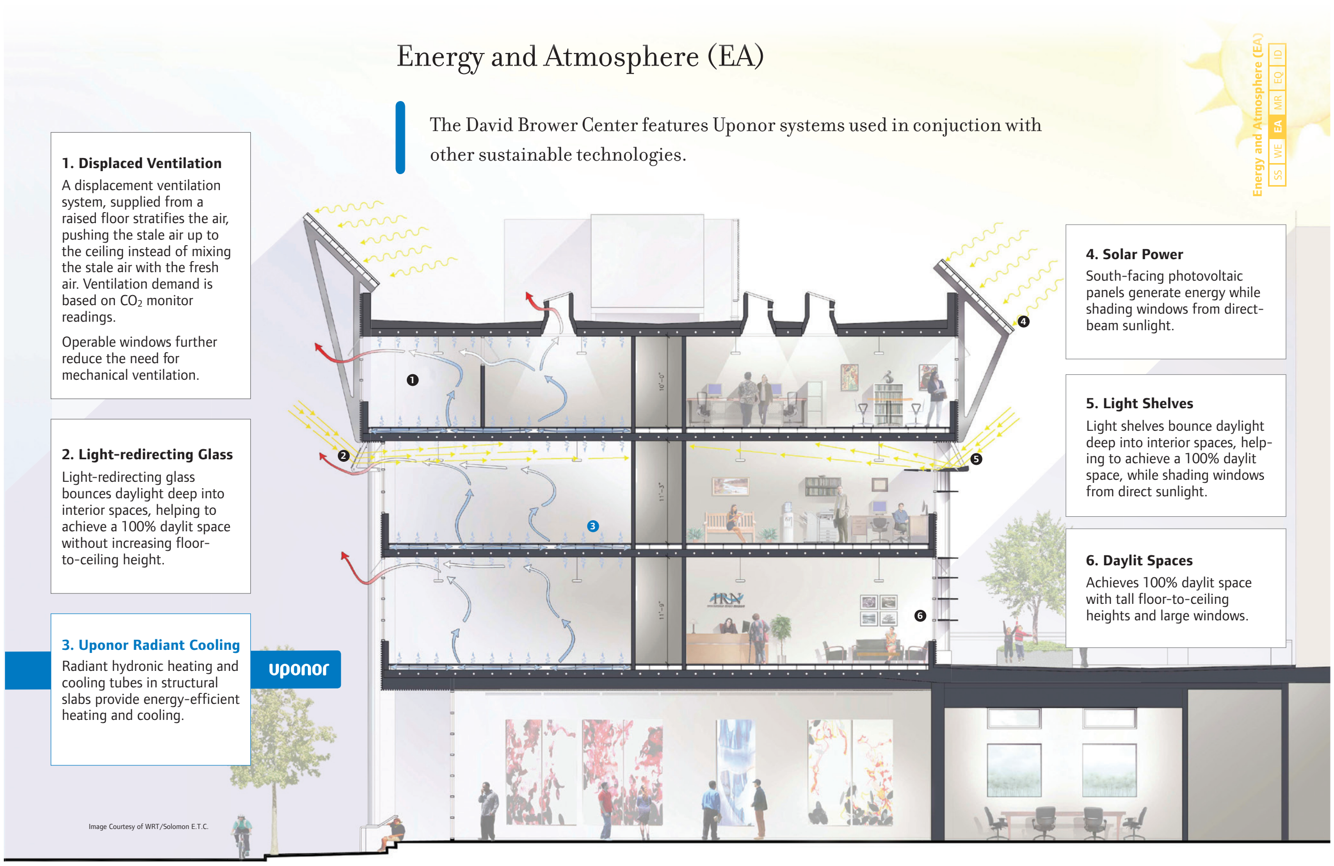
Energy Efficiency

A radiant cooling system can help dramatically reduce the energy consumption of a building through lower transport energy usage, more efficient operating modes, higher room setpoints, and lower transmission losses.

Lower Transport Energy Usage: Because the heat-transfer capacity of water is much higher than that of air, a radiant system that uses a circulator to move water (in lieu of a fan to move air) can achieve the same heat transfer using significantly less energy.

What is LEED®?

Leadership in Energy and Environmental Design (LEED) is a rating system established by the United States Green Building Council to grade the sustainability of a building. There are many ways to achieve points in the LEED rating system. Based on the total number of points achieved, a project can earn the distinction of LEED Certified Silver, Gold or Platinum. One of the key ways to earn points is by maximizing the energy efficiency of the building by incorporating lower energy-consuming systems, such as radiant cooling. For more information, visit the USGBC website at **www.usgbc.org**.



Fan Energy Example: Calculate the power consumption from the fan motor of an air handler with a sensible cooling load of q = 341,180 Btu/h. Assume: t_{supply} = 55.4°F, t_{return} = 80.6°F, c_p = 0.24 Btu/lb·°F, ρ_a = 0.071 lb/ft³, total pressure drop air system Δp = 35.57 lb/sq ft, η_{air} = 0.75

Air Flow

$Q_a = q_a / (60 \text{ min/hr} \cdot \rho_a \cdot c_p \cdot \Delta t)$

Where

q_a = heat transfer rate to or from air, Btu/h
Q_a = airflow rate, cfm
ρ_a = density of air, lb/ft³
c_p = specific heat of air, Btu/lb·°F
Δt = temperature increase or decrease of air, °F

$$Q_a = \frac{341{,}180 \text{ Btu/h}}{(60 \text{ min/hr} \cdot 0.071 \text{ lb/ft}^3 \cdot 0.24 \text{ Btu/lb} \cdot {}^\circ\text{F} \cdot 25.2^\circ\text{F})}$$

Q_a = 13,250 cfm (22,500m³/h)

Fan Motor Power

$$P = \frac{Q \cdot \Delta p}{\eta_{air}} = \frac{13{,}258 \text{ ft}^3\text{/min} \cdot 35.57\text{lb/ft}^2}{0.75} = 628{,}403 \text{ ft} \cdot \text{lb/min} \cdot 0.0226 \approx 14{,}200\text{W}$$

Pump Energy Example: Calculate the power consumption of a circulator with a sensible cooling load of q = 341,180 Btu/h. Assume: t_{supply} = 55.4°F, t_{return} = 62.6°F, c_p = 1 Btu/lb · °F, ρ_a = 8.34 lb/gal, total pressure drop water system Δp = 11.63 psi, η_{water} = 0.30

Water Flow

$Q_w = q_w / (60 \text{ min/hr} \cdot \rho_a \cdot c_p \cdot \Delta t)$

Where

q_w = heat transfer rate to or from water, Btu/h
Q_w = water flow rate, gpm
ρ_a = density of water, lb/gal
c_p = specific heat of water, Btu/lb °F
Δt = temperature increase or decrease of water, °F

$$Q_w = \frac{341{,}180 \text{ Btu/h}}{(60 \text{ min/hr} \cdot 8.34 \text{ lb/gal} \cdot 1.0 \text{ Btu/lb} \cdot {}^\circ\text{F} \cdot 7.2^\circ\text{F})}$$

Q_a = 95 gpm (21.5m³/h) = 12.7 ft³/min

$$P = \frac{Q \cdot \Delta p}{\eta_{air}} = \frac{12.7 \text{ ft}^3\text{/min} \cdot 1{,}675\text{lb/ft}^2}{0.3} = 70{,}908 \text{ ft} \cdot \text{lb/min} \cdot 0.0226 \approx 1{,}600\text{W}$$

In summary:

Total Sensible Load: 341,180 Btu/h
Air Handler Fan Power Required: 14,200 W (approximately 20 hp)
Radiant Cooling System Pump Power Required: 1,600 W (approximately 2.5 hp)

The electrical demand of a circulator to transfer the same amount of heat energy is only 11% of the fan motor.

More Efficient Operating Modes: In addition to reducing energy consumption by utilizing pump power in lieu of fan power, a radiant cooling system can also lower overall energy use by allowing the chiller to operate at more optimum modes. Typical chilled water temperatures for a radiant cooling system are between 55°F (12.7°C) and 63°F (17.2°C). Higher return water temperatures may allow the chiller to operate within a more efficient range. These higher operating temperatures also allow greater flexibility in chilled water source. Potential alternative sources for chilled water may include fluid coolers, geothermal heat pumps or lake/bay water.

Higher Room Setpoints: Because of the way the human body reacts to its surrounding environment, comparable levels of comfort can be achieved with a radiant cooling system at higher room temperatures (e.g., 78°F/25.6°C) than with a forced-air system at lower room temperatures. Therefore, a radiant cooling system, coupled with a smaller forced-air system (for ventilation, latent loads and supplemental sensible loads) can reduce a building's total energy use by operating at higher setpoints.

Lower Transmission Losses: With a conventional forced-air system, transmission losses can occur due to inadequate or poor insulation, and duct leakage. Distribution systems typically experience lower transmission losses.

As a result of these factors, the total energy consumption of a building can be significantly reduced. Recent studies have shown total energy conservation for typical office buildings using radiant cooling on the order of 17 to 53% below ASHRAE Standard 90.1-2010.

The number of projects in North America incorporating radiant cooling to achieve higher energy performance ratings continues to grow. Recently completed projects that have incorporated radiant cooling as part of an energy-efficient design solution are shown throughout this manual.

Superior Comfort

ASHRAE Standard 55-2010, *Thermal Environmental Conditions for Human Comfort* lists six factors that affect thermal human comfort: air temperature, radiant temperature, humidity, air velocity, clothing and metabolism. Forced-air systems attempt to maintain comfort by controlling air temperature and indoor relative humidity, ignoring the impact that radiant temperature has on human comfort. In typical settings, during low activity with light clothing and moderate air velocities, the human body transfers more of its sensible heat through radiation.

Controlling floor temperatures and reducing surface temperature differentials results in reduced stratification and radiant asymmetry. Therefore, a thermal mass system that relies on radiation heat transfer can create a more comfortable environment compared to a system relying exclusively on convective heat transfer.

For more information on ASHRAE Standard 55-2010, visit **www.ashrae.org**.

Greater Architectural Flexibility

With a radiant cooling system embedded in the floor slab, the visible components, such as air handlers, ductwork, grilles, diffusers, etc. can be much smaller, allowing greater flexibility in the aesthetic architectural design. The space requirements for the mechanical system (e.g., mechanical room, roof space, ceiling space for ductwork) can be compacted, potentially reducing building floor-to-floor heights.

Additionally, because a radiant slab can much more effectively deal with direct solar loads, temperatures in areas with high fenestration (e.g., lobbies, atria, etc.) can be more easily controlled with less noise and draft.

CityCenter — Crystals, Las Vegas, Nev.
LEED Gold

Water + Life Museum, Hemet, Calif.
LEED Platinum

Manitoba Hydro Place, Winnipeg, Man.
LEED Platinum

Reduced Operating and Maintenance Costs

The embedded tubing within the concrete slab requires no maintenance. The radiant cooling system, including the chilled water source and distribution, requires no more maintenance than typical fluid-based systems. The smaller forced-air system — made possible by the radiant cooling system — translates to lower operating and capital costs (e.g., reduced fan horsepower, smaller filtration, smaller dehumidification equipment, etc.).

More Effective Control of Ventilation

In many heating, ventilation and air conditioning (HVAC) systems today, the air handling systems are sized to deliver airflow based on the total cooling and ventilation requirements of the spaces and occupants they are serving. These airflow rates are rarely the same, and controls are often ineffective in delivering the proper amount of airflow to satisfy both requirements simultaneously. For example, in some cases rooftop units are used to cycle on and off based on cooling demand, ignoring the continuous demand for ventilation air. In a radiant cooling system, these two functions are decoupled. Decoupling these functions allows more exact ventilation control, ensuring that the occupants always receive the proper amount of outside air.

Cooper Union, New York, N.Y. — LEED Platinum

NREL Research Support Facility, Golden, Colo. — LEED Platinum

Pier 15 Exploratorium, San Francisco, Calif. — LEED Gold

Chapter 2
Fundamentals

Mean Radiant Temperature

As previously mentioned, ASHRAE Standard 55-2010 defines six factors that affect thermal human comfort: air temperature, radiant temperature, humidity, air velocity, clothing and metabolism. Since the latter two factors are occupant-dependent, only the first four can be monitored and controlled by the HVAC system. Traditional air conditioning systems typically only monitor and control three of these space conditions, ignoring radiant temperature. Radiant heating and cooling systems address mean radiant temperature (MRT), which is a key factor in thermal comfort.

MRT is defined as the theoretical uniform surface temperature of an enclosure in which an occupant would exchange the same amount of radiant heat as in the actual non-uniform enclosure. Unlike in an air-only system, the MRT in a radiant conditioned space recognizes the intimate relationship occupants have with the surroundings via radiant heat transfer.

This relationship is a key component in thermal comfort when integrated with air temperature to "operative temperature" indices as referenced in thermal comfort standards.

Operative Temperature

The operative temperature is numerically the average of the air temperature t_a and mean radiant temperature t_r, weighted by their respective heat transfer coefficients. Most requirements for comfort are based on the operative temperature in a space.

The operative temperature is calculated as:

$$\theta_{f,i} = \frac{(h_c \cdot t_a) + (h_r \cdot t_r)}{h_c + h_r}$$

Where

$\mathbf{t_a}$ = air temperature in reference point, °F (°C)

$\mathbf{t_r}$ = mean radiant temperature in reference point, °F (°C)

$\mathbf{h_c}$ = convective heat transfer coefficient for the human body, Btu/h · ft² · °F (W/m² K)

$\mathbf{h_r}$ = radiant heat transfer coefficient for the human body, Btu/h · ft² · °F (W/m² K)

In most practical cases where the relative air velocity is small at <40 fpm (0.2 m/s) or where the difference between mean radiant and air temperature is small at <7°F (4°C), the operative temperature can be calculated with sufficient approximation as the average of air and mean radiant temperature. (Source: ANSI/ASHRAE Standard 55-2010, *Thermal Environmental Conditions for Human Occupancy*.)

$$\theta = \frac{\text{Air Temperature} + \text{MRT}}{2}$$

However, if the mean radiant temperature is significantly lower or higher than the air temperature, the convective and long-wave radiant heat flux should be calculated separately.

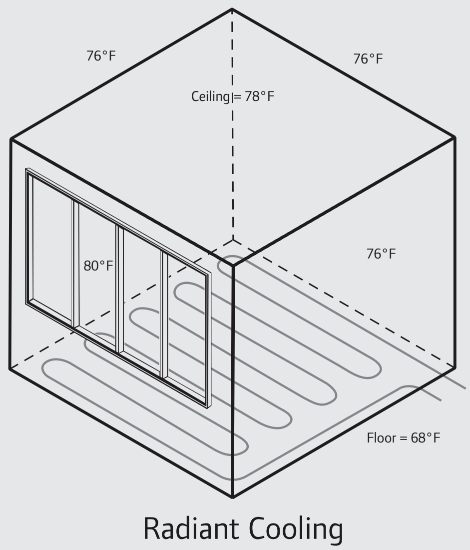


Figure 2-1: MRT can be calculated as the area-weighted average surface temperature of all surfaces.

Component	Area (ft^2)	Surface Temperature
Walls	480	76ºF (24.4ºC)
Windows	60	80ºF (26.7ºC)
Ceiling	225	78ºF (25.6ºC)
Floor	225	68ºF (20ºC) (controlled)

Mean Radiant Temperature Calculation: Calculate MRT given the following room conditions:

Air Temperature = 78°F (25.6ºC)

$$\frac{[76(480) + 80(60) + 78(225) + 68(225)]}{[480 + 60 + 225 + 225]} = 74.7°F\ (23.7°C)$$

Operative Temperature Calculation:

(74.7 + 78) / 2 = 76.3°F (24.6°C)

Therefore, when using a radiant cooling system, the temperature perceived by the human body will actually be lower than the air temperature. Accordingly, the same level of comfort can be achieved with higher air temperatures. In the example above, with a cooled slab, the operative temperature of 76.3°F (24.6°C) is achieved even though the air temperature is 78°F (25.6°C). Typical design room setpoints with radiant heating and cooling system are 68°F (20°C) for heating and 78°F (25.6°C) for cooling; reducing the demands placed on the air-side system.

Heat Transfer Basics

Heat transfer occurs whenever there is a temperature difference between two objects, and it continues until both objects are in thermal equilibrium. According to a formulation of the Second Law of Thermodynamics known as the Clausius statement, heat cannot naturally flow from a colder temperature to a hotter temperature. In other words, heat will always naturally flow from hot to cold. Heat is transferred in three ways: conduction, convection and radiation. A radiant cooling system uses all three modes of heat transfer.

Conduction

Conduction is heat transfer between two solids that are in direct contact with each other. In radiant heating and cooling systems, conduction occurs between the PEX-a tubing and the concrete slab. The heat transfer rate is based on the conductivity of materials, the tubing surface, and the temperature difference between the tubing and the slab. Conduction also occurs between the cooled slab and the objects in the space that are in contact with the slab, including air film, furnishings and occupants. If a person is standing on a cooled slab, then a quantity of body heat will naturally flow via conduction to the slab. The heat transfer rate is based on the cumulative R-values from footwear, the floor conductivity, and temperature difference between the occupant and the floor surface. To prevent discomfort due to temperature differentials, ASHRAE Standard 55-2010 recommends that floor slab temperatures be above 66°F (18.9°C) for occupants wearing normal footwear in occupied spaces. It should be noted that in temperature ranges typical of radiant floor cooling systems, and in consideration of footwear R-values, the amount of conductive heat transfer from foot to slab is relatively low and, therefore, typically considered negligible.

Convection

Convection is heat transferred through a moving fluid or gas. In the case of radiant-based HVAC systems, natural or "free" air convection occurs due to differences in air densities influenced through contact with warmed or cooled surfaces. Natural convection is a design consideration with radiant-cooled ceilings as the layer of air in contact with the cool ceiling will drop due to its higher density, increasing air movement, and thus heat transfer, in the space. Forced convection occurs in the air handler, where fans are used to force the cooled air into the space. Because convection deals with heat transfer through the movement of air, the air temperature is directly affected.

Radiation

Not surprisingly, the sensible heat transfer in a radiant cooling system is through radiation. Radiation is heat transfer through electromagnetic waves travelling through space. When the incident waves from a warmer surface come into contact with a cooler surface, the energy is absorbed, reradiated, reflected or transmitted. An example of radiation is sunlight, which travels through the vacuum of space as short-wave radiation to warm the Earth's surface. The heat-transfer rate is influenced by a number of factors, including the absorptivity, reflectivity and emissivity of the surfaces; wavelength; temperature and the spatial relationship between the cooled surface and the occupant (defined as the view and angle factors). In radiant cooling, the electromagnetic waves from the occupant are drawn toward the cooled surface, resulting in the occupant experiencing a cooling effect.

Long-wave Radiation: Long-wave radiation is the heat flux that occurs between the conditioned surface and the unconditioned room surfaces; its quantity and wave length are temperature-dependent.

Short-wave Radiation: The transfer of short-wave radiation upon room surfaces from solar gains or high intensity lighting is not dependant on the temperature of the absorbing surface. Energy at this intensity upon a surface at room conditions will be absorbed, reflected and/or transmitted based upon the color and optical characteristics (reflectivity, absorptivity, transmissivity) of the receptor surfaces.

LEED Rating: Gold
Project: Hall Winery
Location: St. Helena, Calif.
System: Uponor Radiant Heating and Cooling
Product: 83,000 ft. of ⅝" Wirsbo hePEX tubing
Square Feet: 46,931
Chief Architect: Gehry Partners, LLP
Associate Architect: Lail Design Group
Contractor: Reid Heating & Energy, Inc.
Consulting Engineer: IBE Consulting Engineers
Completed: 2008

The total heat flux of the radiant floor system can be written as the sum of the three types of heat transfer:

$q_{tot} = q_{con} + q_{l,rad} + q_{s,rad}$

Where

$\mathbf{q_{tot}}$ = total energy transfer, Btu/ft^2, (W/m^2)

$\mathbf{q_{con}}$ = convective energy transfer, Btu/ft^2, (W/m^2)

$\mathbf{q_{l,rad}}$ = long-wave radiant energy transfer, Btu/ft^2, (W/m^2)

$\mathbf{q_{s,rad}}$ = short-wave absorption, Btu/ft^2, (W/m^2)

The sum of convective q_{con} and long-wave radiant heat transfer expression $q_{l,rad}$ is defined as the space energy transfer q_s , Btu/ft^2, (W/m^2), and can be written as:

$q_s = q_{con} + q_{l,rad}$

$q_{con} = h_{con} \cdot (t_f - t_{air})$

$q_{l,rad} = h_{s,rad} \cdot (t_f - t_{MRT})$

Where

$\mathbf{h_{con}}$ = convective energy exchange coefficient floor to space, Btu/ft^2 • °F, (W/m^2 K)

$\mathbf{h_{l,rad}}$ = long-wave radiant energy exchange coefficient floor to space, Btu/ft^2 • °F, (W/m^2 K)

$\mathbf{t_{air}}$ = space air temperature, °F (°C)

$\mathbf{t_{MRT}}$ = surrounding surface temperature, °F (°C)

$\mathbf{t_f}$ = floor surface temperature, °F (°C)

Project: Miller Bonded, Inc. Pipe Fabrication Facility
LEED Rating: Gold
Location: Albuquerque, N.M.
System: Uponor Radiant Heating and Cooling
Product: Radiant Rollout™ Mats with Wirsbo hePEX™
Radiant Square Feet: 15,000
Architect: NCA Architects
Contractor: Freeman's Finest Construction
Completed: 2010

As previously discussed, the radiation within a space is usually separated into two groups: long-wave and short-wave. The long-wave radiation is that which occurs between room surfaces. The short-wave radiation upon a cooled floor should be considered; its incident energy will be absorbed, reflected and/or transmitted based upon the color and optical characteristics of the receptor surfaces.

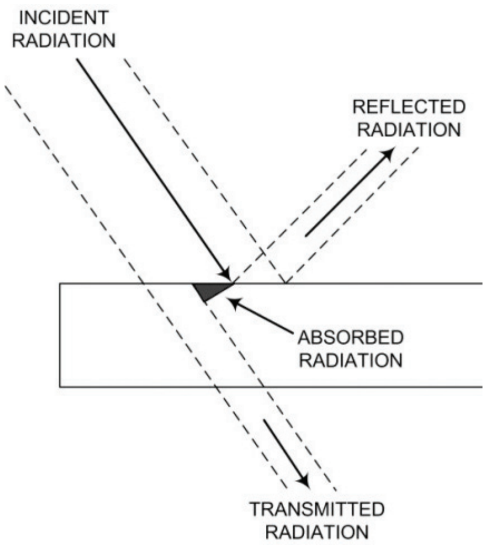


Figure 2-2: Reflection, Absorption and Transmission of Short-wave Radiation

The first law of thermodynamics:

$\alpha + \tau + \rho = 1$

Where

α = fraction of incident radiation absorbed (absorptance).

τ = fraction of incident radiation transmitted (transmittance).

ρ = fraction of incident radiation reflected (reflectance).

The floor surface is opaque, so the transmittance of the floor surface $\tau = 0$. For a black surface where $\alpha = 1$, $\rho = 0$, $\tau = 0$, all short-wave radiation reaching the surface will be absorbed by the black surface. For most surfaces, absorptance for short-wave radiation (high-temperature radiation) is different than emittance for long-wave radiation (low-temperature radiation).

Surfaces	Absorptance α for Solar Radiation
Carpet — dark-colored	0.80 — 0.90
Carpet — light-colored	0.50 — 0.60
Tile or plaster, white or cream	0.30 — 0.50
Red tile, stone or concrete, dark paints (red, brown, green, etc.)	0.65 — 0.80
White-painted surfaces	0.23 — 0.49

Source: ASHRAE Fundamentals

Table 2-1: Absorptances for Solar Radiation

Solar absorptance can also vary with the size of windows. Absorptance can range from 0.90 for dark-colored spaces with small windows to 0.60 or less for light-colored spaces with large windows.

When using textile-based floor coverings, the slab temperature required to draw down the floor surface temperature must be evaluated to ensure it does not approach the dew point temperature.

	Surface Temperature	
	Maximum Heating	**Minimum Cooling**
Floor occupied zone	84˚F (28.9˚C)	66˚F (18.9˚C)
Floor perimeter zone	95˚F (35˚C)	66˚F (18.9˚C)
Wall	104˚F (40˚C)	62˚F (16.7˚C)
Ceiling	80˚F (26.7˚C)	62˚F (16.7˚C)

Table 2-2: Surface Temperatures Providing Thermal Human Comfort

Direct Solar Loads

In lobbies, atria or other areas with high direct solar loads, radiant floor cooling can be especially effective. Without floor cooling, maintaining comfort in these areas could be a significant challenge. Energy from the sun is transmitted through the glazing as short-wave radiation. As it hits the floor surface, a portion of this energy is absorbed by the slab, while the remaining portion is reflected into the space as long-wave radiation, contributing to the space heat gain.

Figure 2-4: Radiant cooling slabs can effectively handle high solar loads by absorbing the sun's energy before it reflects into and heats the space.

Flux, Radiant Floor Cooling Including Short-wave Radiation

$q_c = h_{c,tot} \cdot (t_o - t_s) + q_{s,rad}$

Where

$\mathbf{q_c}$ = specific heat flux between floor surface and space, Btu/ft² (W/m²)

$\mathbf{h_{c,tot}}$ = heat exchange coefficient, Btu/hr•ft²•°F, (W/m² K)

$\mathbf{t_o}$ = operative temperature, °F (°C)

$\mathbf{t_f}$ = floor surface temperature, °F (°C)

$\mathbf{q_{s,rad}}$ = absorbed short-wave radiation, Btu/ft² (W/m²)

In floor areas with absorption of short-wave radiation, the total floor cooling capacity can be as high as approximately 25 to 32 Btu/h/ft² (80 to 100 W/m²). The capacity is dependent on the fin efficiency of the floor viewed as a heat exchanger. If the exchanger shows a high thermal resistance, then the space cooling capacity would be suppressed.

If short-wave absorption through the floor is higher than the steady cooling capacity of the floor, energy not absorbed will raise the temperature of the floor surface and could eventually causes the surface to emit long-wave radiation back into the space.

Long-wave Radiant Energy Exchange Coefficient

It is assumed that all surfaces are radiantly gray, so the radiant heat flux between floor surface and the other surfaces (Fanger 1982) can be written as:

$$q_{rad} = \varepsilon_f \cdot \sigma \cdot T_f^4 - \sum_{i=1}^{N} \varepsilon_i \cdot \sigma \cdot T_i^4 \cdot F_{Af-Ai}{}^4$$

Where

$\mathbf{q_{rad}}$ = radiant heat flux between floor surface and the other surfaces, Btu/h ft² (W/m²)

$\boldsymbol{\varepsilon_f}$ = emittance of floor surface

$\boldsymbol{\varepsilon_i}$ = emittance of the other surfaces

$\boldsymbol{\sigma}$ = Stefan-Boltzmann constant

$\mathbf{T_f}$ = absolute temperature of floor surface, K

$\mathbf{T_i}$ = absolute temperature of surfaces, K

$\mathbf{F_{Af-Ai}}$ = view factor between floor surface $_{Af}$ and surfaces $_{Ai}$ dimensionless

Because of the emittance for gray surfaces, as the case of internal wall surfaces in a space, are nearly equal (0.9 to 0.95), the equation above can be linearized:

$$q_{rad} = \varepsilon \cdot \sigma \sum_{i=1}^{N} \theta_{f,i} \cdot (T_f - T_{air}) \cdot F_{A_f} - {}_{A_i}$$

Where

$$\theta_{f,i} = \frac{T_f^4 - T_i^4}{T_f - T_i} \text{, in K}^3$$

The values of $\theta_{f,i}$ vary only slightly with the temperature level in normal spaces by using floor cooling and heating. Now the equation can be written as:

$$q_{rad} = \varepsilon_f \cdot \sigma \cdot \theta \sum_{i=1}^{N} {}_{f,i} \cdot (T_f - T_{air}) \cdot F_{A_f - A_i}$$

Where the constant value of 1.05 x 108 K³ is now used for $\theta_{f,i}$.

The product $\varepsilon_f \sigma \theta_{f,i}$ is the radiant heat exchange coefficient between floor surface and space, written as:

$$h_{rad} = \varepsilon_f \cdot \sigma \cdot \theta$$

Radiant heat flux can thus be calculated by this equation.

$$q_{rad} = h_{rad} \cdot \sum_{i=1}^{N} {}_{f,i} \cdot (T_f - T_{air}) \cdot F_{A_f - A_i}$$

Of the Stefan-Boltzman constant σ, two different values are given in the literature:

- IP units, 0.1714×10^{-8} Btu/h · ft² · °R^4 or 0.1744×10^{-8} Btu/h · ft² · °R^4
- SI units, 5.67 x 10-8 W/m^2 K^4, (ASHRAE 1996) or 5.77 x 10-8 W/m^2 K^4 (Fanger 1982).

Calculating h_{rad} for different combinations of ε and θ shows that, with only little error, a constant value of h_{rad} = 5.5 W/m² K can be used.

	σ = 5.67 x 10^{-8} W/m^2 K^4	σ = 5.77 x 10^{-8} W/m^2 K^4	σ = 0.1714 × 10–8 Btu/h · ft² · °R^4
ε = 0.90	h_{rad} = 5.35 W/m^2 K	h_{rad} = 5.45 W/m^2 K	h_{rad} = .94 Btu/h · ft² · °F
ε = 0.95	h_{rad} = 5.67 W/m^2 K	h_{rad} = 5.76 W/m^2 K	h_{rad} = 1.00 W/h · ft² · °F

Table 2-4: Variant Calculation of h_{rad} Using Equation Above, θ_f = 1.05 x 108 K3

Solar Radiation

The amount of short-wave solar radiation entering a room depends upon the orientation of window(s), the properties of the glazing, the shading devices, the month and the time of day.

The calculation of the short-wave, direct-sun transmission through the window may be determined with a computer program. The amount of short-wave radiation entering the floor surface may be estimated, based on the percentage of the floor surface covered by furniture or equipment.

The specific sun radiation to the floor surface is the direct sun transmission through the window on the floor per radiated floor area, written as:

$$q_{s,rad} = \alpha \cdot \frac{Q_{directsun}}{A_f}$$

Where

$q_{s,rad}$ = specific short-wave sun radiation per ft² (m²) upon the cooled floor, Btu/ft² (W/m²)

$Q_{directsun}$ = sun radiation through the window on the floor, Btu/h (W)

A_f = radiated floor area ft² (m²)

α = absorptance of the floor surface (dimensionless)

Floor Cooling

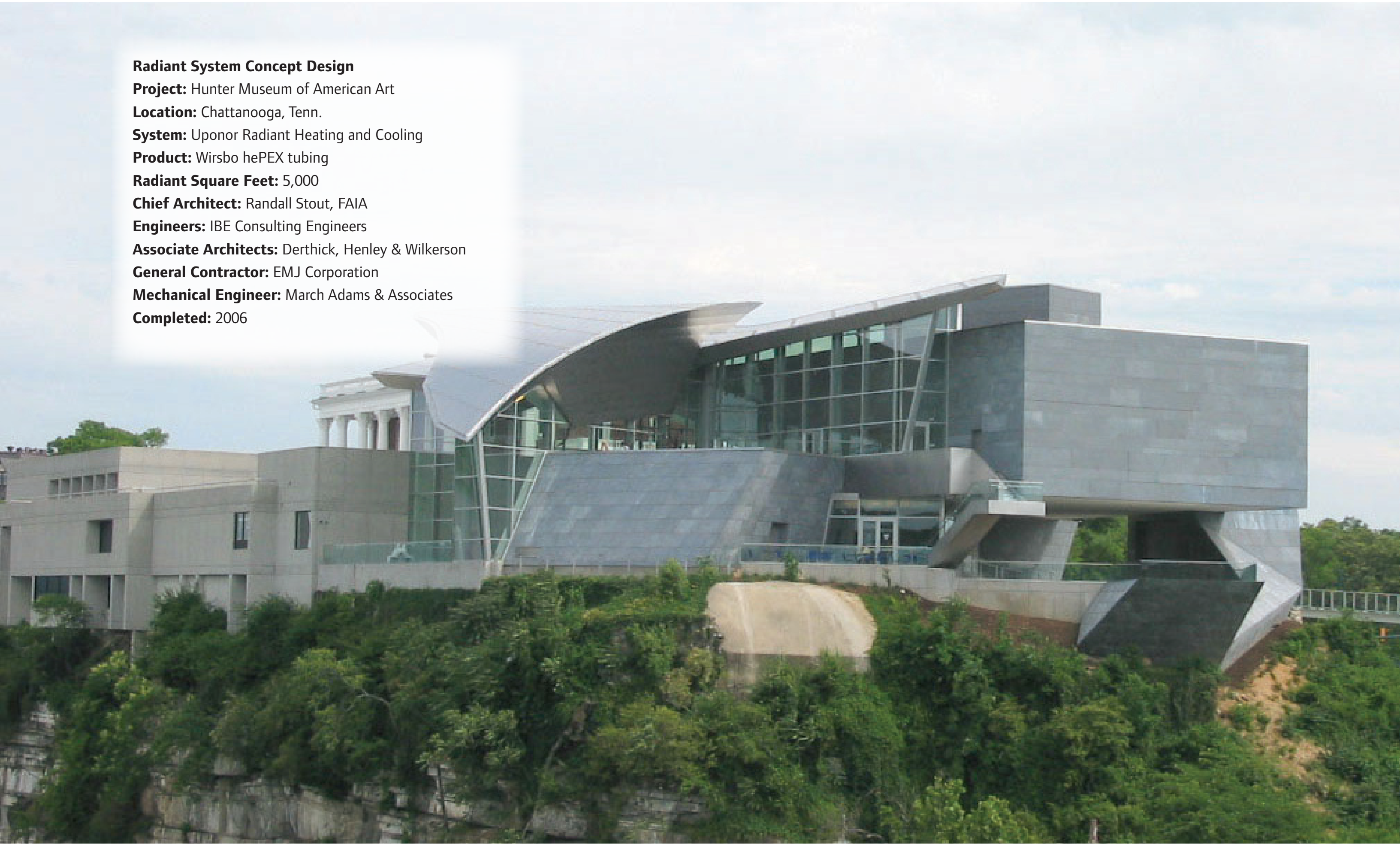
Calculating the convective heat transfer coefficient for floor cooling [Δt between 5.4°F (3 K) to 12.6 °F (7 K)] gives a range of h_{con} between 0.19 to 0.25 Btu/h•ft² °F (1.1 to 1.4 W/m² K) (ASHRAE Fundamentals) and 0.14 to 0.18 Btu/h • ft² •°F (0.8 to 1.0 W/m² K) (Recknagel/Sprenger). The formula from Recknagel/Sprenger gives only the natural convective heat exchange factor, without consideration of the space air currents.

Experimental tests have been made to measure and calculate the natural convective heat exchange coefficient (Olesen, Michel, Bonnefoi and DeCarli, 1998) with the result that a value of 0.18 Btu/h•ft²•°F (1.0 W/m² K) can be used. This result corresponds nearly with the variant calculation by using the literature formulas.

Approach: h_{con} = 0.18 Btu/h • ft² •°F (1.0 W/m² K)

The space heat exchange coefficients above are a summation of h_{con} and $h_{l,rad}$ (1.0W/m² K + 5.5W/m² K = 6.5W/m² K).

The radiation heat exchange coefficient, $h_{l,rad}$, remains fairly consistent at 0.97 Btu/h • ft² •°F (5.5 W/m² K) when surface temperature is in the range of 59°F to 95°F (15°C to 35°C). The convective heat exchange coefficient will vary, not only due to the space and air-temperature difference, but also due to air velocity (REHVA). Hence, in floor cooling, the space heat exchange coefficient can be taken with reasonable accuracy as 0.97 + 0.26 = 1.23 Btu/h • ft² •°F. This simplification is physically correct if the air temperature of the space and the surrounding surface temperature are the same. For common applications like office spaces, the surface temperatures of the exterior elements (wall, window and roof) in summer are above the air temperature, while the temperature of the other surfaces are similar to the air temperature. This means for the perimeter zones, a physical higher space heat flux can be achieved. For the interior zones, the assumption of similar temperatures of air and surrounding surfaces is nearly correct.



Radiant System Concept Design
Project: Hunter Museum of American Art
Location: Chattanooga, Tenn.
System: Uponor Radiant Heating and Cooling
Product: Wirsbo hePEX tubing
Radiant Square Feet: 5,000
Chief Architect: Randall Stout, FAIA
Engineers: IBE Consulting Engineers
Associate Architects: Derthick, Henley & Wilkerson
General Contractor: EMJ Corporation
Mechanical Engineer: March Adams & Associates
Completed: 2006

Floor Heating

Unlike the radiant heat exchange in a space which is relatively well defined, natural convective heat transfer has several influences — many functioning simultaneously on the air mass flow rate. Such factors include:

- Mean radiant temperature
- Differential pressures across the enclosure due directly to wind, thermal buoyancy or mechanical systems
- The number and activity level of the occupants
- Interstitial differential pressures due to in-space fans, personal heaters or from ventilation flow
- Room geometry and interference from furnishings and equipment
- Orientation of the radiant panel (vertical or horizontal with upward or downward transfer)
- Its operating mode (heating or cooling)
- Percentage of the floor area which is actually conditioned

For heated floors, there are several papers referencing convective heat transfer coefficients, and designers should note there are variances based on the above considerations. Olesen et. al. provide guarded guidance for combined heat transfer coefficient stating, "While the radiant heat exchange coefficient is for all cases approximately 0.97 Btu/h • ft² • °F (5.5 W/m² K), the convective heat exchange coefficient will change." In general applications, the convective heat transfer coefficient can also be taken as a nominal 0.97 Btu/h/ft² (5.5 W/m²), but detailed analysis using sophisticated modeling tools may result in values as low as 0.58 Btu/hr/ft² (3.3 W/m² K).

Approach: h_{con} = 0.97 Btu/h • ft² • °F (5.5 W/m² K)

In floor heating, the combined h_{con} and $h_{l,rad}$ is 0.97 + 0.97 = 1.94 Btu/h • ft². The space heat exchange coefficient is correct when the average unheated surface temperature (AUST) is lower than the air temperature. This is a correct assumption for heated perimeter zones due primarily to conductive losses through the enclosure. However, if the heat load is caused primarily by infiltration, then either a lower space heat exchange factor should be used, or the convective and long-wave radiant heat flux should be calculated separately as described before.

Space Heat Flux Coefficient — Floor Systems

The idealized method of calculating the heat flux between floor surface and space requires that convective and the long-wave radiant heat flux be calculated separately. The convective heat flux is calculated using the temperature difference between floor surface and air temperature, and the long-wave radiant heat exchange is calculated using the temperature difference between floor surface and the surrounding surface temperatures. For specific calculations as well as for optimization calculation, this method should be used.

The generalized method described in this manual lends itself to the simplified use of a combined heat exchange coefficient referred to as the space heat exchange coefficient (hs). Since most comfort requirements and standards are based on the operative temperature as are some heat load calculation procedures, the operative temperature will used as the reference temperature (Olesen, Michel, Bonnefoi and DeCarli, 1998, ASHRAE 55-1992, DIN 4701).

It can be written:

$q_s = h_s \cdot (t_f - t_o)$

Where

$\mathbf{h_s}$ = space heat exchange coefficient, Btu/h · ft² · °F (W/m² K)

$\mathbf{t_f}$ = floor surface temperature, °F (°C)

$\mathbf{t_o}$ = operative temperature, °F (°C)

Understanding the approximation, the space heat exchange coefficient for common applications such as radiant floors in office buildings with normal ceiling height, residential buildings, and similar buildings and spaces are as follows:

Values Reflect Both Radiant and Convective Transfer	Floor		Wall		Ceiling	
	Heating	Cooling	Heating	Cooling	Heating	Cooling
Btu/h · ft² · °F	1.94	1.23	1.40	1.40	1.06	1.94
W/m² · K	11	7	8	8	6	11

Source: REHVA, Table #4.1

Table 2-5: Nominal Surface Heat Transfer Coefficients, h_{tot}, from Various Surfaces

Flux, Radiant Floor Heating

For example, using the recommended floor surface temperature (t_f) of 84°F (28.9°C) in permanently occupied spaces and a winter indoor design temperature (t_o) of 68°F (20°C), with h_s equal to 1.94 Btu/h•ft²•°F (11 W/m_2•K), the maximal space heating capacity of the radiant floor in IP units becomes:

$$q_s = h_s \cdot (t_f - t_o)$$

$$q_s = 1.94 \cdot (84 - 68)$$

$$q_s = \frac{31 \text{ Btu}}{\text{h ft}^2}$$

In SI units,

$$q_s = \frac{97.8 \text{ W}}{\text{m}^2}$$

Within unoccupied perimeter zones, using the upper floor surface temperature limit (tf-max) of 95°F (35°C), the space heating capacity of the radiant floor in IP units becomes:

$$q_s = h_s \cdot (t_{f\text{-max}} - t_o)$$

$$q_s = 1.94 \cdot (95 - 68)$$

$$q_s = \frac{52.4 \text{ Btu}}{\text{h ft}^2}$$

In SI units,

$$q_s = 165.3 \frac{\text{W}}{\text{m}^2}$$

Flux, Radiant Floor Cooling

For example, using the recommended minimum floor surface temperature ($t_{f\text{-min}}$) of 66°F (18.9°C) and a summer indoor design temperature (t_o) of 78°F (25.6°C), with h_s equal to 1.23 Btu/h•ft²•°F (11 W/m_2•K) excluding short-wave radiation, the sensible space cooling capacity of the radiant floor in IP units becomes:

$$q_s = h_s \cdot (t_o - t_{f\text{-min}})$$

$$q_s = 1.23 \cdot (78 - 66)$$

$$q_s = \frac{14.7 \text{ Btu}}{\text{h ft}^2}$$

In SI units,

$$q_s = \frac{46.3 \text{ W}}{\text{m}^2}$$

The maximum space cooling capacity of a radiant floor cooling system can be stated as 14.7 Btu/h/ft² (46.3 W/m²) when using an operative design temperature of 78°F (25.6°C).

	Surface Temperature	
	Maximum Heating	**Minimum Cooling**
Floor occupied zone	84°F (28.9°C)	66°F (18.9°C)
Floor perimeter zone	95°F (35°C)	66°F (18.9°C)
Wall	104°F (40°C)	62°F (16.7ºC)
Ceiling	80°F (26.7°C)	62°F (16.7°C)

Table 2-6: Maximum Heating/Minimum Cooling Temperatures

Sensible Capacity Calculation

Calculate total sensible cooling capacity of a radiant-cooled floor surface with hs equal to 1.23 Btu/h•ft²•°F (11 W/m2•K) and given the following room conditions:

Room Area (A): 2,000 ft²
Surface Temperature (t_f): 66°F (18.9°C)
Operative Temperature (t_o): 76°F (24.4°C)

$$q = h_s \cdot A (t_o - t_f)$$

$$q = 1.23 \cdot 2{,}000 (76 - 66)$$

q = 24,600 Btu/h, in SI units, q = 7.21 kW

Chapter 3
Zoning, Controls and Piping

Zoning the System

As with any type of HVAC system, there are a number of factors to consider when zoning a radiant heating and cooling system. Variances in envelope load, internal load, occupancy and schedule are important considerations. The level of control desired also needs to be assessed against the cost of the associated controls.

With radiant heating and cooling systems, the control system is used to manage the slab temperature by controlling both the temperature and the flow of the water circulating in the loops. A system can have single or multiple water temperature zones, where water temperature is controlled. Each water temperature zone can have single or multiple local zones, where water flow is controlled. This system is analogous to a variable air volume (VAV) system. The chilled water control valve for the air handler is modulated to maintain a setpoint discharge air temperature; with local room thermostats controlling the VAV boxes to hold target space temperatures.

Water Temperature Zones

For each water temperature zone, a series of sensors (space temperature, operative temperature, relative humidity and slab temperature) is used to evaluate space conditions to determine the optimum target supply water temperature for the zone. A set of control valves (two-way or three-way) and pumps then modulate to maintain that ideal water temperature in the loop.

Base and Peak (Trim) Loads

In some applications for multiple occupancies and uses, it serves to use a single fluid temperature for a floor, parts of the building or the entire building; and to designate the fluid flow to the radiant system for the base sensible load. The ventilation system can then be fitted with the necessary primary coils and secondary zone coils to condition the air for control of latent loads and secondary (peak) sensible loads.

Local Zones

A building zone served by a target fluid temperature can be subdivided into multiple space zones, where room thermostats can provide additional occupancy and room use control. This is accomplished either by controlling the flow through stand-alone control valves or the flow through one or more loops connected to a zoned distribution manifold (see **Chapter 4**).

Determining the Load Requirements

As with any system design, determining the heating and cooling load requirements of the building is one of the first steps to correctly size the system. There are a variety of tools available to determine heating and cooling loads. Regardless of the method used, it is important to identify the following components that comprise the total load:

- Total heating load
- Sensible cooling load, including direct solar load
- Latent cooling load

Total Heating Load

Radiant heating systems are capable of effectively handling most heating loads. Depending on system parameters (i.e., surface flux, floor covering, tube spacing, etc.), surface temperatures, and design room temperatures, the capacity of a radiant heating system can be upward of 25 to 30 Btu/h/ft^2 (78.9 to 94.6 W/m^2) for offices and considerably higher for industrial and utility spaces.

Sensible Cooling Load

A radiant cooling system can manage all or part of the sensible cooling load. Average capacities are between 12 and 14 Btu/h/ft^2 for bare concrete installations. Loads exceeding this base capacity will require supplemental systems to handle the trim loads.

Latent Cooling Load

Since the radiant cooling is tasked exclusively to sensible loads, parallel schemes are required for latent loads. These methods are typically part of the ventilation strategy such as found in the use of dedicated outdoor air systems.

Direct Solar Load

In areas with high direct solar load, a radiant cooling system capacity can increase up to 25 to 30 Btu/h/ft^2 (78.9 to 94.6 W/m^2).

By understanding each of these components, one can properly design the radiant system to maximize its effectiveness with base building loads, while sizing the secondary system to handle latent, ventilation and trim loads.

Multiple Water Temperature Zones

If a radiant cooling system is used for the base load, while the secondary system is used to take care of the balance of load, when would multiple water temperature zones ever be necessary?

In many cases, a single water temperature zone is adequate. However, there are cases where having multiple water temperature zones is beneficial. For example, if a multistory office building has different tenants, it may make sense to have each tenant (or each floor) zoned as separate systems, each with their own water temperature. This way, tenants (or floors) can be isolated if needed. Also, if one zone has a much higher indoor relative humidity (due to process loads or occupancy), the water temperature may be limited to prevent surface condensation. If the system had a single water temperature zone, then the entire building would be limited due to this isolated condition. For more information on zoning strategies, please contact your Uponor representative.

Project: Suvarnabhumi Bangkok Airport
Location: Bangkok, Thailand
System: Uponor Radiant Cooling
Product: Wirsbo hePEX tubing
Square Feet: 6,000,000
Chief Architect: Murphy/Jahn Architects
General Contractor: Italian-Thai Development
Consulting Engineers: Flack + Kurtz, Dorsch Consult, Scott Wilson Kirkpatrick & Partners/Transsolar
Completed: 2006

Load Analysis Example 1

Estimate the radiant heating and cooling capacities of a system, given the following parameters:

Room Conditions

Room Area: 5,000 ft^2 (464.5 m^2) (bare concrete floor)

Total Cooling Load: 141,175 Btu/h (44.8 kW)

Sensible Cooling Load: 120,000 Btu/h (38.0 kW)

Latent Cooling Load: 21,175 Btu/h (6.7 kW)

Total Heating Load: 150,000 Btu/h 47.5 (kW)

Note: Direct solar load does not make up a significant portion of the total sensible cooling load.

Depending on entering air conditions, this space would require an air-based system with a nominal capacity of 12.5 tons.

Slab Conditions

Active Floor Area: 5,000 ft^2 (464.5 m^2)

Cooling Operative Temperature: 77°F (25°C)

Cooling Slab Temperature: 66°F (18.9°C)

Heating Operative Temperature: 68°F (20°C)

Heating Slab Temperature: 84°F (28.9°C)

Based on These Parameters

Sensible Cooling Capacity (IP Units)

$\mathbf{q_c} = h_s \cdot A\,(t_o - t_f)$

$\mathbf{q_c} = 1.23$ Btu/h · ft^2 · °F x 5,000 ft^2 (77°F – 66°F)

$\mathbf{q_c} = 67{,}650$ Btu/h, in SI units 19.82 kW

Heating Capacity (IP Units)

$\mathbf{q_h} = h_s \cdot A\,(t_f - t_o)$

$\mathbf{q_h} = 1.94$ Btu/h · ft^2 · °F x 5,000 ft^2 (84°F – 68°F)

$\mathbf{q_h} = 155{,}200$ Btu/h, in SI units 45.49 kW

Note: while the radiant floor can adequately manage the total heating load, a supplemental system will be required to handle the balance of the cooling loads.

Sensible Load: 120,000 Btu/h (38.0 kW)

Radiant Floor Sensible Capacity: 67,650 Btu/h (21.4 kW)

Supplemental System Capacity: 120,000 – 67,650 Btu/h = 52,350 Btu/h (16.6 kW)

Therefore, the supplemental system will be required to provide

Total Cooling Load: 73,525 Btu/h (23.3 kW)

Sensible Cooling Load: 52,350 Btu/h (16.6 kW)

Latent Cooling Load: 21,175 Btu/h (6.7 kW)

Total Heating Load: 0 Btu/h (0 kW)

Depending on entering air conditions, this space would require a supplemental air-based system with a nominal capacity of 7.5 tons.

Control System

The control system is a critical component of any high-efficiency building system. The radiant control system continuously monitors indoor temperature and relative humidity to determine the optimal target supply water temperature for maximizing the system's performance while ensuring that condensation never forms on the slab. Inadequate control strategies often lead to sub-par performance, poor response times, energy inefficiencies, inconsistent operation and condensation.

Over the years there have been many different control solutions for embedded systems; most have been for heating. The advent of cooling systems has brought different approaches. The control systems described in this section can be used for both heating and cooling.

The control system should be designed to make efficient use of energy while avoiding overheating or overcooling the building. This should include keeping distribution losses as low as possible, e.g. reducing flow temperature when normal comfort temperature level is not required.

To maintain the stable thermal environment, the control system is required to manage the heat balance between enclosures losses/gain and the HVAC system under transient occupant and outdoor climate conditions.

Without a doubt, the performance of the enclosure plays a major role in stabilizing the inherent indoor climate oscillations due to transitory conditions. When the building can solve a significant portion of the heating and cooling load it, enables the radiant-based HVAC system to work within a considerably more stable indoor environment, especially during the spring and fall. Cooled surfaces further stabilize the indoor climate by absorbing uncontrolled and less predictable short-wave and long-wave energy while shading and enclosure strategies can manage periodic and predicable solar radiation.

LEED Rating: Platinum
Project: San Jose Civic Center
Location: San Jose, Calif.
System: Uponor Radiant Heating and Cooling
Product: Wirsbo hePEX tubing
Square Feet: 550,000
Architects: Richard Meier & Partners and Steinberg Architects
Engineers: Englekirk & Sabol Consulting
General Contractor: Turner/Devcon Joint Venture
Completed: 2005

Principally, the control strategy depends on the design characteristics, such as building envelope, thermal inertia, the system response times and others. The heating control modes are based on three system levels:

- Central control, where the heat supplied to the whole building is controlled by a central system
- Zone control, where the heat supplied to a zone normally consisting of several spaces (rooms) is controlled
- Local (individual) control, where the heat supplied to a heated space is controlled

The control system classification is based on performance level:

- Manual — the heat supply to the heated space is only controlled by a manually operated device
- Automatic — a suitable system or device automatically controls heat to the heated spaces
- Timing function — heat supplied to heated space is shut off or reduced during scheduled periods, e.g. night setback
- Advanced timing function — heat supplied to the heated space is shut off or reduced during scheduled periods, e.g. daytime with more expensive electricity tariff. Re-starting of the heat supply is optimized based on various considerations, including reduction of energy use.

Decades ago, most of the controls were manual, i.e. the user could regulate a water temperature or a water flow rate by manually adjusting a valve or, even simpler, the system could be turned on or shut off. Today, automatic controls are used everywhere and have in the last decade developed significantly (e.g., fuzzy logic, wireless data transmission, introduction of protocols for data communication, etc.).

For a floor heating and cooling system, the control is normally split up in a central control and an individual room control. The central control will evaluate the outside climate (based on the heating curve, which is influenced by building mass, heat loss, and differences in heat required by the individual rooms) and control the supply water temperature to the floor system. The room control will then control the water flow rate or water temperature individually for each room, according to the setpoint selected by the user.

Control Strategies

Central Control (Heating)

Instead of controlling the supply water temperature it is recommended to control the average water temperature (mean value of supply and return water temperature) according to outside and/or indoor temperatures. This is more directly related to the heat flux into the space. If during the heating period, for example, the internal space temperature rises due to occupant, lighting and equipment loads, the heat output from the floor system will decrease and the return temperature will increase. If the central control is controlling the average water temperature, the supply temperature will automatically decrease due to the increase in return temperature. This will result in a faster and more accurate control of the heat input to the space and will provide better energy performance than controlling the supply water temperature. If the heating system is operated intermittently (night and/or weekend set-back) the central control is also important for providing adequate water temperatures (boost effect) during the pre-heat period in the morning (additional 10 to 15%; of course, the absolute heat requirement compared to no night set-back will be lower). The energy savings by night set-back in residential buildings are, however, relatively low due to the high thermal insulation standard in newer structures.

Zone or Local Control

The installation of individual room temperature controls is recommended to improve comfort and potential energy savings. It is also essential for the thermal comfort of the occupants that they have individual control adjustment of the room temperature setpoint from room to room.

The influence of the individual room control strategy for floor heating and radiators has shown a 15 to 30% energy savings by using an individual room control compared to central control only. Also, a study on the effect of night set-back and boost by re-heating in the morning showed an advantage for a boost heating, i.e. the water temperature is increased above the temperature corresponding to the heating curve during the beginning of the pre-heat period in the morning. This reduces the pre-heat time and makes a longer set-back period possible.

Control of Thermo Active Building Systems (TABS)

Thermo Active Building Systems (TABS) engage the entire concrete mass as a thermal battery using chilled or heated water to charge the system. Specifically for TABS, individual room control using the floor is not practical. However, a zoning strategy such as northside/southside or compass quadrants is suggested for cases where supply water temperature, average water temperature or the flow rate may differ from zone to zone.

Relatively small temperature differences between the heated or cooled surface and the space are typical for TABS. This matter results in a significant degree of self control. In specific cases with low heating/cooling loads, a concrete slab can be controlled at a constant core (water) temperature year round. If, for example, the core is kept at 72°F (22.2°C), then the slab will be space heating when room temperatures are below 72°F (22.2°C) and space cooling when room temperatures are above 72°F (22.2°C).

Condensation Control

An effective HVAC system must provide humidity management, including dew point control for microbial control over pathogens and allergens. This promotes respiratory and thermal comfort for occupants as well as dimensional stability in hygroscopic materials like wood.

When humidity is managed to enhance the indoor climate for health of the environment and, by association, health of the occupants, and for the dimensional stability of architectural materials, it enables radiant cooling systems to operate at their peak capacity within acceptable thermal comfort parameters.

Cooling control systems should set lower limits for supply fluid temperature and limit surface temperatures for comfort to 62°F (16.7°C) and 66°F (18.9°C) for walls or ceilings and floors, respectively (ASHRAE Standard 55-2010).

The indoor operative temperature should also be controlled so the standard required temperature for Class A systems (as per ISO 7730) corresponding to 10% PPD is maintained within the range specified by ASHRAE Standard 55-2010. This can be achieved with control I/O logic using if/then statements on feedback from space conditions; including instruction to terminate fluid flow to a cooled surface until space humidity and surface temperatures return to acceptable conditions.

Dew Point Control

The surface temperature at any point on the floor is location dependant on the fin efficiency of the slab. Fin efficiency being the thermal characteristics due to the log mean temperature differential (LMTD), tube diameter, spacing and depth, and conductivities of the materials in the slab. The dew point calculation and location for surface sensor placement should be where the coldest temperature ought to exist for acceptable control.

For radiant cooled, naturally ventilated spaces, bin-based climate data must be used for a thorough assessment of potential space conditions imposed on the conditioned surface.

Interior Zones

It is likely the interior zones of larger spaces may only need cooling. In this case, the EWT can be fixed and the flow varied through control of valves or circulators based on room temperature set-points.

During unoccupied times, there is no benefit in pulling the slab temperature down lower than what is necessary to compensate for the next occupied load. Control strategies should consider terminating flow to the slab when the core temperature of the slab has been reached.

Perimeter Zones

Perimeter zones may be equipped with a radiant floor system that provides both heating and cooling to the space. If the radiant floor is the only heating system, the radiant floor must be designed for the entire heating load. The EWT may be controlled by a weather-compensation control combined with individual occupant controlled zones. In cooling mode, the EWT should be kept constant. In most cases, the radiant floor cooling system for a perimeter zone is combined with either a mechanical ventilation or a natural ventilation system to provide the remaining cooling capacity and the necessary fresh air and to reduce the latent loads. It is important to avoid the cooling of a heated floor slab or the reverse situation during normal weather situations.

The following strategy may be used: During periods where heating and cooling is necessary during the same day, the radiant floor should provide only heating to the space. The space cooling should be provided by the parallel system (may be through natural ventilation). This can be designed by using a delay element of at least one day to switch the radiant floor system between heating and cooling mode. Outside temperatures are usually not as high during periods that require heating and cooling during the same day. So the parallel air ventilation system may be used in economizer mode. During periods where usually no heating is necessary, the floor is used only for cooling as the first cooling system in a same way as in the interior zones.

Controlling the Water Temperature Using Indoor Adaptive Reset

A combination radiant heating and cooling system can be effectively controlled using an indoor adaptive reset strategy. This strategy determines the ideal target water temperature by assessing the space conditions (temperature, operative temperature and relative humidity), the water temperature (supply and return) and the slab temperature. The control system then continually adjusts the target water temperature based on the rate at which the space temperature changes to maximize the effectiveness of the slab while ensuring that the surface temperature never reaches dew point or gets too cold or too hot.

Control Integration with the Air-side System

The radiant cooling slab is able to effectively handle all or a portion of the building's sensible load. A supplemental system — such as an air handling unit or dedicated outside air system (DOAS) — is assigned to handle the balance of the sensible load, the latent load and the ventilation load. It is important to control these systems together so that they do not function in opposite modes of operation. A common strategy is to operate the radiant system as an offset to room setpoint, using the radiant slab to handle the base sensible load and relying on the air-side system to manage the trim loads.

Using this two-stage approach, the radiant system setpoint could be set at 76˚F (24.4°C), while the air-side system setpoint is set at 78˚F (25.6°C). If the space temperature exceeds 76˚F (24.4°C), the radiant loop starts flowing chilled water through the embedded tubing to control the slab and space temperatures. As the load increases, the flow rate and supply water temperature would adjust accordingly until the system is operating at maximum capacity. If the space temperature continues to increase and exceeds 78˚F (25.6°C), the air-side system comes on to handle the rest of the load.

Piping Strategy for Mixed Water Temperature Control

For each water temperature zone, there are a variety of piping strategies that can be used to deliver the target supply water temperature for combination radiant floor heating and cooling applications. It is important to note that with each of these strategies, the assemblies shown in the diagrams below are necessary for each mixed water temperature, not necessarily for each local zone or manifold. The manifold shown in the diagram can represent a single or multiple manifolds in the system.

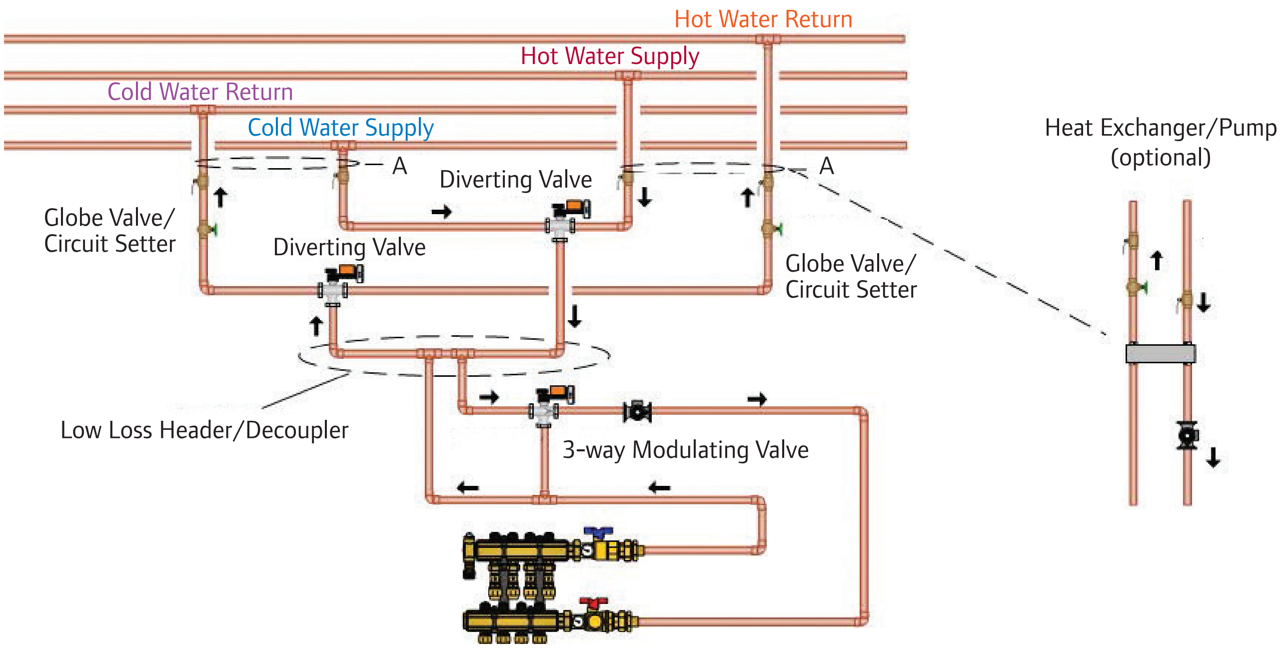


Figure 3-1: Mixing with Heating/Cooling Switchover

Heating/Cooling Switchover with Diverting Valves

This arrangement requires the following components:

- Two (2) three-way diverting valves
- One (1) three-way modulating mixing valve
- One (1) radiant system circulator

Heat exchangers can be installed if the system pressure is high or to ensure that the heating hot water and chilled water sources do not mix.

With this arrangement, the supply water temperature is controlled as follows:

1. Upon a call for cooling, the supply and return diverting valves open to the chilled water ports.
2. The radiant circulator starts.
3. The control system determines the optimum target water temperature based on space temperature, indoor relative humidity, calculated operative temperature and slab temperature.
4. The control system controls the three-way modulating mixing valve to the target loop temperature.
5. Upon a call for heating, the cold diverting valves are closed. A timer is engaged to delay the changeover. Once the delay period has ended, or the slab temperature has drifted up to a predetermined base temperature, the supply and return diverting valves are opened to the heating hot water ports. Target water temperature is based on space temperature, outdoor temperature, calculated operative temperature and slab temperature.

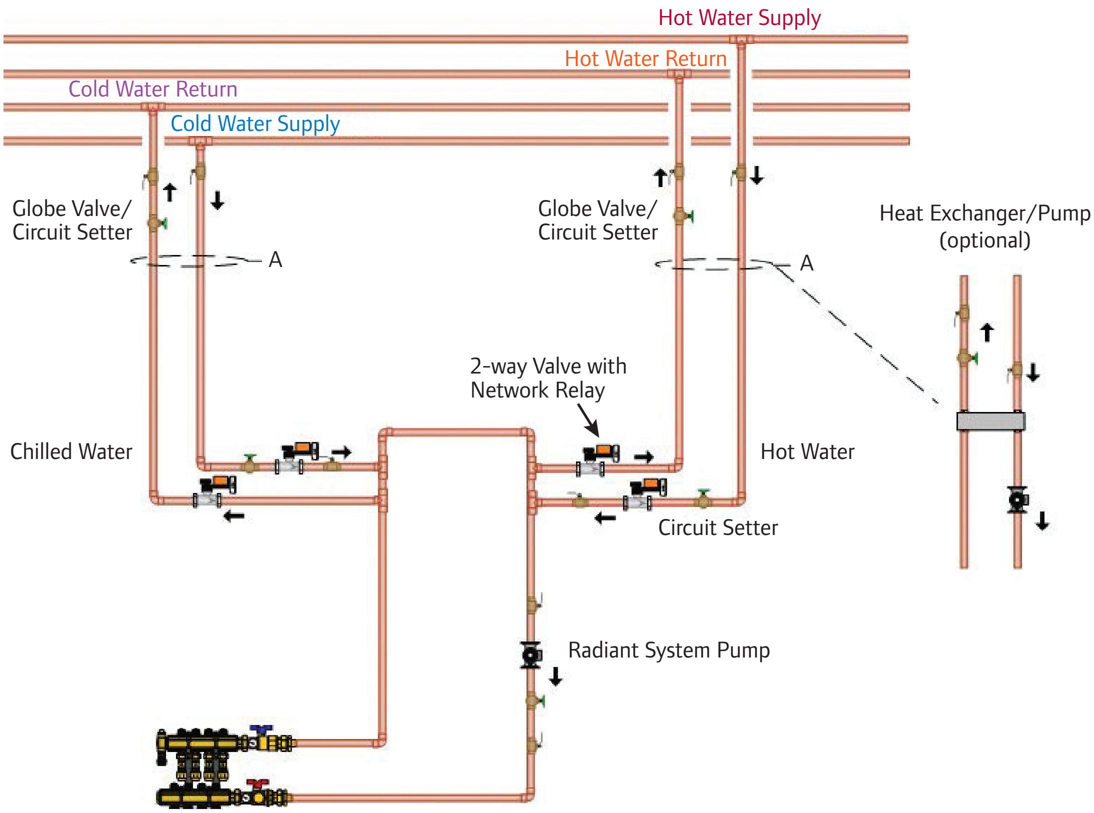


Figure 3-2: Local Secondary Injection System Using Two-way Valves

Four-pipe Injection System

This arrangement requires the following components:

- Two (2) two-way modulating control valves [select characteristics (linear or logarithmic) based on good control valve practices]
- Two (2) two-way solenoid valves or on/off zone valves with <45 second closure
- One (1) radiant system circulator

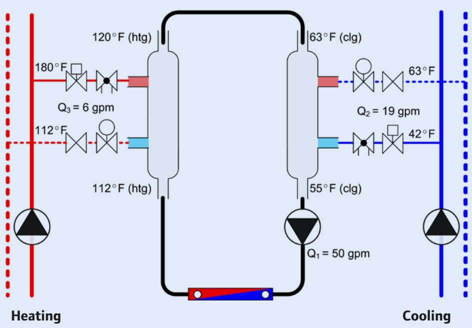
Heat exchangers can be installed if the system pressure is high or to ensure that the heating hot water and chilled water sources do not mix.

With this arrangement, the supply water temperature is controlled as follows:

1. Upon a call for cooling, the control system determines the optimum target water temperature based on space temperature, indoor relative humidity, calculated operative temperature and slab temperature.
2. The radiant circulator is then ramped up or turned on.
3. The chilled water solenoid valve fully opens while the modulating control valve is regulated to inject sufficient chilled water into the radiant system to maintain target water temperatures. Upon a call for heating, the cooling solenoid valve and associated modulating control valve are allowed to close. A timer is engaged to delay the changeover. Once the delay period has ended, or the slab temperature has drifted down to the base temperature, the heating water solenoid valve fully opens while its associated modulating control valve is regulated to inject sufficient heated water into the radiant system to maintain target water temperature.

Temperature Differences and Flow Rates

Using the layout shown in **Figure 3-3**, we can first start by dimensioning the flow through the embedded system. The radiant circulator flow is generally determined for cooling as this is more critical. Typical supply and return temperatures through the floor are 55°F (12.8°C) and 63°F (17.2°C) so from these values and the load, the flow rate can be determined. The flow rate through the embedded system is constant volume. Variable volume systems can also be used.



Flow in radiant system

Q_1 = q, Btu/hr / ((500 x (t_1 - t_2))

Q_1 = 200,000 Btu/hr / ((500 x (63°F - 55°F))

Q_1 = 50 gpm

Cooling injection flow

Q_2 = q, Btu/hr / ((500 x (t_1 - t_2))

Q_2 = 200,000 Btu/hr / ((500 x (63°F - 42°F))

Q_2 = 19 gpm

Heating injection flow

Q_3 = q, Btu/hr / ((500 x (t_1 - t_2))

Q_3 = 200,000 Btu/hr / ((500 x (180°F - 112°F))

Q_3 = 6 gpm

Figure 3-3: Heating and Cooling Connections to a Radiant Floor Loop

To illustrate this further we will assume the embedded system will have a cooling capacity of 200,000 Btu/hr (63.4 kW).

Assuming a supply water temperature of 55°F (12.8°C) and a return water temperature of 63°F (17.2°C), the flow rate through the embedded system will be 50 gpm (3.15 L/s).

This is the constant volume flow through the embedded system. There are both heating and cooling connections to the control loop.

Assuming the floor is in full design cooling capacity, then the return water from the embedded system will be 63°F (17.2°C) and this will have to be cooled to 55°F (12.8°C) to provide the required cooling from the embedded system. The mixing pipe is connected to a chilled water supply and return. Again we can assume that the chilled water supply temperature to the mixing pipe is 42°F (5.6°C). The amount of cooling required from the primary chilled water is the same as the cooling output from the embedded system. The temperature differential through the mixing pipe is a 63°F (17.2°C) return from the loop and a 42°F (5.6°C) supply so the Delta T is 21°F (63°F - 42°F).

The flow rate through the primary chilled water connection to the mixing pipe is 19 gpm (1.2 L/s).

By keeping the primary flow rate lower than the radiant flow rate, the primary connections are also smaller. This enables the two-way control valve in the chilled water connection to have an improved Cvs (kvs) value and authority.

Another reason for this design option is that the primary chilled water flow rate is much lower than the radiant flow rate. This limits the amount of 42°F (5.6°C) water required for the floor.

For heating we have a very similar situation. The flow rate through the loop remains the same constant flow rate. The maximum surface temperature of an embedded system for heating is 84°F (28.9°C). Typically the average heating temperatures in the circuit are 105°F (40.6°C) +/- 23°F (11°C), but the maximum heating water primary supply to the mixing pipe could be 180°F (82.2°C). The flow rate to the mixing pipe would then be 6 gpm (0.4 L/s), which is about one-tenth of the radiant flow rate. This keeps the primary connections smaller than the circulating loop, which in turn keeps the control valve to a small size, thus improving the Cvs (kvs) and the valve authorities.

In practice, the supply temperature (t_s) and return temperature (t_r) are established from the average temperature (t_{avg}). This comes from the design of the radiant panel based on its fin efficiency which includes tube diameter, spacing, depth, and conductivities of the slab and various boundary layers.

$t_s = t_{avg} + \Delta t/2$ and $t_r = t_{avg} - \Delta t/2$

Where, the differential temperature (Δt) is a selected value based on good practice. Normally for reversible floors, less than a nominal 7°F (4°C) is used. For heating-only floors, this number can be considerably higher [greater than 15°F (8°C)]. The Δt, as well as the loop depth and pattern, has an influence on the surface temperature efficacy and should be selected carefully for floors requiring high-quality surface temperatures.

Constant Flow, Variable Temperature

For illustrating this control concept, the water supply temperature to the floor varies, and the floor surface temperature is maintained at 68°F (20°C). As the cooling output to the space increases to maintain space setpoint temperature, the water flow through the floor is constant. For this control option, the supply water temperature to the floor varies from 61°F (16.1°C) to a minimum of 52°F (11.1°C) which is proportional to the cooling output from the floor. As the supply water temperature decreases to provide the cooling output from the floor, the leaving water temperature from the floor decreases to a minimum of 63°F (17.2°C).

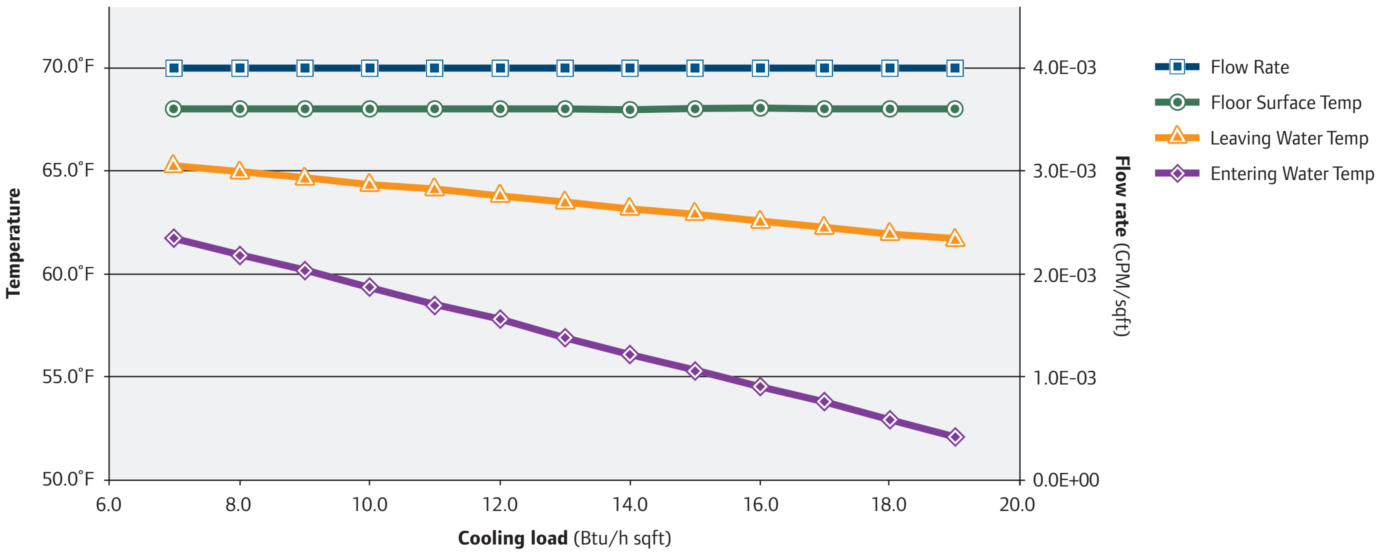


Figure 3-4: Characteristics of a Constant Flow, Variable Temperature Control

Variable Flow, Constant Temperature

For illustrating this control concept, the entering water supply temperature to the floor is kept at a constant 54°F (12.2°C), and the floor surface temperature is maintained at 68°F (20°C). As the cooling output to the space increases to maintain space setpoint temperature, the water flow through the floor is increased. For this control option, the water flow rate through the floor is proportional to the cooling output from the floor. As the water flow rate increases to provide the cooling output from the floor, the leaving water temperature from the floor decreases to a minimum of 61°F (16.1°C).

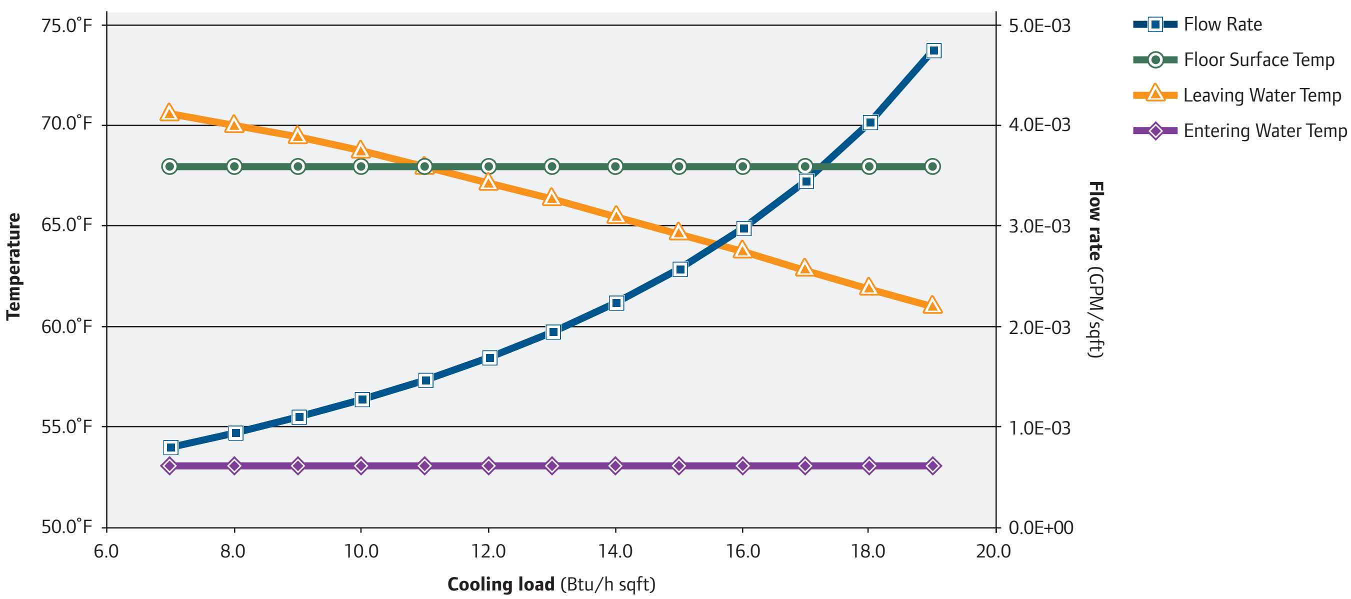


Figure 3-5: Characteristics of a Variable Flow, Constant Temperature Control

Constant Flow, Constant Temperature

For this control concept, the water supply temperature to the floor is kept at a constant 55°F (12.8°C), and the floor surface temperature varies from 62°F (16.7°C) to 71°F (21.7°C). As the cooling output to the space increases to maintain space setpoint temperature, the water flow through the floor is constant. For this control option, the leaving water temperature from the floor is proportional to the cooling output from the floor. As the cooling output increases to provide the cooling output from the floor, surface temperature is also increased.

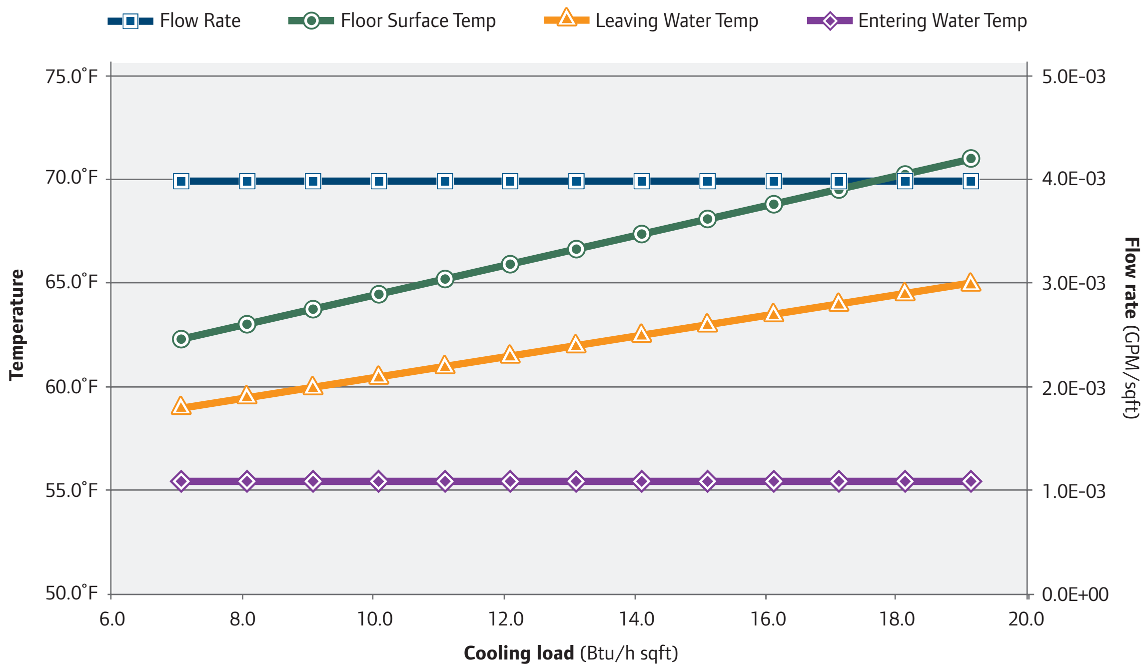


Figure 3-6: Characteristics of a Constant Flow, Constant Temperature Control

Note: From these three alternatives, the constant flow, variable temperature concept provides the smoothest control.

Local Zone Control

As described previously, it is possible to have local zone control within each mixed water temperature zone. While the below piping arrangements will dictate target water temperature, zone valves can add local control by controlling water flow. Depending on the size of the local zone, zone valves can be added to control a group of manifolds or a single manifold. Individual loops can be controlled with thermal actuators mounted directly on the manifold. The valves and actuators are controlled by space temperature sensors. In special cases where humidity may be a concern, local relative humidity sensors may also be used.

Figure 3-7: Uponor Motorized Valve Actuator and Zone Valve

Figure 3-8: Uponor Thermal Valve Actuator

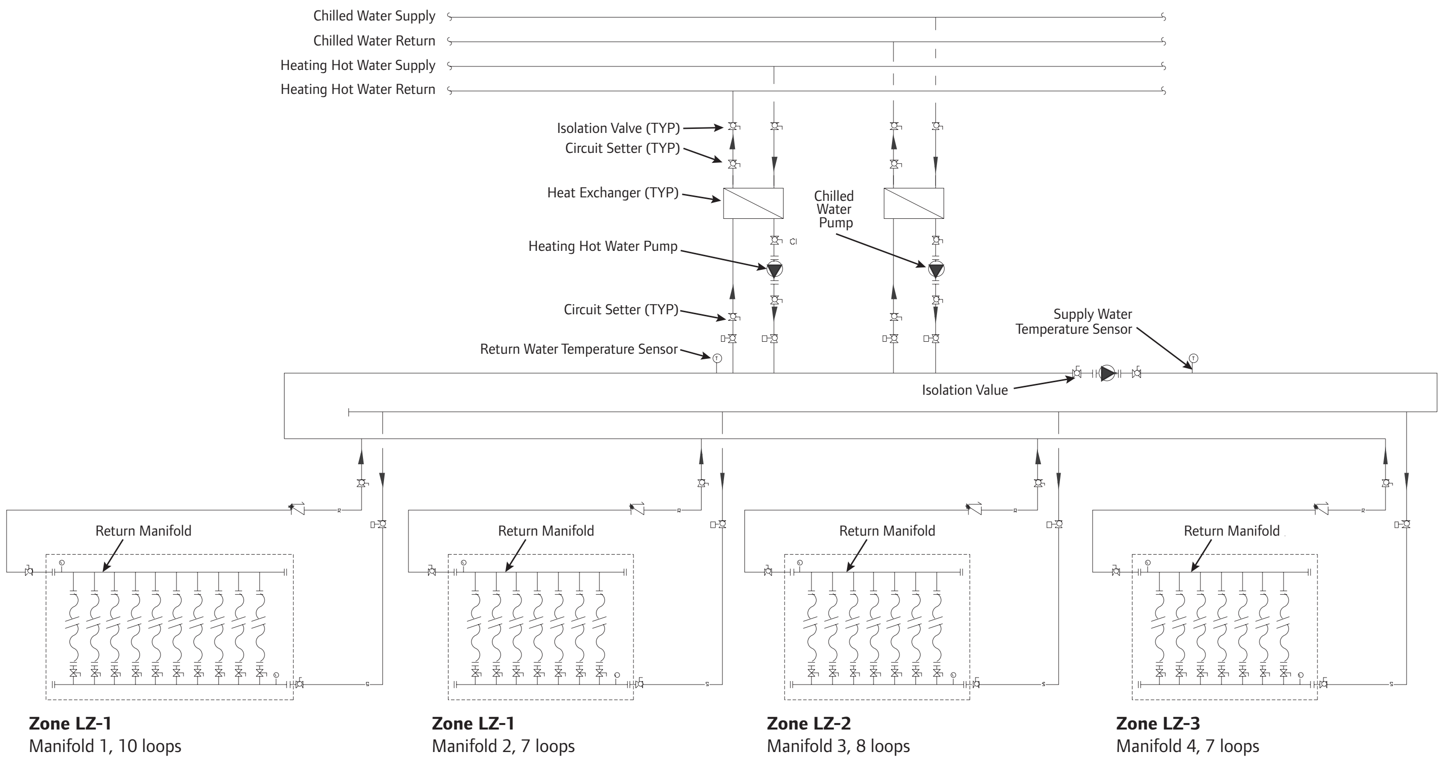


Figure 3-9: Piping Diagram Showing Four Manifolds with Zone Valves in One Water Temperature Zone

Mixing or Injection Valves

Depending on the specific design requirements, a radiant heating/cooling system can have one or more operating temperatures or "mixed water temperatures." For each mixed water temperature, valves will be needed to reach the target supply water temperature using the main chilled water and heating hot water supply temperatures.

Temperature and Humidity Sensors

The following are temperature and humidity sensors which are required to effectively manage the space and radiant surface conditions.

- Indoor air temperature sensor
- Outside air temperature sensor
- Supply and return water temperature
- Slab temperature sensors
- Indoor relative humidity sensor

Room Thermostats/Sensors

Wireless and wired thermostats/sensors are available as standard offerings. Regardless of the choice of temperature and humidity sensing for feedback or feed forward, the receiving controller will process "if/then" logic to control the flow entering the occupied zone via the water temperature zone by regulating valves and circulators.

The sensing should always take place to best represent the controlled element without interference from other aggravating influences. For example, outdoor sensors for heating controls should best represent the outdoor dry bulb temperature without interference from solar gains which would incorrectly feed forward the wrong signal to the controller. Floor surface sensors should be within the near surface of the floor to represent what the occupants sense. Sensing for dew point with textile flooring should be done under the floor covering instead of on top.

Additionally, space temperature control is about providing a reading to the HVAC control system which best represents what the occupants are experiencing. Therefore, the sensing should take place in the occupied area without influences from other heat sources.

Follow good practice, such as keeping wall-mounted sensors off exterior walls. Instead, place them on interior walls at a representative height for seated or standing work, and away from high-intensity heat sources, such as lamps and office equipment.

For wireless operative controls with specially designed radiant sensors, locate the control in such a place which can take advantage of both the air and surface temperature influences as well as direct solar gains. Ideally the best placement would be near the occupant and in such a position to sense what the occupant is thermally sensing.

Peak Shaving with TABS

Incorporating TABS can exploit the high thermal inertia of the slab to perform peak shaving. Peak shaving can reduce the peak in the required cooling power, making it possible to efficiently cool the building during unoccupied periods, reducing energy consumption and using lower off-peak electricity rates. This can also reduce the size of heating/cooling system components, including the chiller.

TABS may be used both with natural and mechanical ventilation (depending on weather conditions). Mechanical ventilation with dehumidifying may be required depending on external climate and indoor humidity production. In the example in **Figure 3-10**, the required peak cooling power needed for dehumidifying the air during day time is sufficient to cool the slab during night time.

When designing TABS, the engineer needs to determine whether or not the system capacity at a given operating water temperature is sufficient to maintain the room temperature within a given comfort range. The indoor temperature will change moderately during the day. The goal is to maintain internal conditions within the range of comfort, i.e. –0.5 < PMV < 0.5, according to ISO 7730 and ASHRAE Standard 55-2010. The engineer also needs to determine the heat flow on the water side to properly size the heat distribution system and the chiller/boiler.

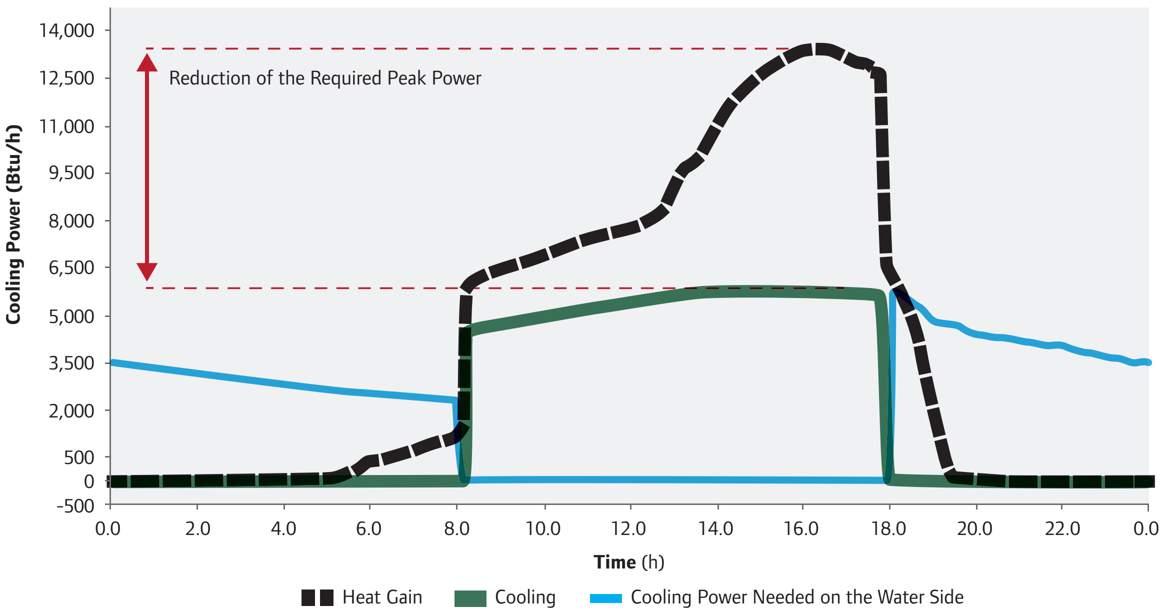


Figure 3-10: Example of Peak Shaving Effect

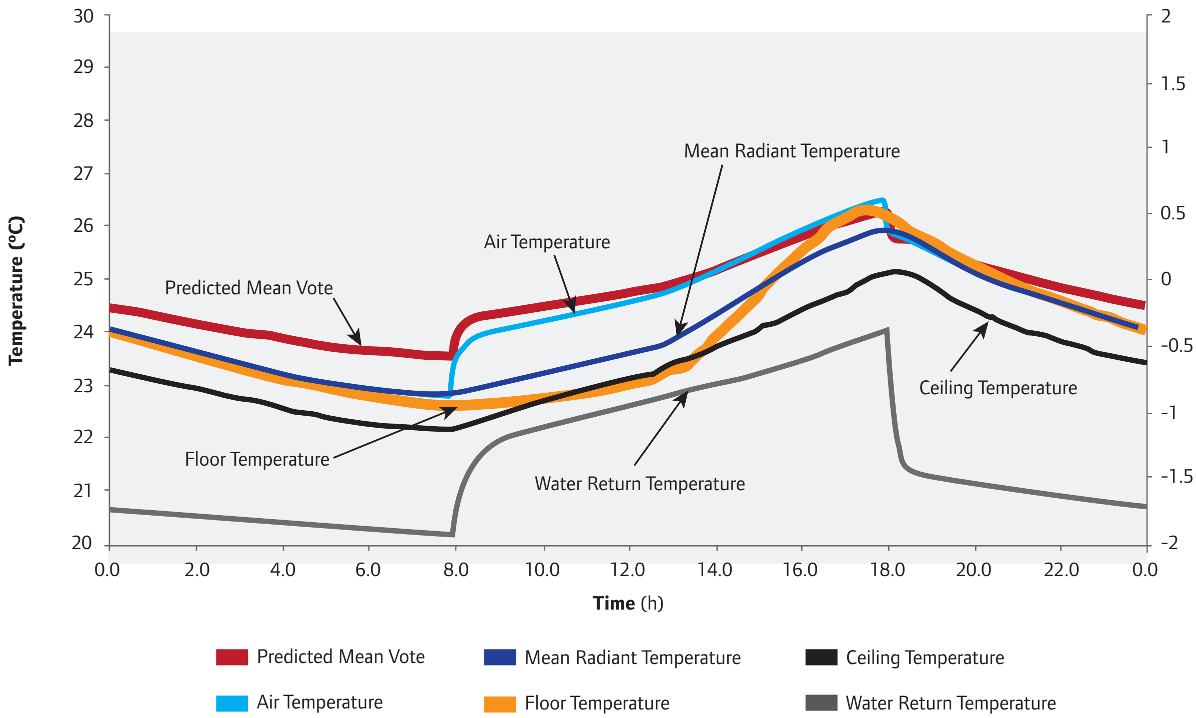


Figure 3-11: Example of Temperature Profiles and PMV Values vs. Time

Detailed building system calculation models have been developed which evaluate the heat exchanges under unsteady state conditions in a single room, the thermal and hygrometric balance of the room air, prediction of comfort conditions, condensation on surfaces, availability of control strategies and the calculation of the incoming solar radiation. The use of such detailed calculation models is, however, limited due to the high amount of time needed for the simulations. A simplified approach, as shown here, can be used to simulate thermo active building systems.

The diagrams in **Figures 3-12 and 3-13** show an example of the relation between internal heat gains, water supply temperature, heat transfer on the room side, hours of operation and heat transfer on the water side. The diagrams refer to a concrete slab with raised floor (R = 2.6, RSI = 0.46) and an allowed room temperature range of 70°F (21.1°C) to 78°F (25.6°C).

The upper diagram shows on the Y-axis the maximum permissible total heat gain in space (internal heat gains plus solar gains) [Btu/h/ft^2], and on the X-axis the required water supply temperature. The lines in the diagram correspond to different operation periods (8 hours, 12 hours, 16 hours and 24 hours) and different maximum amounts of energy supplied per day [Btu/(ft^2 • d)].

The lower diagram shows the cooling power [Btu/h/ft^2] required on the water side (to dimension the chiller) for thermo active slabs as a function of supply water temperature and operation time. Further, the diagram shows the amount of energy rejected per day [Btu/(ft^2•d)].

The example shows that a system with a maximum internal heat gain of 12 Btu/h/ft^2 (37.9 W/m^2) and 8-hour operation requires a supply water temperature of 64.8°F (18.2°C). If, instead, the system is in operation for 12 hours, the system requires a supply water temperature of 66.7°F (19.3°C). In total, the amount of energy rejected from the room is approximately 106.2 Btu/ft^2 (1.2 MJ/m^2) per day. In the same conditions, the required cooling power on the water side is 11.7 Btu/h/ft^2 (36.9 W/m^2) (for 8-hour operation) and 7.9 Btu/h/ft^2 (24.9 W/m^2) (for 12-hour operation), respectively. Thus, by 12-hour operation, the chiller can be much smaller.

For more information on how to simulate TABS, contact your Uponor representative.

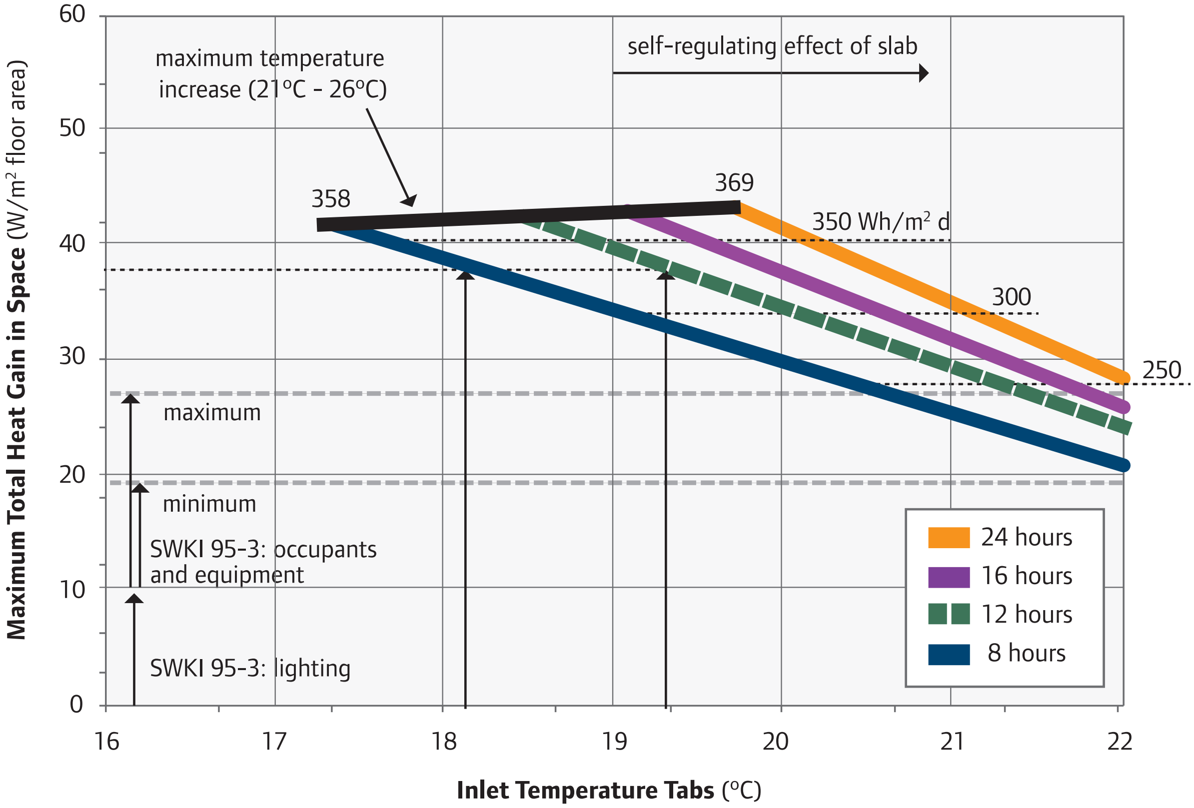


Figure 3-12: Maximum Total Heat Gain in Space

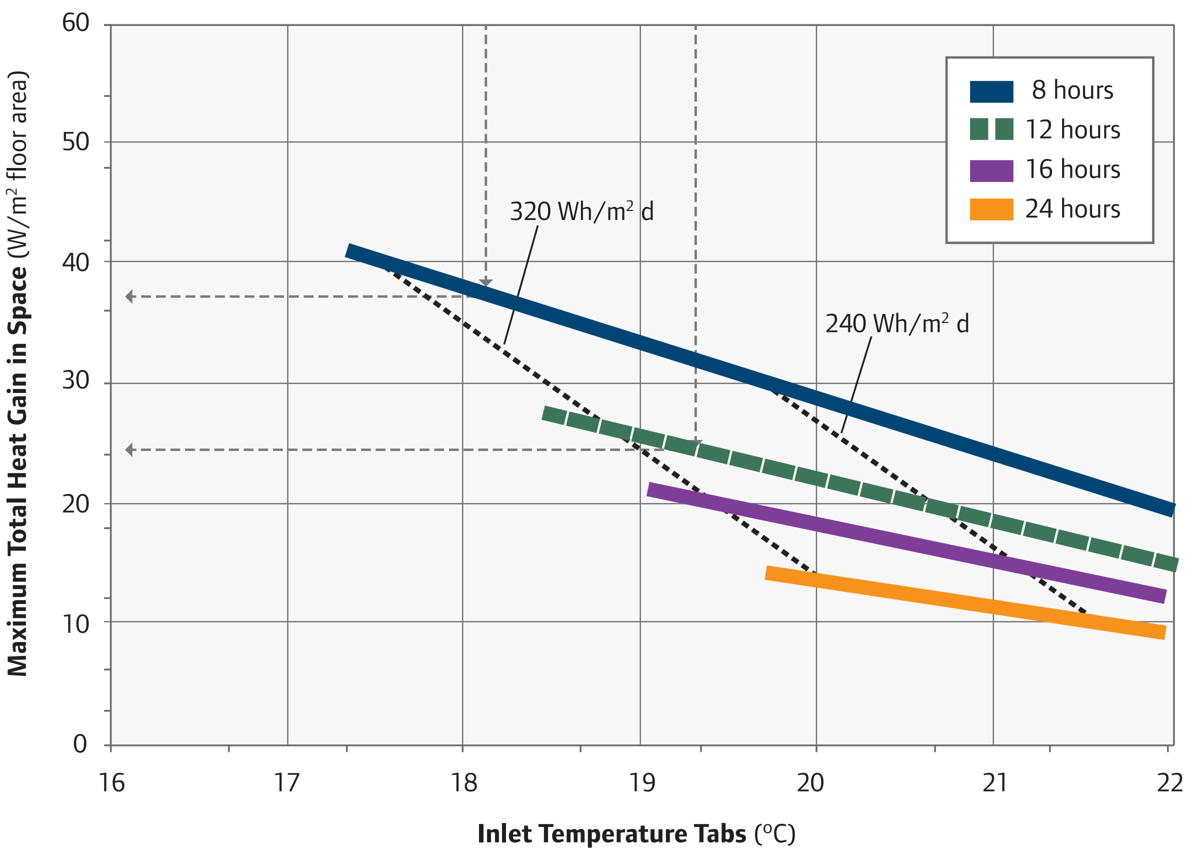


Figure 3-13: Required Cooling Power on the Water Side

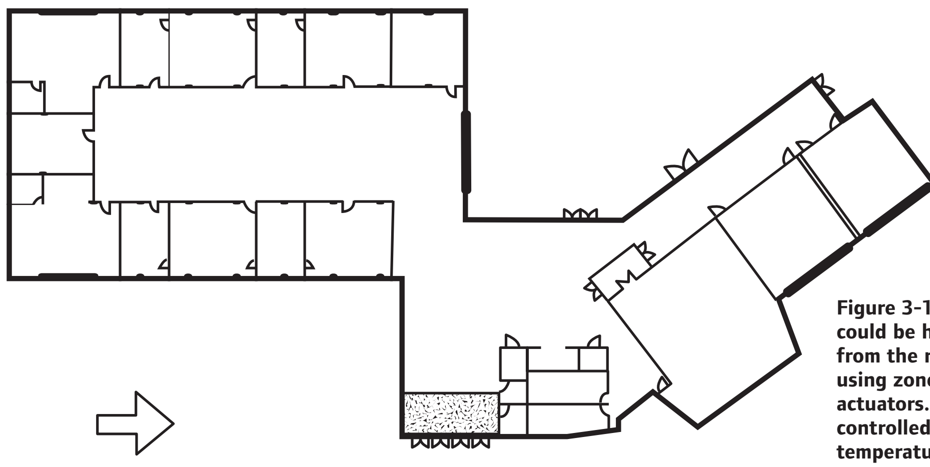


Figure 3-14: An entry area could be hydronically isolated from the rest of the system by using zone valves or thermal actuators. This zone could be controlled so the supply water temperature is reset based on outdoor relative humidity.

Strategies for Dealing with Common Control Issues

The control strategy described above lays the basic framework for effectively controlling the radiant heating and cooling slab. It also points out the flexibility in addressing atypical situations.

High Humidity Isolation

It may be necessary on some projects in some climates to isolate atypical spaces from the base load cooling system due to an inherent localized rise in humidity. Consider high-volume vestibules, water parks, kitchens, laundry or other rooms that may experience an extraordinary control condition. In these cases, it is prudent to place these types of zones on a separate space control which would limit the fluid temperature and/or flow based on feedback or feed forward sensing of temperature and humidity.

Rapid Swings in Internal Loads

The optimum conditions for an occupied building are where the enclosure has been designed around the stable and self-regulating characteristics of the radiant cooling and heating system. Through the radiative and convective principles of heat transfer to/from a conditioned slab, a rise in space temperature will suppress heat transfer; likewise a drop in space temperature will promote heat transfer. The greater the performance of the enclosure, the more stable this phenomena occurs. However, in spaces that may see rapid changes to a controlled condition, it is best to respond with fast-acting systems and use the radiant system for the base load. Take for example a lecture hall, museum or hotel. In such cases, occupancy can move from vacant to fully occupied in a very short period of time. By having a parallel scheme such as a packaged terminal air conditioner (PTAC) or dedicated outdoor air system (DOAS), aggressive fluctuations in latent and sensible loads can be effectively managed while allowing the efficient and stable radiant system to operate in the background.

Condensation Control

As noted previously, moisture is necessarily managed for the health of the environment, the respiratory and thermal comfort of the occupants and for the dimensional stability of hygroscopic materials.

This removes the need for monitoring conditions on or in the supply to the cooled surface. Surfaces used for cooling should be kept 2°F to 3°F (1°C to 2°C) above the occupied dew point. This can be accomplished with control I/Os based on if/then statements.

The feedback to the control can be based on the entering water temperature (EWT) for operational control and feedback from the floor surface for safety limit control. EWT sensing should be done at the manifold cabinet which best represents the fluid temperature before it enters the floor. Control output will be to regulate fluid temperature and flow to the cooled surface.

Chapter 4

System Design, Construction and Commissioning

Radiant Cooling System Components

A radiant heating and cooling system is comprised of the following primary components.

Cooling and Heating Water
Unlike traditional HVAC, the water temperatures in radiant systems can often be within 20°F (11°C) of space temperature. In fact, it's not uncommon to see fluid temperatures for heating to be below core human body temperatures.

These low temperatures for heating and high temperatures for cooling enable higher efficiencies in traditional components such as chillers, boilers, solar and heat pumps, and enable the use of non-traditional sources such as ground water. More commonly on high-performance buildings, ground source heat pumps can employ a bypass for the shoulder seasons. This flexibility adds another design dimension as systems can be integrated under a common plant and distribution piping with localized tempering; or parallel plants can be employed to optimize energy efficiency.

Circulators
Standard circulators with or without speed control can be used for radiant systems. Certainly, due to the necessarily higher cooling fluid temperatures, there is less concern for condensation on circulator motors in comparison to traditional systems.

Selection for circulators follows good engineering practice as with traditional systems.

Manifolds
The central hub for distributing flow to a slab is the manifold and cabinet which can be furnished with a number of flow control and service options. To account for system hydraulics and maintenance, manifold locations must be carefully coordinated with the architect.

Conditioned Slab
The slab is warmed or cooled by water flowing through tubing embedded in the slab, either the structural slab or a topping slab. The tubing material of choice for radiant heating and cooling applications is Wirsbo hePEX™, which is a PEX-a material that has an oxygen-diffusion barrier to protect the system's ferrous components. See **Appendix B** for more information about the benefits of PEX-a over alternative materials.

Control System
The HVAC control system is a critical component of any building system; and will manage indoor temperature, fluid and surface temperatures and relative humidity. In addition to being a key component in facilitating plant efficiency, it will also provide safety dew point monitoring in case of failure in the latent control systems.

Figure 4-1: Uponor Motorized Valve Actuator and Zone Valve

Figure 4-2: Uponor Thermal Valve Actuator

Figure 4-3: Manifold in Flush-mounted Wall Cabinet (See Uponor Product Catalog for available sizes.)

Selecting the Construction Method

There are a variety of options for installing a radiant heating and cooling system, depending on the building construction. It is important to discuss these installation methods with the architect and structural engineer early during the design process. The most common configurations for commercial construction are:

- Floor slab on grade
- Floor slab over steel deck
- Topping slab on slab
- Floor slab on wood subfloor

Installing Tubing in a Structural Slab — In most radiant system installations, PEX-a tubing is embedded directly in the structural slab. This method transforms the building structure into a controllable thermal mass. Depending on the design and construction of the slab, coordination between the mechanical engineer and structural engineer is required during the design phase. Some jurisdictions will require structural calculations to show the strength of the slab with the proposed tubing in place. During the construction phase, the mechanical contractor should coordinate with the general contractor to ensure that the manifold locations are properly prepared and that there are no interferences between the PEX-a tubing and any reinforcing steel, post-tension tendons, electrical conduits, etc. In many cases, the PEX-a tubing can be secured with wire ties directly to the rebar.

LEED Rating: Gold
Project: Mountain Equipment Co-op
Location: Montreal, Québec, Canada
System: Uponor Radiant Heating and Cooling
Product: 46,000 ft. of ⅝" Wirsbo hePEX tubing
Square Feet: 45,000
Architect: MTF Architects
Engineer: Pageau Morel and Associates
Contractor: The Rojec Group
Completed: 2003

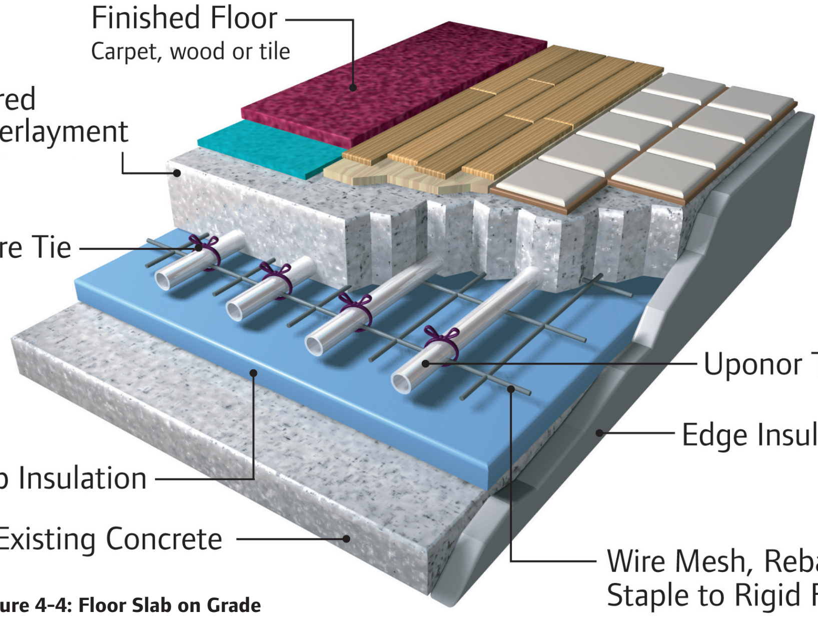


Figure 4-4: Floor Slab on Grade

Floor Slab on Grade

The most common installation method for commercial construction is slab on grade, where the PEX-a tubing is embedded directly in the structural slab. A vapor barrier, such as high-density polyethylene sheeting, is recommended between the radiant slab and supporting layers.

Insulation — Insulation is crucial for proper and efficient operation of the radiant floor system. Heat energy flows in the line of least resistance. Proper use of insulation facilitates the flow of heat toward the intended space, which is especially important in areas with high water tables and/or moist soil conditions. Good insulation practices also increase the response time of the system. In the absence of local codes, the insulation should have a minimum R-value on the order of five times the R-value of the proposed floor covering to minimize downward heat loss. Typical extruded polystyrene foam (XPS) has an R-value of 4.5 to 5.0 per inch, so 1-inch insulation is adequate for most tile, stone or wood flooring applications in mild climates. However 2-inch insulation is recommended, especially in more severe climates. Under-slab insulation must be rated for use in slab applications. Insulation below concrete slabs must be able to withstand the weight of the slab along with any additional dead or live loads. When concrete is applied over the insulation, the weight may slightly compress some types. Although this compression reduces the insulating effect of the foam, it presents little concern if the foam is properly selected and installed. Consult your local Uponor representative for additional insulation design assistance.

Securing the Tubing — The PEX-a tubing is looped at the prescribed spacing and secured in place using one of the following methods:

- **Plastic staples:** Staples can be used to secure the tubing directly to the foam insulation board. Staples should be placed a maximum of 3 feet along straight runs, at the top of each 180-degree arc and once on each side 12 inches from the top of the arc.
- **Fixing wire:** Wire ties can be used to secure the tubing onto a non-structural wire mesh or rebar. Wire ties should be placed a maximum of 3 feet along straight runs, at the top of each 180-degree arc and once on each side 12 inches from the top of the arc.
- **PEX rails:** Tubing can be secured using plastic PEX rails. PEX rails should be fastened to the subfloor perpendicular to the loop direction 12 inches from the edge of the wall and every 36 inches thereafter.

Once the tubing is in place and connected to the manifold, the system should be pressure tested at 50 psi for 24 hours. The system should be kept under pressure until after the concrete is poured. There should be a minimum of ¾ inch concrete on top of the tubing. Slab thickness should be determined by the structural engineer.

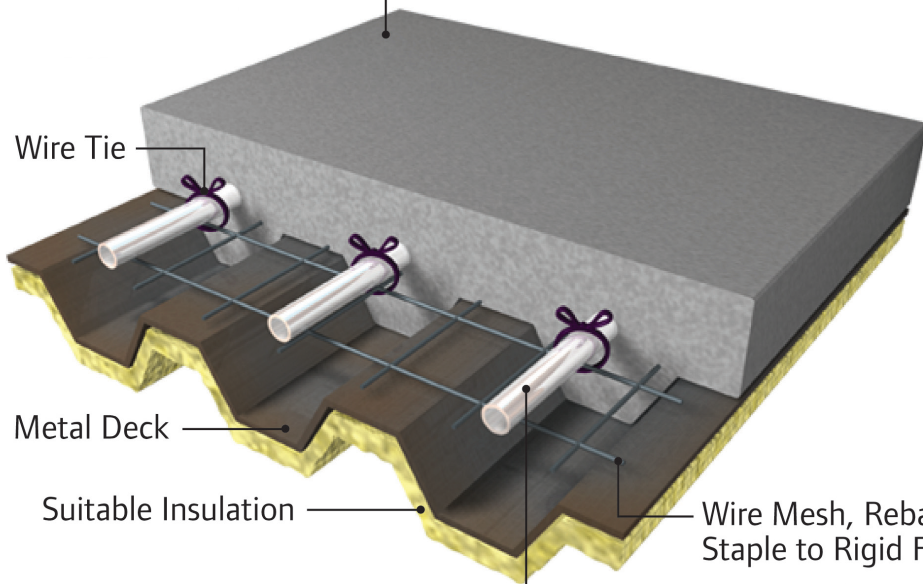


Figure 4-5: Slab on Steel Deck

Slab on Steel Deck

Structural slab on metal deck installations are common for the upper levels of multi-story buildings. The installation of radiant tubing is very similar to slab-on-grade installation. The main difference is the insulation, which is typically polyurethane spray foam applied to the underside of the deck. In some cases, the contractor may wish to lay rigid foam board insulation on top of the metal deck under the structural slab. Coordination with the structural engineer is critical to ensure that such an installation does not affect the integrity of the slab.

Securing the Tubing — The PEX-a tubing is looped at the prescribed spacing and secured in place using one of the following methods:

- **Fixing wire:** Wire ties can be used to secure the tubing onto a non-structural wire mesh or rebar. Wire ties should be placed a maximum of 3 feet along straight runs, at the top of each 180-degree arc and once on each side 12 inches from the top of the arc.
- **PEX rails:** Tubing can be secured using plastic PEX rails. PEX rails should be fastened to the metal deck perpendicular to the loop direction 12 inches from the edge of the wall and every 36 inches thereafter.

Once the tubing is in place and connected to the manifold, the system should be pressure tested at 50 psi for 24 hours. The system should be kept under pressure until after the concrete is poured. There should be a minimum of ¾ inch of concrete on top of the tubing. Slab thickness should be determined by the structural engineer.

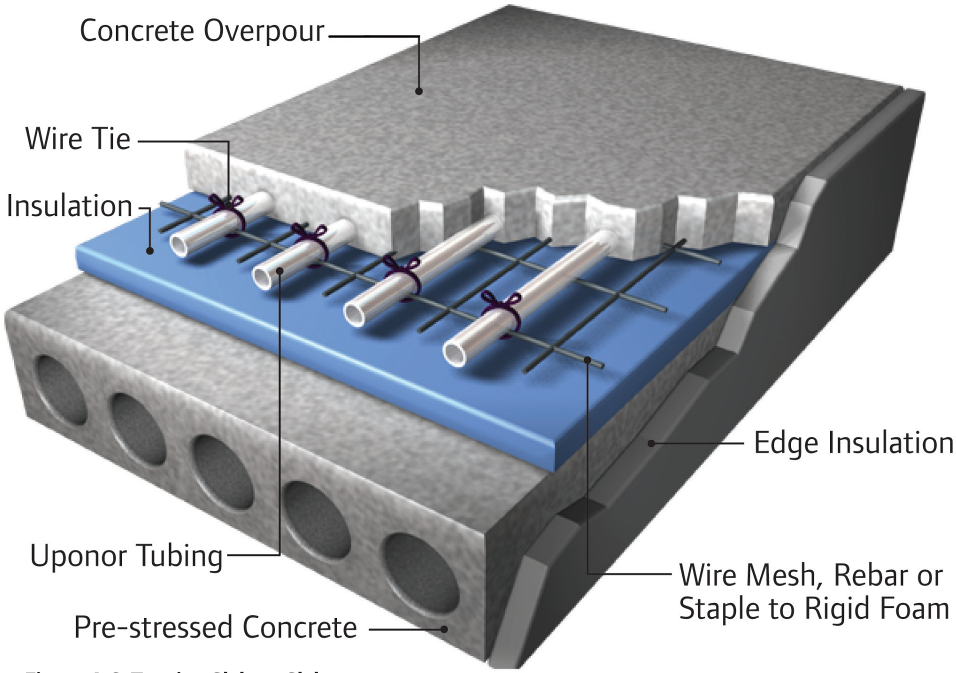


Figure 4-6: Topping Slab on Slab

Topping Slab on Slab

For installations on existing slabs, or where the structural engineer or local jurisdiction prohibits the installation of tubing within the structural slab, the tubing can be installed in a non-structural topping slab. This installation method is very similar to a slab-on-grade installation. Since the topping slab does not provide any structural support, it is typically thinner (approximately 2 to 3 inches) and is therefore considered a low-mass system. A topping slab has shorter response times, but it also has less thermal mass due to the thermal break of the insulation layer. Design of an unbonded topping slab should be done by the project structural engineer. Consult with your local Uponor representative for applications where bonded topping slabs may be permissible.

Securing the Tubing — The PEX-a tubing is looped at the prescribed spacing and secured in place using one of the following methods:

- **Plastic staples:** Staples can be used to secure the tubing directly to the foam insulation board. Staples should be placed a maximum of 3 feet along straight runs, at the top of each 180-degree arc and once on each side 12 inches from the top of the arc.
- **Fixing wire:** Wire ties can be used to secure the tubing onto a non-structural wire mesh or rebar. Wire ties should be placed a maximum of 3 feet along straight runs, at the top of each 180-degree arc and once on each side 12 inches from the top of the arc.
- **PEX Rails:** Tubing can be secured using plastic PEX rails. PEX rails should be fastened to the insulation perpendicular to the loop direction 12 inches from the edge of the wall and every 36 inches thereafter.

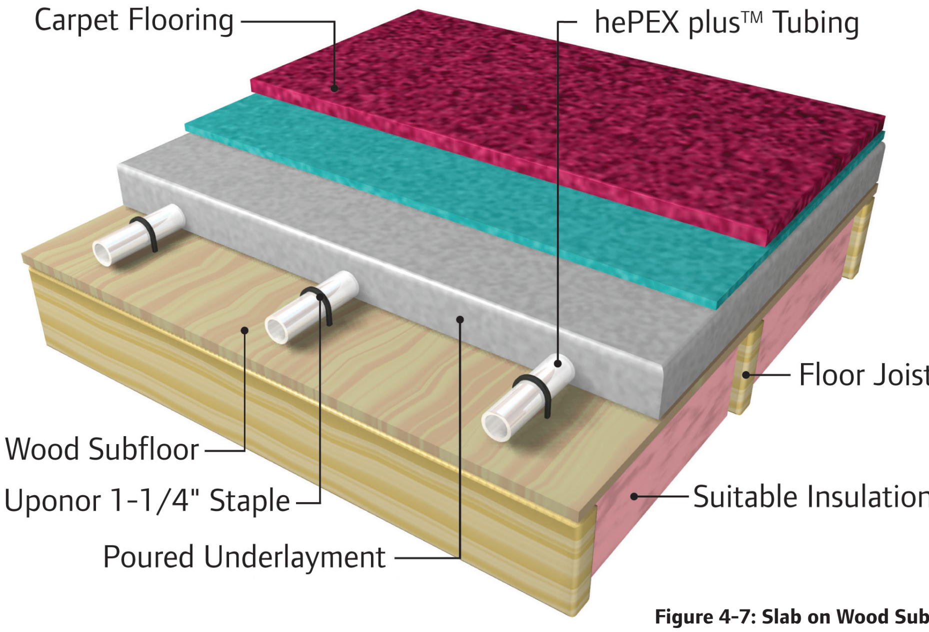


Figure 4-7: Slab on Wood Subfloor

Slab on Wood Subfloor

Installation of radiant tubing on a wood subfloor is similar to the low-mass topping slab installation. Fiberglass batt insulation is typically installed on the underside of the wood subfloor between the floor joists.

Securing the Tubing — The PEX-a tubing is looped at the prescribed spacing and secured in place using one of the following methods:

- **Staples:** Staples can be used to secure the tubing directly to the subfloor. Staples should be placed a maximum of 3 feet along straight runs, at the top of each 180-degree arc, and once on each side 12 inches from the top of the arc.
- **PEX Rails:** Tubing can be secured using plastic PEX rails. PEX rails should be fastened to the subfloor perpendicular to the loop direction 12 inches from the edge of the wall, and every 36 inches thereafter.
- **Quik Trak®:** For a low-profile installation on a wood subfloor, ⁵⁄₁₆" tubing can be installed in Uponor Quik Trak, a pre-manufactured ½-inch thick plywood panel solution with aluminum heat transfer sheets and pre-cut grooves 7 inches on center. The panels are screwed directly onto the wood deck and the tubing is snapped in place prior to installation of the flooring.
- **Fast Trak™:** Tubing can be snapped into a knobbed mat for quick and easy installation.

For other configurations, including wall and ceiling installations, please contact your local Uponor representative.

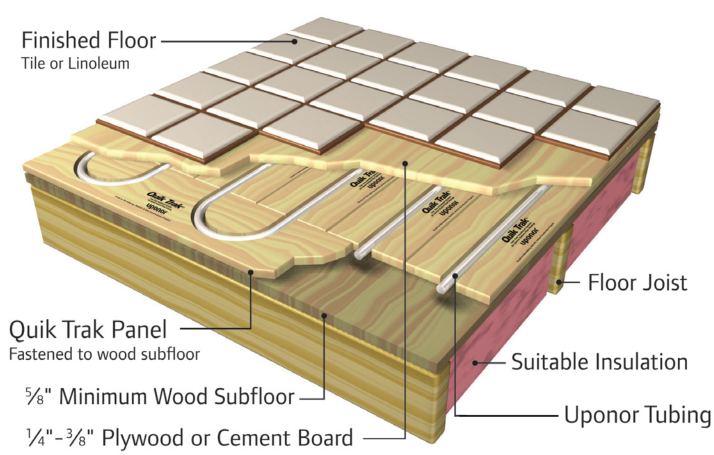


Figure 4-8: Quik Trak® Radiant Panels

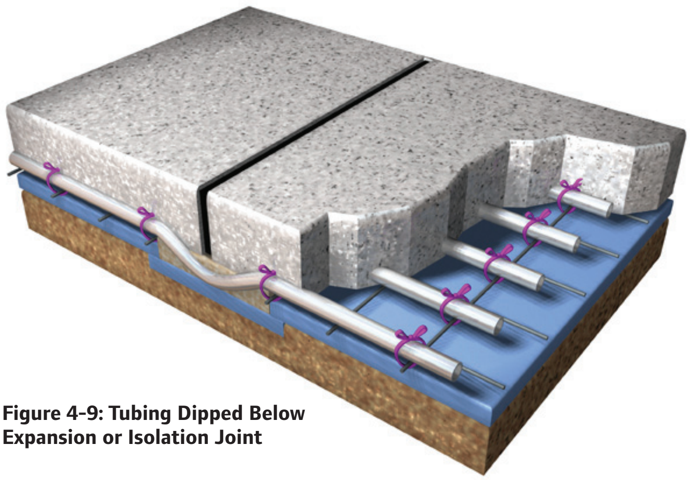


Figure 4-9: Tubing Dipped Below Expansion or Isolation Joint

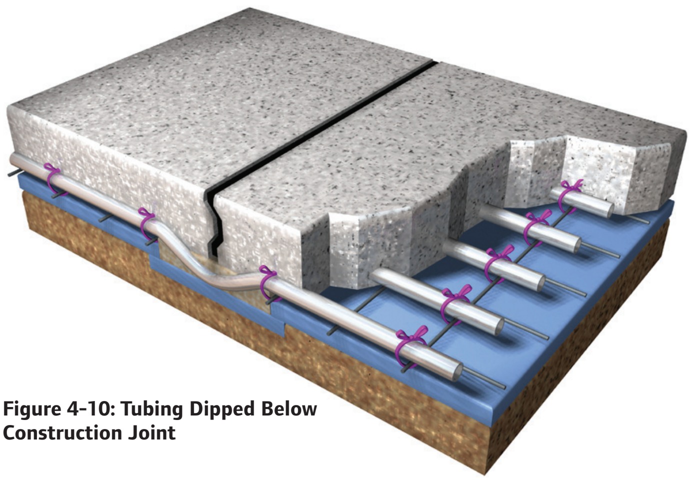


Figure 4-10: Tubing Dipped Below Construction Joint

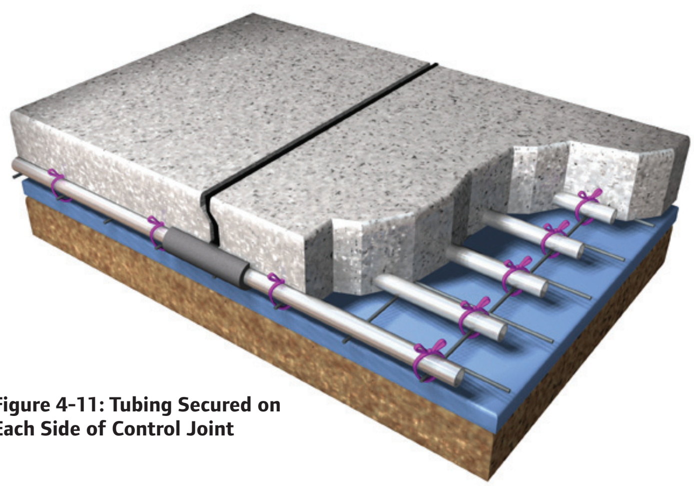


Figure 4-11: Tubing Secured on Each Side of Control Joint

Control Joints – Control joints allow the concrete to fracture along a controlled line. Depending on the depth of the concrete, the control joint may penetrate from ½ inch to depths greater than 1 inch. Ensure that the tubing is secured from the reach of the saw blade and cannot be harmed. It is recommended to secure the tubing 6 inches on each side of the control joint. It is important to mark where the joint can be made after the pour.

Expansion/Isolation and Construction Joints – If the PEX-a tubing must pass through expansion or isolation joints in the slab, tubing should be wrapped with pipe insulation for 6 inches on both sides of the joint. Alternately, the tubing can be positioned to dip below the slab at the joint locations.

Determining System Parameters and Operating Conditions

Once the construction method is established, the following system parameters can be determined:

- Active area
- Tubing diameter
- Tubing spacing
- Average loop lengths
- Flow rates
- Flooring considerations
- Operating water temperatures

Active Area

The active area is defined as the actual area where tubing can be installed. When calculating system capacity, it is important to consider the active area, not the gross area.

For example, if 10% of a cooled floor is covered by cabinets, equipment or furniture, or is void of tubing, then only 90% of the floor should be considered for the total cooling capacity.

Tubing Diameter

The most common tubing sizes for commercial heating and cooling applications are ½", ⅝" and ¾". Tubing diameters are selected on the same engineering principals for other piping systems — maintaining head losses between 1 and 4 feet of head per 100 feet of tubing, which typically occurs in velocities between 2 and 5 fps.

In general, larger diameter tubing means lower head losses, fewer loops and fewer connections. However, larger diameter tubing and associated fittings are more costly and more difficult to work with, particularly at colder temperatures. Smaller diameter tubing and fittings cost less and are more easily handled, but require more connections and are restricted by loop distances.

Reference Velocity Chart in Feet per Second (FPS)					
GPM	⅜"	½"	⅝"	¾"	1"
1.0	3.34	1.81	1.24	0.91	-
2.0	6.67	3.62	2.48	1.82	1.10
3.0	-	5.43	3.72	2.72	1.65
4.0	-	7.24	4.96	3.3	2.20
5.0	-	-	6.20	4.54	2.75

Table 4-1: Typical Flow Velocities

Head (Feet of Water) per Foot of Tubing, 100% water						
GPM	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00446	0.00421	0.00402	0.00388	0.00378	0.00370
1.0	0.01537	0.01454	0.01388	0.01340	0.01307	0.01280
1.5	0.03173	0.03004	0.02870	0.02772	0.02703	0.02648
2.0	0.05312	0.05031	0.04808	0.04645	0.04530	0.04437

Table 4-2: Typical Pressure Drop for ⅝" Wirsbo hePEX Tubing
See Appendix G for complete charts.

Tubing Spacing

The quality of the floor surface temperature is based on its thermal uniformity, which is directly affected by the tubing layout, spacing and depth. There is also a direct correlation between tubing spacing and supply water temperature such that the closer the tube spacing, the lower the difference between room temperature and average water temperature (t_{avg}). Keeping fluid temperatures as close as possible to the operative temperature delivers greater thermal stability and more control over the system dynamics.

Tubing spacing is typically between 6 to 12 inches on center for radiant floor heating systems. For cooling or reversible floors (those used for both heating and cooling) spacing should be no greater than 9 inches on center.

Average Loop Lengths

The maximum tubing length is normally between 250 and 450 feet per loop to limit pressure drop. This length includes the active length serving the space and the distance between the manifold and the space being served. The combined total length of tubing (sum of all loops) needed for a space is a function of the area (in square feet) and the on-center spacing. To approximate the active length, simply multiply the active area by the following multiplier:

6 inches on center	Area served x 2.0
7 inches on center	Area served x 1.7
8 inches on center	Area served x 1.5
9 inches on center	Area served x 1.33

In practice, try to keep the lengths of all of the loops on a manifold similar to normalize the pressure drop across each loop and make balancing easier. As tubing coils customarily come in 1,000-foot lengths, designing a system with 330 or 333 foot loops provides flexibility for changes in the field while reducing tubing waste (see **Tubing Calculation 1** above).

Tubing Calculation 1

Estimate the length of tubing and number of loops needed, given the following parameters.

Room Area: 2,000 ft^2 active area

6 inches on-center spacing

Average Active Loop Length: 300 ft.

Assume an average leader length of 10 ft. per loop.

Active Length Required:

Area x 2.0 ft / area = Length of tubing required

2,000 ft^2 x 2.0 ft / *sf* = 4,000 feet of active tubing

Loop Calculation

Number of loops = Total active length / average loop length

Number of loops = 4,000 ft./300 ft. = 13.333 or 14 loops

Assuming 14 loops, the active length per loop would be:

4,000 ft. / 14 loops = 286 ft. / loop

Total length per loop = active length + leader length

Total length per loop = 286 ft. + 10 ft. = 296 ft. / loop

Therefore:

Total length: 296 / loop x 14 loops = 4,144 ft.

Total number of loops: 14

Flooring Considerations

To determine the required flow rates and operating temperatures, it is important to recognize how the system parameters above affect capacity. All of the calculations presented here have assumed bare concrete floors. When any type of floor covering is installed on top of the concrete slab, the system performance is affected. For example, a mean water temperature of 55°F (12.8°C) will produce 11 Btu/ft^2/h for a bare concrete (R = 0) floor, but a carpeted floor (R = 1.5) will produce only 6 Btu/ft^2/h at that same mean water temperature (see **R-Value Charts** on the following page).

Since the absorptivity for common floor coverings are nominally the same, the potential flux remains constant across various types at the same surface temperature. However, the thermal resistance of each floor type has an immediate effect on back (downward) losses, tube spacing and, thus, fluid temperatures. At a fixed average fluid temperature and spacing, increasing the floor R-value will decrease heating or cooling capacity. Since several flooring systems entail layers of building materials, it is important to the total R-value of all of the layers.

Construction Materials	⅛"	¼"	⅜"	½"	⅝"	¾"
Plywood (Douglas fir)		0.31	0.47	0.62	0.77	0.93
Oriented strand board (OSB)		0.31	0.47	0.62	0.78	0.94
Asbestos-cement board	0.03	0.06	0.09			
Particle board (underlayment)	0.17	0.33	0.49	0.66	0.82	

Sheet Goods

Vinyl	0.20					
Linoleum (uninsulated)	0.20					
Linoleum (insulated)		0.40				

Tiles and Stone

Ceramic tile		0.23	0.34	0.45	0.57	0.68
Cork tile	0.28	0.56	0.84			
Limestone			0.38	0.50	0.63	0.76
Quarried stone			0.30	0.40	0.50	0.60
Marble		0.20	0.30	0.40	0.50	0.60
Brick			0.38	0.50	0.63	0.76

Carpeting

Commercial glue down		0.60	0.90			
Acrylic level loop		1.04	1.56	2.08	2.60	3.12
Acrylic plush		0.83	1.25	1.66	2.08	2.49
Polyester plush		0.96	1.44	1.92	2.40	2.88
Nylon saxony		0.88	1.32	1.76	2.20	2.64
Nylon shag		0.54	0.81	1.08	1.35	1.62
Wool plush		1.10	1.65	2.20	2.75	3.30

Carpet Pads

Rubber (solid)		0.31	0.47	0.62	0.78	0.93
Rubber (waffled)		0.62	0.93	1.24	1.55	1.86
Hair and jute		0.98	1.47	1.96	2.45	2.94
Prime urethane (2-lb. density)		1.08	1.62	2.16	2.70	3.24
Bonded urethane (4-lb. density)		1.04	1.56	2.08	2.60	3.12
Bonded urethane (8-lb. density)		1.10	1.65	2.20	2.75	3.30
Floating wood floor pad	0.20	0.40				

Wood Flooring	⅛"	¼"	⅜"	½"	⅝"	¾"
Ash			0.35	0.47	0.59	0.71
Cherry			0.35	0.46	0.58	0.69
Elm			0.33	0.45	0.56	0.67
Redwood			0.51	0.68	0.84	1.01
Maple			0.35	0.46	0.58	0.69
Oak			0.33	0.45	0.56	0.67
Walnut			0.34	0.45	0.57	0.68
Douglas fir			0.40	0.53	0.66	0.80
Southern pine			0.38	0.50	0.62	0.75
Spruce			0.51	0.68	0.84	1.01

Windows

Single glass	0.91
Single glass with storm	2.00
Double glazed – 3/16" air space	1.61
Double glazed – ¼" air space	1.69
Double glazed – ½" air space	2.04
Double glazed – ¾" air space	2.38
Double glazed – with suspended film	2.77
Double glazed – with 2 suspended films	3.85
Low-E	3.13
Low-E – with suspended film	4.05
Low-E – with 2 suspended films	5.05

Note: The R-values depicted in this chart are representative and may vary by manufacturer. For specific R-values, check with the appropriate floor covering manufacturer.

R to RSI (R-value Systême International) Conversion:

R x 0.176 = RSI

RSI x 5.68 = R

Operating Temperatures and Flow Rates

The capacity of a radiant cooling systems, given floor covering, tube diameter and tube spacing, is a function of the average water temperature (t_{avg}), which can be simply defined as the average of the supply and return water temperatures. The differential temperature (Delta T) for radiant cooling systems is typically 5 to 8 degrees. The differential temperature for radiant heating systems is typically 10 to 20 degrees.

The target design supply water temperature can be determined based on the sensible load assigned to the floor, indoor design condition, tube spacing and floor construction. In most cases, the supply water temperature will be on the order of 55°F to 58°F (12.8°C to 14.4°C). A commonly used strategy to maximize the effectiveness of the slab is to maintain the lowest supply water temperature allowed, such that:

- The supply water temperature is above the calculated dew point in the space.
- The supply water temperature does not result in a slab temperature below 66°F (18.9°C).

To avoid inadvertently overcooling the slab, it is important to control the target water temperature based on the difference between room temperature and setpoint. The Uponor control sequence utilizes an indoor adaptive reset strategy that controls target water temperature to ensure that the slab temperature never drops below 66°F (18.9°C).

Given the AWT, along with the other parameters above, the operating conditions can be approximated using graphical data. Based on the conditions of a specific project, Uponor Design Services can properly model the performance of the slab and provide you with the proper design conditions, including operating water temperature and required flow rates.

LEED Rating: Gold
Project: Normand Maurice Building
Location: Montreal, Quebec, Canada
System: Uponor Radiant Heating and Cooling
Product: Wirsbo hePEX tubing
Square Feet: 169,000
Chief Architect: Busby Perkins+Will
Associate Architects: Beauchamp et Bourbeau Canada and ABCP Architecture & Urbanisme
General Contractor: Decarel
Completed: 2006

Capacity Calculation: Estimate the capacity of a radiant cooling system, given the following parameters:

Room Area: 2,000 ft² active area

6" on center spacing

¼" commercial glue-down carpet

5°F Delta T

Indoor Condition: 78°F (25.6°C) at 40% indoor relative humidity

Given these indoor conditions, the local dew point can be taken off the psychrometric chart:

The local dew point is 54°F (12.2°C). To avoid surface condensation, a conservative approach ensures that the supply water temperature is no lower than 54°F (12.2°C). Therefore, with a 5°F Delta T, the return water temperature would be 59°F (15°C) and the average water temperature would be 56.5°F (13.6°C).

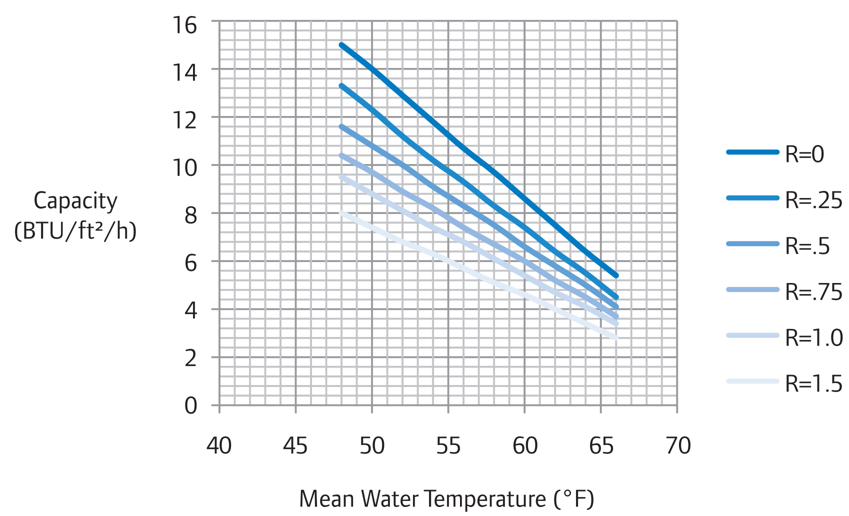
The estimated R-value of ¼" commercial glue-down carpeting is on the order of 0.60.

From the R-value charts, the capacity would be 8 Btu/h/ft² with a surface temperature of approximately 69°F (20.6°C).

Therefore, with an active surface of 2,000 ft², the total sensible capacity would be 16,000 Btu/h (4.7 kW).

This capacity can be increased if the surface temperature is dropped. For example, if the surface temperature is carefully maintained at 67°F (19.4°C), then the average water temperature would be 54°F (12.2°C). This change would increase the total sensible capacity to approximately 18,000 Btu/h (5.7 kW).

Since the supply water temperature would be below the dew point, the exposed supply water tubing would require insulation.



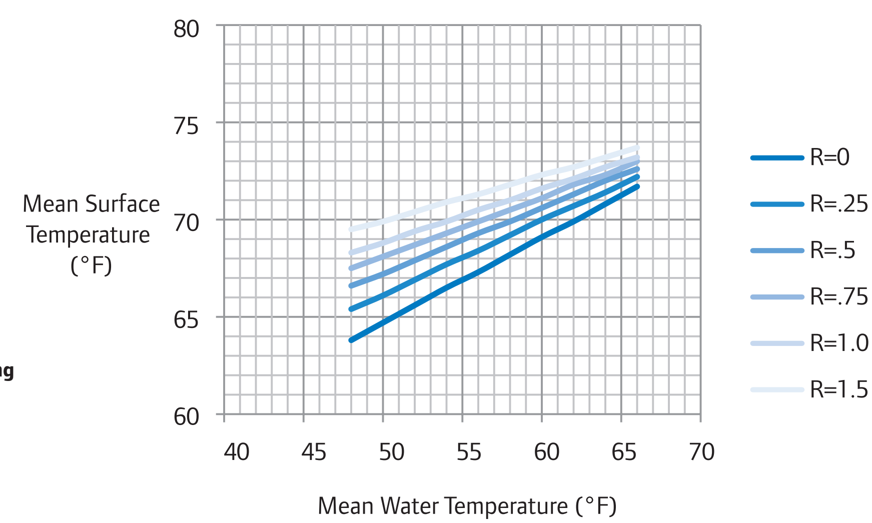


Figure 4-12: Average Water Temperature Charts for Tubing with 6" O.C. Spacing

Note: See **Appendix D** for additional charts.

Determining Flow Rates and Pressure Drops

The flow rate is a function of the load and the water temperature Delta T.

$Q_w = q_w / (60 \text{ min / hr} \cdot \rho_a \cdot c_p \cdot \Delta t)$,

Where

q_w = heat transfer rate to or from water, Btu/h

Q_w = water flow rate, gpm

ρ_a = density of water, lb/gal

c_p = specific heat of water, Btu/lb ·°F

Δt = temperature increase or decrease of water, °F

This can be simplified to:

Q = 500 x gpm x Delta T

Pressure drops can be calculated using the tables provided in **Appendix G**. Pressure drops for 180° bends can be approximated as two long radius elbows with equivalent lengths on the order of 3.0 ft/180° bend.

Flow Rate Calculation: Calculate the required flow rate for the above example, assuming negligible downward losses.

16,000 Btu / h total sensible capacity

Q = 500 x gpm x Δt

5°F Δt

16,000 Btu / h = 500 x gpm x 5

gpm = 16,000 Btu / h / [500 x 5]

Flow Rate = 6.4 gpm (0.4 L/s)

Downward Losses and Upward Gains

Without slab insulation, the downward loss in heating or upward gain in cooling may be significant. For suspended floors without insulation, the cooled floor serves as a chilled ceiling, wherein the heat exchange coefficient to the space below is approximately 1.94 Btu/h/ft²/°F (11 W/m² K) in comparison to the heat exchange coefficient of the radiant floor of 1.23 Btu/h/ft²/°F (7 W/m² K). Also, the air temperature at the ceiling (for example, within a false ceiling) may be higher than the air temperature at the floor level. Downward losses for slab-on-grade floors can be calculated as specified in the ASHRAE Handbook. Please contact your Uponor representative for more information.

Figure 4-13: Uponor Engineered Polymer (EP) Manifold

Figure 4-14: Uponor Four-loop EP Manifold Assembly

Sizing and Locating Manifolds

Supply and return water connections are made to distribution manifolds, which connect to the floor tubing. By convention, the supply manifold is normally installed below and in front of the return manifold. Space permitting, the manifolds are typically installed in a reverse-return arrangement, with supply water connecting on one side of the assembly and the return water connecting on the opposite side.

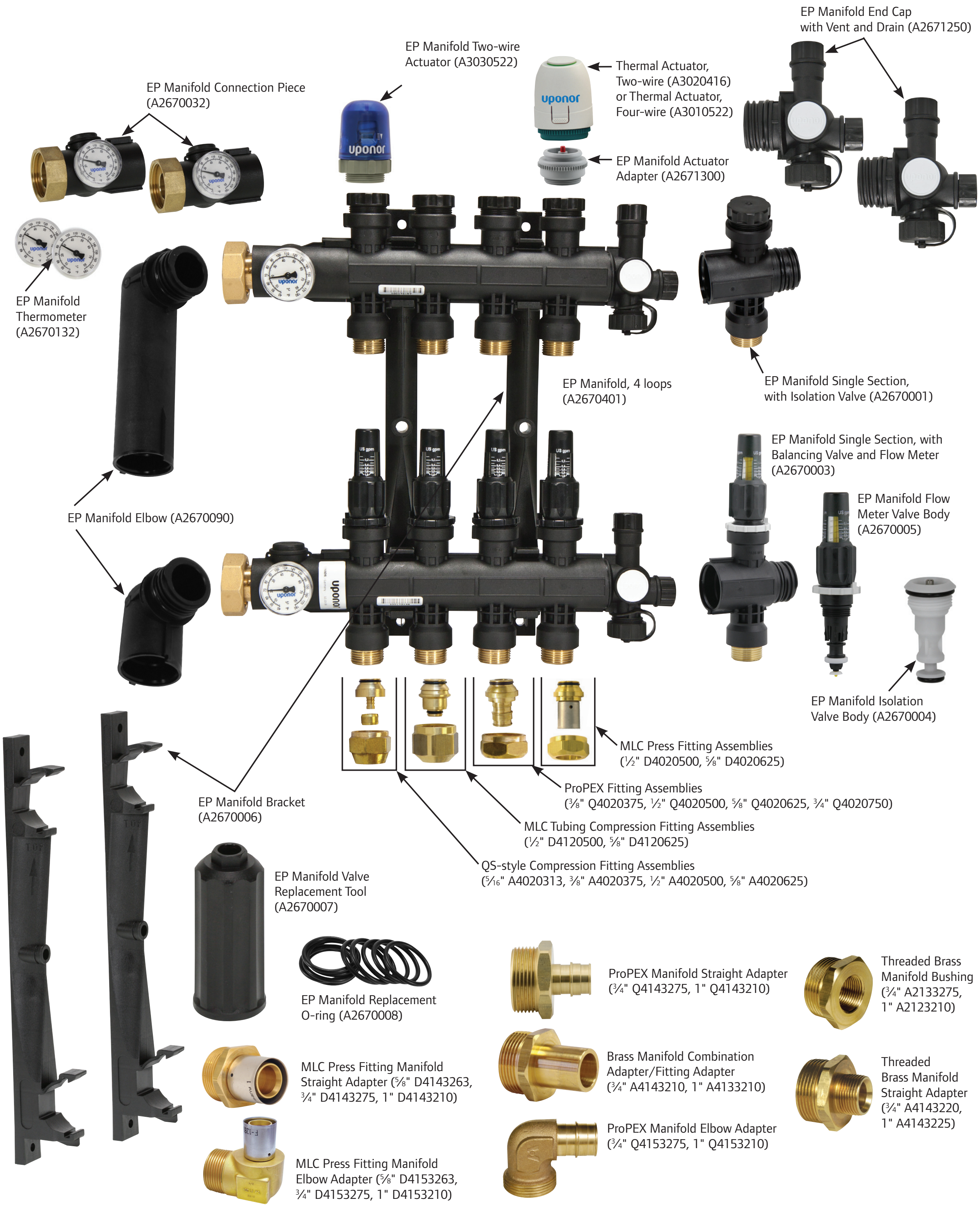
Manifold Types

There are a variety of options in manifold types and accessories.

Engineered Polymer (EP) Manifold Assembly

The Uponor Engineered Polymer (EP) Manifold is a cost-effective manifold assembly that can accommodate up to eight radiant loops (expandable to 12) and flow up to 15.4 gpm. It is made of a high-performance thermoplastic, specifically designed to handle the heat and moisture associated with a radiant heating and cooling system. The EP manifold assembly includes isolation valves, balancing valves, flow meters, vent and drain ports, supply and return thermometers, and mounting brackets.

Engineered Polymer (EP) Manifold Exploded View



Manifold Calculation: Calculate the number of EP Manifolds needed to serve the following area:

Area: 50,000 ft^2 active area
Tube spacing at 6" o.c.
5°F Δt
625,000 Btu/h sensible capacity
EP Manifolds

Average Loop Lengths: 450 feet (including 10 ft. leaders) = 440 ft. active length

Tubing length required:

50,000 ft^2 x 2.0 ft / SF = 100,000 ft. of tubing
100,000 ft / 440 ft. = 227.3 = 228 loops

Using the maximum 12 loops per EP Manifold:

228 loops / (12 loops/manifold) = 19 manifolds

Flow Rate Check:

625,000 Btu/h / 19 manifolds = 32,895 Btu/h per manifold
32,895 Btu/h = 500 x gpm x 5°F Δt

Flow rate = 13.2 gpm per manifold

The EP Manifold can accommodate 15.4 gpm, so this design is within the acceptable range.

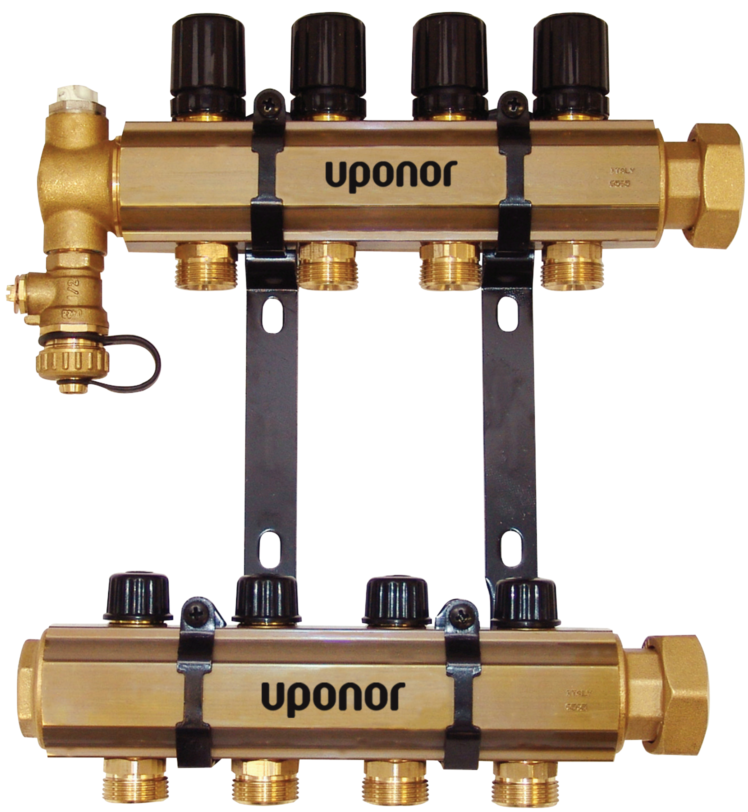


Figure 4-15: The Uponor TruFLOW Manifold family offers enhanced capabilities with a wide variety of accessories and options.

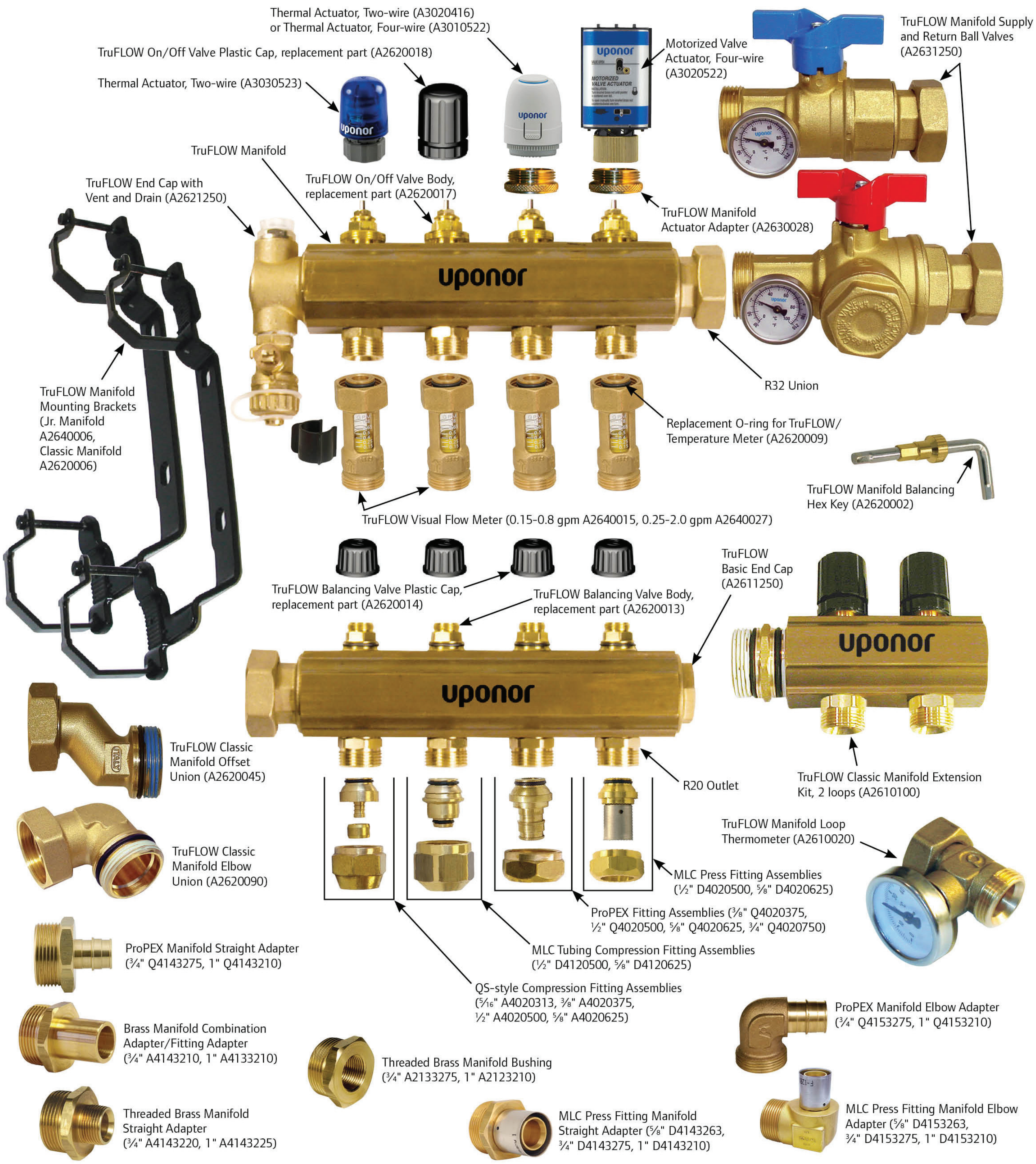
TruFLOW™ Manifold Assembly
Uponor TruFLOW™ Jr. and TruFLOW Classic manifold assemblies offer enhanced range capabilities and greater flexibility for consistent, reliable radiant control and balancing. The manifolds are manufactured from extruded brass and come with a complete line of accessories. The TruFLOW Jr. Assembly accommodates up to eight radiant loops (expandable to 12 with the TruFLOW Jr. Modular Manifold) and flow up to 14 gpm. It includes balancing valves, a vent and drain end cap, and mounting brackets. It can be ordered with or without isolation valves. The TruFLOW Classic Manifold Assembly accommodates up to 12 radiant loops and flow up to 21 gpm. It includes balancing valves, isolation valves, a vent and drain end cap, and mounting brackets.

Copper Manifolds
Uponor offers large diameter copper manifolds for flow rates up to 48 gpm. The 2" diameter copper manifolds accommodate 12 radiant loops and are available with or without ball valves.

Manifold Locations
Because radiant loops are typically limited to maximum lengths of 250 to 450 feet, there are limits to the area that a single manifold can effectively serve.

To maximize the area served by a manifold, it is best to locate the manifold as close as possible to the space being served. It is common in large areas for multiple manifolds to be located in the same area. Manifold locations must be carefully coordinated with the architect. Uponor offers a number of recessed wall cabinets to accommodate both the EP manifold assembly and the TruFLOW manifold family. The wall cabinets can be mounted in a 2x4 or 2x6 stud wall.

TruFLOW Manifold Exploded View



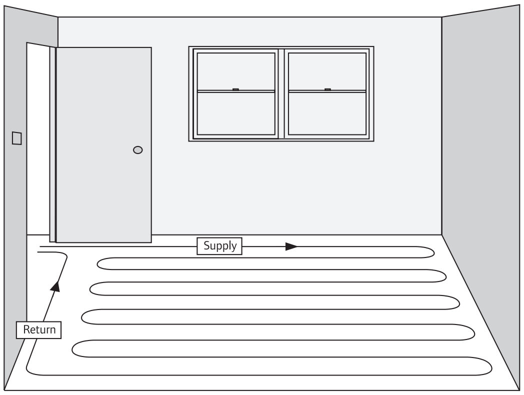


Figure 4-16: Single-wall Serpentine Tubing Layout

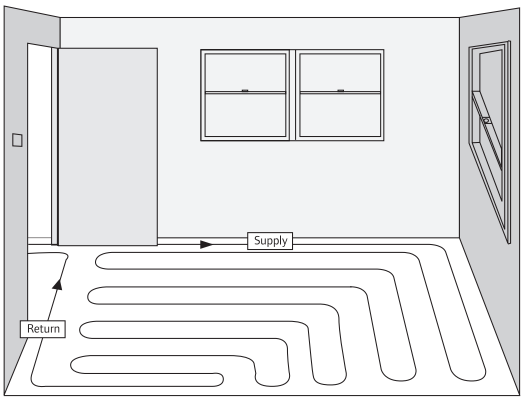


Figure 4-17: Double-wall Serpentine Tubing Layout

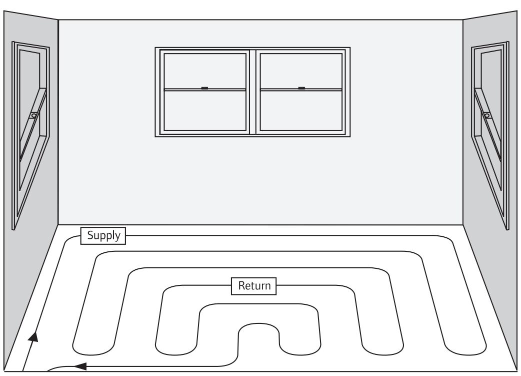


Figure 4-18: Triple-wall Serpentine Tubing Layout

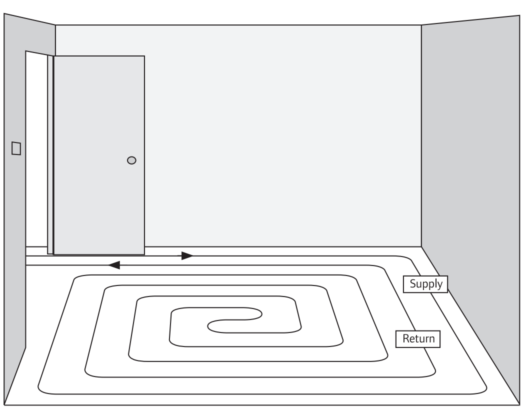


Figure 4-19: Counter Flow Tubing Layout

Loop Layouts

There are several options for arranging the tubing in the slab:

- Serpentine layout
- Counter-flow layout
- Reverse return layout
- Radiant Rollout Mat

The method used will depend on a number of factors, including the size and shape of the room, obstructions, and the heat gain in the space.

Serpentine Layout

One strategy is to locate the coldest supply water as close as possible to the highest heat gains. Because internal heat gains are often difficult to predict and are subject to change over the life of the building, this strategy is normally executed by locating the colder supply water close to the perimeter of the building, where envelope loads are more concentrated.

Counter-flow Layout

For large areas or spaces with no exterior exposure, a counter-flow pattern is usually used to maintain even temperatures across the entire surface area. In many cases, a combination of patterns will be used to make the most efficient use of tubing to cover the required space. Layout dictated by exterior exposure is also not as critical for cooling applications, where the Delta T is only 5 to 10°F.

Should loop layouts be shown on construction documents?

While having the loop layouts included as part of the construction documents can help the contractor visualize the scope of the work, it often unnecessarily complicates the floor plans. The installing contractor will typically use the manufacturer's shop drawings, rather than the construction documents, for actual tubing layouts. To ensure that the contractor properly quotes the job, it is important to show all manifold locations, including a completed manifold schedule and clear identification of the active radiant floor areas associated with each manifold. Your local Uponor representative can assist you in providing the information required for construction documents. After the bid is accepted, Uponor will put together a comprehensive submittal package, including the loop layouts.

Reverse Return Layout

An alternative method for laying out tubing is the Reverse Return method. In this arrangement, larger diameter supply and return headers are used with loops of equal length connected in parallel. This arrangement results in equal pressure drops throughout the system and can allow larger spaces to be covered with a fewer (or potentially no) manifolds. The larger diameter headers act as the distribution manifolds.

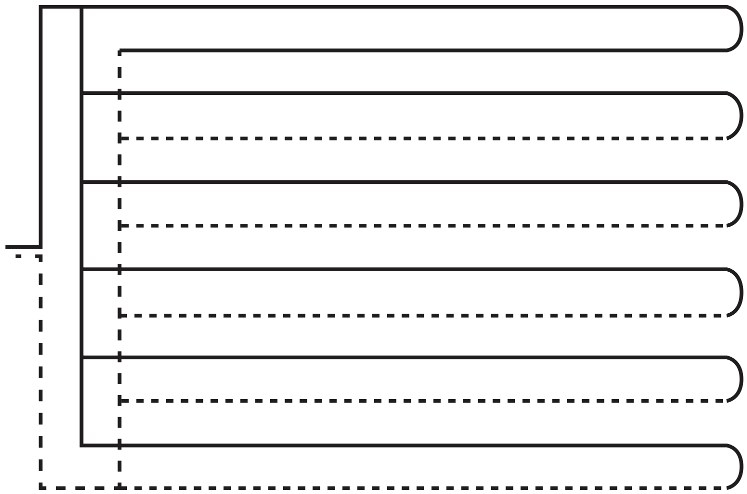


Figure 4-20: Reverse Return Method Layout

Can fittings be installed in the slab?

Under most circumstances, fittings should not be installed in the concrete slab, especially crimp/clamp type fitting where metal can adversely react with the concrete. Uponor ProPEX® EP fittings are non-metallic, can be visually inspected prior to the concrete pour and can accommodate pressures much higher than normal operating pressures. In special circumstances (e.g., Radiant Rollout Mat, Reverse Return method layout, etc.), installing ProPEX fittings directly in the concrete slab is acceptable if installed by an Uponor factory-trained installer. For more information, contact your local Uponor representative.

Radiant Rollout™ Mat

For large, open areas, the Uponor Radiant Rollout™ Mat solution can dramatically reduce installation time and labor costs. The mat consists of a custom-designed, prefabricated, pre-pressurized network of ½" or ⅝" Uponor PEX-a tubing (Wirsbo hePEX barrier tubing or Uponor AquaPEX® non-barrier tubing) connected with ProPEX EP fittings, which are safe for burial in the slab. The mat comes in 5-foot or 10-foot wide sections with lengths customized between 40 and 225 feet. The mat layout is designed with tubing at 6 or 9 inches on center, with either a reverse-return in-slab header (similar in principle to the Reverse Return method) or headers routed to a traditional wall manifold. Contact your local Uponor representative for design assistance and custom layouts using the Radiant Rollout Mat.

Figure 4-21: Uponor Radiant Rollout Mats are delivered to the job site in 5-foot or 10-foot wide sections that are rolled out onto the prepared grade, significantly reducing installation time and labor.

Energy Modeling

There are a number of commercially available software applications designed to accurately model the performance and energy use of a radiant heating and cooling system. There are also a number of firms throughout North America that specialize in energy modeling and have the tools and experience to provide detailed calculations and energy-use projections.

One common strategy to approximate the energy use of a radiant system is to model the system as a four-pipe fan coil unit. The water temperatures are adjusted to match the actual Delta T of the radiant system. The horsepower of the fan coil unit is then replaced by the system pump horsepower. This method provides a conservative approximation of the load, as it somewhat accurately determines the Btu demand on the chiller. However, it does not factor in the radiant effect of the slab thermal mass.

Commissioning

Commissioning the radiant heating and cooling system is a critical step to ensure that the system is operating at optimum efficiency. It is important that the commissioning agent have a good understanding of how the system works during the design phase. In some cases, a commissioning plan will need to be submitted to the commissioning agent as part of the final construction documents. Uponor has a number of commissioning plan templates that can be used for functional performance testing of the system. These templates should be modified based on the actual system components and control strategy. Contact your local Uponor representative for more information.

Appendix A
Glossary

This glossary identifies and defines some frequently used industry terms.

Active Loop Length — The length of tubing within the total loop length that is physically installed within the room to be conditioned.

Below-grade Edge Insulation — The amount of insulation (expressed in R-value) placed against the vertical edge of a radiant slab that is more than 4 feet below grade.

Below-grade Perimeter Insulation — The amount of insulation (expressed in R-value) placed horizontally under the first 4 feet from the perimeter of a radiant slab that is more than 4 feet below grade.

Conduction — A process of heat transfer whereby heat moves through a material or between two materials that are in direct contact with each other.

Convection — The transfer of heat by movement of a liquid or a gas. Natural convection is a result of movement caused by changes in density as temperature changes within a fluid medium such as a liquid or a gas. Forced convection is the result of mechanical force moving a fluid or gas.

Crosslinking — A chemical process that changes the molecular structure of a polymer material by linking otherwise independent hydrocarbon chains. Crosslinking creates a three-dimensional network of hydrocarbons. The end product cannot be melted and is insoluble.

Differential Temperature (Delta T, Δt) — The difference in temperature between two opposing masses; it is used to describe the potential that exists for heat transfer.

Diffusion — A distribution process that describes the tendency of gas or liquid molecules to spread out into the entire space available (including the spaces that exist within solids, like concrete). Diffusion is expressed as a function of the volume of space that is available. A related process, permeation, describes the movement of such substances through a solid membrane and is expressed in terms of the area of membrane penetrated.

Downward Loss — The amount of heat energy in Btu/h/ft^2 transferring downward from a radiant floor.

Edge Area — The exposed surface of a radiant slab equal to the thickness of the slab multiplied by the exposed linear perimeter length.

Edge Insulation — The amount of insulation (expressed in R-value) placed vertically along the exposed perimeter of the slab.

Effective Floor Area (EFA) — The approximate square footage of a radiant floor that effectively radiates heat to satisfy the heat load of a zone. EFA is the result of multiplying the net floor area by the effective floor factor.

Effective Floor Factor (EFF) — An approximation (expressed in percentage) used to describe the amount of net floor area that will effectively radiate heat. This factor is used by the designer to take into consideration intangibles (such as abnormally large furniture that covers a large percentage of floor space) that might interfere with heat transfer from the floor.

Emittance — A surface property of a material governing the emission of thermal radiation relative to that emitted by a perfect emitter, or black body, at the same surface temperature.

Engel Method — A peroxide-based method of manufacturing crosslinked polyethylene (PEX) tubing. Engel-method PEX is crosslinked during the extrusion process while the raw polyethylene is above its crystal-melting temperature, creating an even, consistent three-dimensional network of joined hydrocarbons.

Engineered Polymer (EP) — A polymer composite material that is resistant corrosion, pitting and scaling, high chlorine levels and withstands extreme temperatures.

Exposed Perimeter Insulation — The amount of insulation (expressed in R-value) placed either horizontally or vertically to a distance or depth of 4 feet along an exposed perimeter of a radiant slab less than 4 feet below grade.

Exposed Perimeter Length — The linear feet of perimeter less than 4 feet below grade along an outside wall.

Extrusion — A method used for the continuous formation of tubing from polymer materials.

Gross Floor Area — The entire floor surface area of a room or zone whether heated or not.

Injection Mixing — A method of regulating water temperature by injecting source-side water temperature into the return stream of the load side. The supply stream of the load can then be controlled to a set point or reset temperature based on weather conditions using modulating or on/off injection valves or variable speed injection circulators.

Leader Loop Length — The horizontal and vertical distance from the heated room to the manifold in which the loop originated. This distance is multiplied by two (supply and return) and added to the active loop length to obtain the total loop length.

Lightweight Concrete — Thinly poured concrete (typically 1½ inches) with small aggregate that can be used in some poured-floor applications. In radiant floor systems, the concrete is poured over the tubing that is directly fastened to a plywood subfloor. Lightweight concrete must be leveled and is prone to cracking due to structural movement if reinforcing material is not used in the concrete. Do not confuse with gypsum-based concrete underlayment. (See definition for poured-floor underlayment.)

Linear Expansion (thermal) — Refers to the physical characteristic of a material to expand in the presence of heat. It is known as heat expansion. Linear expansion creates a force within the material which, if held back by huge compressive strengths such as concrete, will transmit itself as an internal stress. Unlike other tubing products, PEX is highly resistant to stresses caused by linear expansion.

Manifold — A primary pipe with several outlets/nozzles to feed radiant loops.

Mean Radiant Temperature — The average of the average uncontrolled surface temperature (AUST) and the controlled surface temperature. Theoretically, the uniform surface temperature of an enclosure in which an occupant would exchange the same amount of radiant heat as in the actual non-uniform enclosure.

Net Floor Area (NFA) — The gross floor area minus the unheated floor area. NFA is the area of the radiant floor, measured in square feet, in which PEX tubing is installed.

Partially Exposed Basement Slab — A concrete slab in which a portion of the slab is more than 4 feet below grade and a portion is less than 4 feet below grade. This feature is common in homes with walk-out lower levels.

PE (polyethylene) — A thermoplastic material heavily used in consumer products. Its name originates from the monomer ethene used to create the polymer. Polyethylene is created through polymerization of ethene. It can be produced through radical polymerization, anionic polymerization and cationic polymerization as ethene does not have any substituent groups that influence the stability of the propagation head of the polymer. Each of these methods results in a different type of polyethylene.

Perimeter Area — The first four horizontal feet in from the exposed perimeter of the slab (applicable to under-slab insulation).

Perimeter Insulation — The amount of insulation (expressed in R-value) placed horizontally for the first 4 feet along the exposed perimeter of the slab.

Perimeter Length — The linear length of perimeter of the slab for a room exposed to outside conditions; used to calculate edge area.

PEX (crosslinked polyethylene) — A medium to high-density polyethylene containing crosslinked bonds introduced into the polymer structure, changing the thermoplast into an elastomer. The high-temperature properties of the polymer are improved, its flow is reduced and its chemical resistance is enhanced.

Poured-floor Underlayment — A thin (typically 1½ inches) underlayment of gypsum-based concrete. In radiant floor systems, the material is poured over the tubing that is directly fastened to a plywood subfloor. The material is self-leveling and requires minimal finishing by the installer. The poured underlayment must be sealed for moisture after the concrete has cured. Do not confuse with lightweight concrete.

ProPEX Fitting System — An Uponor-exclusive fitting system that uses the shape-memory of PEX-a tubing to ensure a strong, secure connection for PEX tubing systems. The ProPEX fitting system uses a ProPEX ring and an expander tool to expand the tubing and the ring over the fitting. Once the tubing retracts to its original shape, a strong, tight connection is made.

R-value — A measure of a material's ability to resist the flow of heat. R-value is expressed in Btu/h/ft^2 (1 / U = R).

Radiation — Act or process of radiating, specifically the process by which photons of electromagnetic energy is emitted from molecules and atoms, owing primarily to internal temperature change.

Relative Humidity (RH) — Ratio of the partial pressure or density of water vapor to the saturation pressure or density, respectively, at the same dry-bulb temperature and barometric pressure of the ambient air.

Room Setpoint Temperature — The desired operative temperature for the room, typically 67°F to 74°F (19.4°C to 20°C) for heating; and 74°F to 78°F (23.3°C to 25.6°C) for cooling (ref.: ANSI/ASHRAE Standard 55).

Slab Below Grade — A concrete slab with the entire slab at a minimum of 4 feet below grade.

Slab Depth — The thickness of the slab at the perimeter.

Slab on Grade — A concrete slab with a perimeter that is less than 4 feet below the surface.

Surface Temperature — The necessary temperature at the floor surface required to transfer the calculated Btu/h into a room for a given setpoint temperature to satisfy the current load.

Suspended Floors — Any floor that does not rest directly on the surface of the earth. Suspended floors may be constructed of any material and may be installed over heated or unheated spaces.

Temperature Below — The temperature of the soil or air below the center of the radiant slab or suspended floor. For slab on-grade or slab below-grade floors not exposed to very high water tables, Uponor recommends using a temperature below or equal to the room setpoint temperature. This temperature is likely to occur for the longest portion of the heating season and under design conditions.

Thermal Conductivity (K) — A property of materials that indicates the amount of heat (Btu) that penetrates 1 square foot of a uniform material, 1-inch thick, in one hour for each degree Fahrenheit difference in temperature between the surfaces. It is expressed in Btu/h/ft^2/°F. The thermal conductivity of PEX is 0.22 Btu/h/ft^2/°F.

Thermal Mass — Any material used to store heat energy or the affinity for heat energy.

Thermal Transfer Coefficient — Describes the transfer of heat from a bordering surface and is expressed in Btu/h/ft^2/°F. The thermal transfer coefficient is comprised of radiation, convection and conduction properties, as well as the orientation of the radiant surface (floor, ceiling or wall).

Total Loop Length — The active loop length added to the leader loop length equals the total loop length.

U-value — The capability of a substance to transfer heat; used to describe the conductance of a material or composite of materials, in construction. U-value is expressed in Btu/h/ft^2 and is the inverse function of R-value (1 / R = U).

Under-slab Area — The interior portion of the slab that includes all but the first 4 feet from the perimeter.

Under-slab Insulation — The amount of insulation (expressed in R-value) under the interior area of the slab, excluding the perimeter area.

Unheated Floor Area — The amount of floor included in the gross floor area in which tubing is not installed.

Upward Load — The amount of heat energy, expressed in Btu/h/ft^2, required to overcome the envelope losses of the room.

Water Table Temperature — Equal to the estimated temperature of the water table for the area; used when the presence of a water table will affect the performance of the radiant panel heating system. Typically, insulation should be added below a radiant slab if there is a water table within 8 feet of the slab.

Weather-responsive Reset — A method of fine tuning a radiant system by changing the system supply water temperature based on changing weather conditions. In heating, as the outside temperature decreases, the supply water temperature increases. Likewise, as the outside temperature increases, the supply water temperature decreases.

Zone — An area of a radiant panel served by one or more loops and individually controlled through a thermostat.

Appendix B

The Benefits of PEX-a

Currently, three methods for producing crosslinked polyethylene (PEX) tubing exist:

- Engel or peroxide method (PEX-a)
- Silane method (PEX-b)
- Electron beam (E-beam) or radiation method (PEX-c)

All three processes generate tubing that is crosslinked to varying degrees and is acceptable for potable water distribution applications according to ASTM F876 and F877 standards.

Engel Method (PEX-a) — Uponor manufactures Engel-method, PEX-a tubing. The PEX tubing industry considers this tubing superior because the crosslinking is done during the manufacturing process when polyethylene is in its amorphic state (above the crystalline melting point). The Engel method produces the highest degree of crosslinking — approximately 85% —resulting in a more uniform product with no weak links in the molecular chain. PEX-a has a high degree thermal memory — meaning kinked tubing can be reshaped with the use of a heat gun.

Silane Method (PEX-b) — PEX-b tubing is crosslinked after the extrusion process by placing the tubing in a hot water bath or steam sauna. The degree of crosslinking for PEX-b is typically around 65 to 70%. This method produces PEX that is not as evenly crosslinked and with a lower degree of thermal memory than PEX-a.

E-beam Method (PEX-c) — PEX-c uses an electron beam to achieve crosslinking after the extrusion process. The PEX-c method requires multiple passes under the beam to reach a 70 to 75% degree of crosslinking. Side effects of this process are discoloration due to oxidation (from natural white to yellow, unless other pigment is added) and a slightly stiffer product.

PEX-a Distinctions

The properties of PEX-a tubing make it the most flexible PEX on the market. Flexibility gives PEX-a tubing the tightest end radius available — as little as 3½" for ½" tubing. Its flexibility also greatly reduces kinks. However, if there is the rare occurrence of kinked tubing, the thermal memory of PEX-a means the tubing can be repaired with a simple shot of heat from a heat gun.

The shape memory of PEX-a tubing offers the unique opportunity for fitting connections. Shape memory allows PEX-a tubing to expand and then shrink back to normal size, creating strong, durable and reliable fitting connections.

Finally, of the three types of PEX, PEX-a tubing offers the greatest resistance to crack propagation (how a crack grows). This resistance means if a crack occurs in PEX-a tubing, it is least likely to grow over time and cause leaks or damage.

Uponor Tubing

With more than 40 years of service — longer than any other PEX manufacturer in North America — Uponor is the leader in PEX tubing for radiant heating, plumbing and fire safety systems. More than 2 billion feet of Uponor PEX tubing is in service in North America alone, and more than 15 billion feet of tubing is installed worldwide. With that kind of history, you can count on Uponor PEX to offer the highest quality tubing for all your application needs.

Uponor Tubing	Application and Design Considerations	Linear Expansion Rate	Coil Lengths
Wirsbo hePEX Wirsbo hePEX is Engel-method PEX-a tubing with an oxygen-diffusion barrier.	**Application** — Wirsbo hePEX is designed for use in closed-loop hydronic radiant heating systems operating at sustained temperatures up to 200°F. Corrodible or ferrous components may be used in hot- water heating systems designed with Wirsbo hePEX tubing.	The unrestrained linear (thermal) expansion rate for Wirsbo hePEX tubing is approximately 1.1 inches per 10°F temperature change per 100 feet of tubing.	Refer to the Uponor Product Catalog for available coil lengths.

Codes, Standards, Listings and Ratings	Barrier Information	Dimensions
Wirsbo hePEX is manufactured to meet ASTM F876 and ASTM F877 standards. Wirsbo hePEX has a Standard Grade Hydrostatic Design Stress and Pressure Rating in accordance with all three temperatures and pressures listed in Table 1 of ASTM F876. Wirsbo hePEX tubing is tested in accordance with PPI TR-3 and listed in PPI TR-4. The Standard Grade Hydrostatic Ratings are: • 200°F at 80 psi • 180°F at 100 psi • 73.4°F at 160 psi The Hydrostatic Design Stress Board of the Plastics Pipe Institute (PPI) issues these pressure and temperature ratings. These values listed are ratings, not limitations. If the designer stays within these parameters during design, there should not be a problem with the product. Burst pressures are values used only in manufacturing the product, not for the system specification or design. **Codes:** IMC, IPC, IRC, NSPC, UMC, UPC **Listings:** AWWA, HUD, NSF, IAPMO, ICC, Intertek, ITS, PHCC, PPI, UL, QAI **Standards:** ASTM E84, ASTM E814, ASTM E119, ASTM F876, ASTM F877, ASTM F2023, ASTM F1960, ASTM F2657, ANSI/NSF 14 and 61	Wirsbo hePEX is sealed with a special polymer barrier to prevent the diffusion of oxygen through the tubing wall and to protect the ferrous components of a closed-loop hydronic heating system from corrosion damage. The barrier consists of an ethylene vinyl alcohol (EVOH) layer co-extruded onto the tubing during the manufacturing process. Uponor applies another thin polyethylene layer over the EVOH barrier on the tubing to reduce possible onsite damage to the oxygen-diffusion barrier. This polyethylene layer also provides protection for the EVOH barrier if the tubing is immersed in high-moisture applications. The Wirsbo hePEX barrier meets the requirements of the German DIN Standard 4726 for oxygen-diffusion prevention. The amount of oxygen that enters the system must be less than 0.10 grams per cubic meter per day at 104°F.	• 5⁄16" nominal inside diameter (contains 0.35 gallons/100' of tubing) • 3⁄8" nominal inside diameter (contains 0.50 gallons/100' of tubing) • ½" nominal inside diameter (contains 0.92 gallons/100' of tubing) • 5⁄8" nominal inside diameter (contains 1.34 gallons/100' of tubing) • ¾" nominal inside diameter (contains 1.84 gallons/100' of tubing) • 1" nominal inside diameter (contains 3.03 gallons/100' of tubing) • 1¼" nominal inside diameter (contains 4.54 gallons/100' of tubing) • 1½" nominal inside diameter (contains 6.33 gallons/100' of tubing) • 2"nominal inside diameter (contains 10.85 gallons/100' of tubing) • 2½" nominal inside diameter (contains 16.53 gallons/100' of tubing) • 3" nominal inside diameter (contains 23.51 gallons/100' of tubing) • 4" nominal inside diameter (contains 41.05 gallons/100' of tubing)

Appendix C
Frequently Asked Questions

What is radiant floor cooling?

Uponor radiant floor cooling is a comfortable and efficient form of cooling where chilled water circulates through flexible, specially designed PEX tubing installed under the floor. The heat in the space is absorbed evenly by the floor, cooling people and objects in the room and providing improved comfort using less energy.

Is a supplemental cooling or ventilation system required?

In many cases, a radiant cooling system will be able to address all or most of the building's sensible load. A reduced-size air system is required to address the ventilation and latent loads and, perhaps, the balance of the sensible load.

Can the floor get too cold?

No. A properly designed radiant floor cooling system will deliver a floor surface at a temperature that is comfortable to the touch. The control system continuously monitors floor conditions and supply water temperatures to ensure that the surface temperature is maintained within acceptable limits.

What is the difference between Wirsbo hePEX or Uponor AquaPEX?

Wirsbo hePEX is Engel-method PEX-a tubing with an oxygen-diffusion barrier. Uponor AquaPEX is essentially the same product, but without the oxygen-diffusion barrier. Radiant heating and cooling systems typically use Wirsbo hePEX to protect ferrous components in a closed-loop hydronic system.

Are there different types of radiant cooling?

Yes. Specifically, there are low mass and high-mass radiant cooling systems. Low-mass radiant systems circulate cool water in specialized panels or beams and typically operate when the building or space is occupied. High-mass systems typically cool the building structure (slab, walls and/or ceilings) when the building is unoccupied. High-mass systems provide the additional advantage of off-peak cooling and further reduction in energy costs.

What makes radiant floor cooling so comfortable?

Unlike traditional cooling systems that just cool the air, radiant cooling quietly and evenly lowers the surface temperatures in the space which draws heat out of and away from the occupants.

How is condensation addressed when designing a radiant floor cooling system?

The moisture in a building is necessarily controlled by a parallel system dedicated to removing moisture for the health of the environment, for respiratory and thermal comfort of the occupants and for dimensional stability of hygroscopic materials like wood. Additionally, the control system monitors space temperatures and humidity for the purposes of monitoring dew point and can shut the flow off to the cooled floor if the latent system should ever fail.

What is the maximum cooling capacity for most spaces?

The maximum cooling capacity for a floor slab is approximately 14 Btu/ft²/h. In spaces with direct sunshine on the floor (e.g., atriums, entrance halls and show rooms), the cooling capacity will be significantly higher — up to a maximum of 32 Btu/ft²/h. Higher capacities can also be obtained through ceiling cooling slabs.

What are the factors that can affect the cooling capacity of a radiant floor cooling system?

The cooling capacity of a floor system depends on:

- Heat exchange between the floor surface and the space (convective and radiant heat exchange coefficient)
- Heat conduction between the floor surface and the tubing (floor surface material, type of concrete, slab thickness and spacing between tubing)
- Heat transport by water (water flow rate and temperature difference between supply and return).

Dew point, floor coverings and average water temperature are also factors that can affect the cooling capacity.

Is separate embedded tubing needed to heat and cool the building?

No, a properly designed system can both heat and cool using the same tubing.

Do the fluctuations in slab temperature between heating and cooling modes make the slab more susceptible to cracking?

Regardless of whether a slab is heated or cooled, concrete will shrink as it cures and this sets up stress cracks which are effectively managed with control joints. Embedded pipes have little to no effect on concrete shrinkage nor will they promote cracking so long as the ACI 318 and CSA-A23 standards addressing structural concrete and embedded pipes are followed. It's important to remember fluids in radiant systems are typically within 20°F (11°C) of space temperatures and actually prevent slabs from experiencing wide extreme swings in temperature.

How do you identify tubing after it has been embedded in the slab?

Prior to drilling into a radiant slab, the tubing should be located. Tubing can be identified by raising the operating water temperature and using a thermal imager.

What are the Uponor PEX standards?

Uponor PEX and associated fittings are manufactured to the following standards:

- ASTM F876 Standard Specification for Cross-linked Polyethylene (PEX) Tubing
- ASTM F877 Standard Specification for Cross-linked Polyethylene (PEX) Plastic Hot and Cold Water Distribution Systems
- ASTM F1960 Standard Specifications for Cold Expansion Fittings with PEX Reinforcing Rings for use with Cross-linked Polyethylene (PEX) Tubing
- ASTM F2080 Standard Specifications for Cold Expansion Fittings with Metal Compression Sleeves for Cross-linked Polyethylene (PEX) Tubing
- CSA B137.5 Thermoplastic Pressure Piping Compendium

Additional standards for Uponor AquaPEX tubing and associated fittings include:

- ANSI/NSF Standard 14 Plastics Piping System Components and Related Materials
- ANSI/NSF Standard 61 Drinking Water System Components — Health Effects
- UL 1821 Standard for Safety for Thermoplastic Sprinkler Pipe and Fittings for Fire Protection Service

What code approvals does Wirsbo hePEX tubing have?

- IMC
- UMC
- IRC

What listings does Wirsbo hePEX tubing have?

- CSA
- ICC
- ITS
- PPI
- UL
- NSF-rfh
- NSF-pw

What temperature and pressure ratings does Uponor PEX carry?

Uponor PEX carries the following hydrostatic temperature and pressure ratings:

- 200°F at 80 psi (93.3°C at 5.51 bar)
- 180°F at 100 psi (82.2°C at 6.89 bar)
- 120°F at 130 psi (49°C at 9 bar) (½" Uponor AquaPEX tubing only)
- 73.4°F at 160 psi (23°C at 11 bar)

What fire-rated assemblies does Wirsbo hePEX tubing have?

In the United States:

- Tested in accordance with ASTM E119/UL 263
- G573 – Two-hour Hambro floor/ceiling assembly
- K913 – Two-hour concrete floor/ceiling assembly
- L557 – One-hour wood frame floor/ceiling assembly
- U372 – One-hour wood frame wall assembly
- V444 – One-hour steel stud wall assembly

In Canada

- Tested in accordance with CAN/ULC S101
- G573 – Two-hour Hambro floor/ceiling assembly
- UW/WA 60-01 – One-hour steel stud wall assembly
- UW/WA 60-02 – One-hour wood frame wall assembly
- WC/FCA 60-01 – One-hour wood frame floor/ceiling assembly
- WC/FCA 120-01 – Two-hour concrete floor/ceiling assembly
- WC/FCA 120-02 – Two-hour concrete floor/ceiling assembly
- NBC of Canada

What is the Warnock Hersey Plenum Rating for Wirsbo hePEX?

- 25 flame spread/50 smoke developed (plenum rated) to ASTM E84:
  - Up to ¾" un-insulated with spacing of 18" between each run of tubing
  - Up to 3" when insulated with ½" fiberglass insulation
  - 1" through 2" when used with Uponor PEX-a Pipe Support, ProPEX rings and EP fittings
- CAN/ULC S102.2:
  - ½" has no restrictions on spacing requirements
  - ¾" through 1" un-insulated with spacing of 18" between each run of tubing
  - Up to 3" when insulated with ½" fiberglass insulation

What is PEX tubing?

Crosslinked polyethylene (PEX) tubing is specially designed plastic tubing with distinctive properties that make it ideal for radiant floor heating and plumbing systems. Uponor produces PEX-a tubing, which is considered the superior type of PEX.

What is Wirsbo hePEX?

Wirsbo hePEX is crosslinked polyethylene (PEX-a) heat-transfer tubing that features a patent-pending oxygen-barrier coating technology for closed-loop hydronic heating and cooling applications.

What's the difference between PEX-a, PEX-b and PEX-c tubing?

Currently, three methods for producing crosslinked polyethylene (PEX) tubing exist:

- Engel or peroxide method (PEX-a)
- Silane method (PEX-b)
- Electron beam (E-beam) or radiation method (PEX-c)

All three processes generate tubing that is crosslinked to varying degrees, and all are acceptable for potable water distribution applications according to ASTM F876 and F877 standards. Uponor manufactures Engel-method PEX-a tubing. The PEX tubing industry considers this tubing superior because the crosslinking is done during the manufacturing process when polyethylene is in it amorphic state (above the crystalline melting point). Accordingly, the degree of crosslinking reaches around 85% (higher than the other methods), resulting in a more uniform product with no weak links in the molecular chain. Learn more about why PEX-a tubing is superior in **Appendix B**.

How long will PEX-a tubing last?

From 1973 to 2009, Uponor PEX-a tubing was subjected to ongoing testing at 203°F/175 psi by Studvik in Sweden and BASF in Germany. The resulting data indicates a life expectancy of well over 100 years.

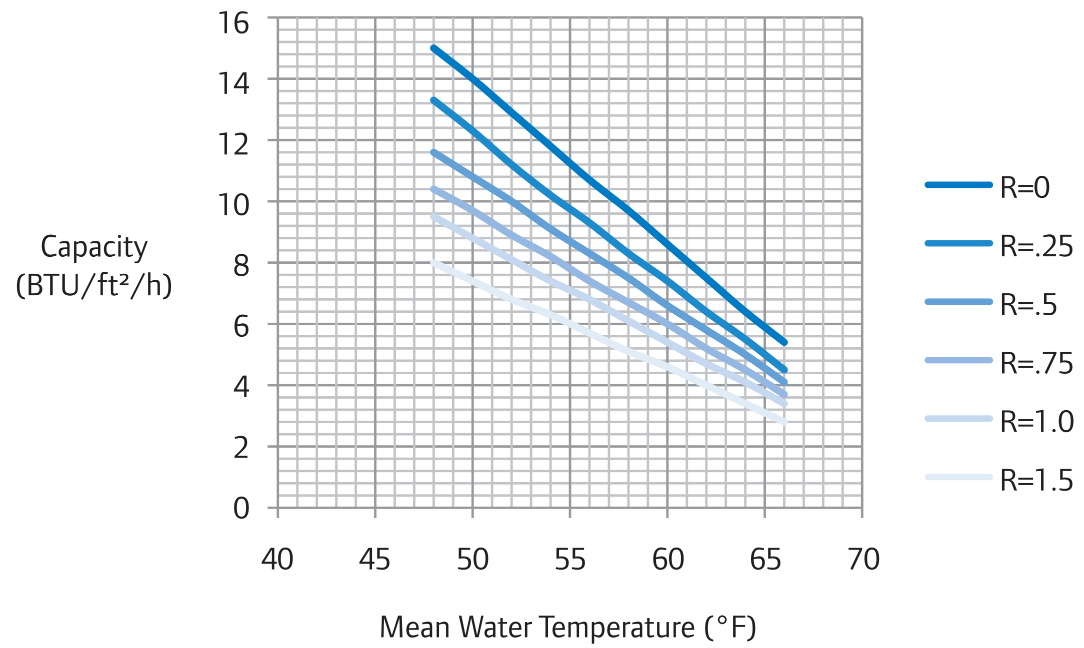
Do you offer a warranty on your tubing?

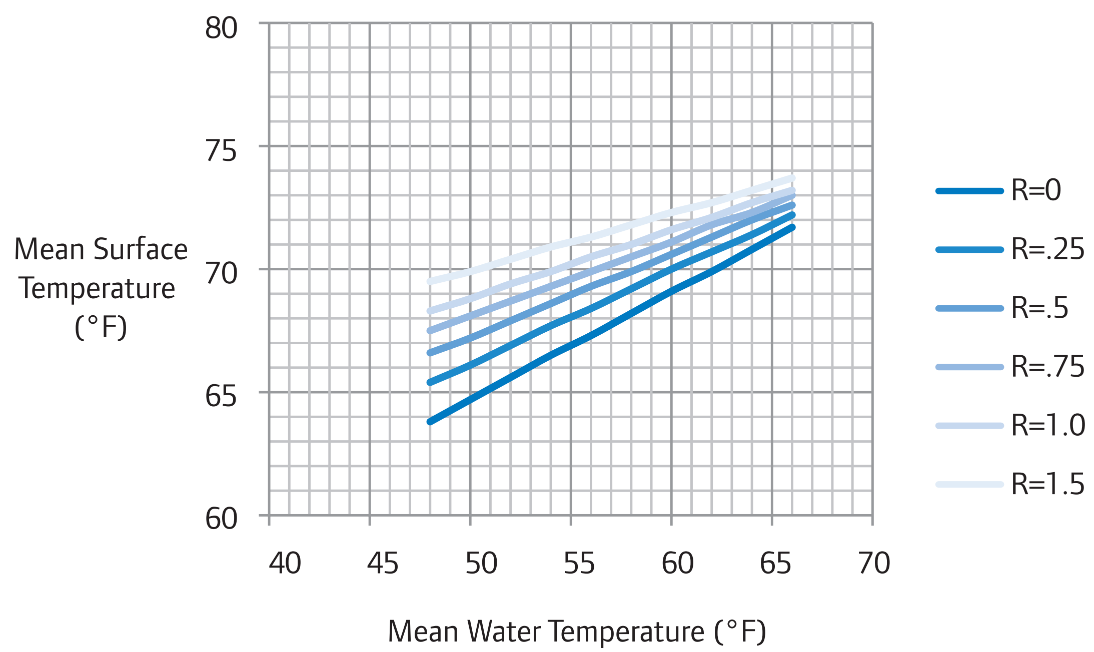
Yes. Uponor offers a 25-year limited warranty when installed by an Uponor-trained professional, or a 30-year warranty when installed by a PROadvantage Elite member.

Appendix D

Mean Water Temperature and Mean Surface Temperature Charts

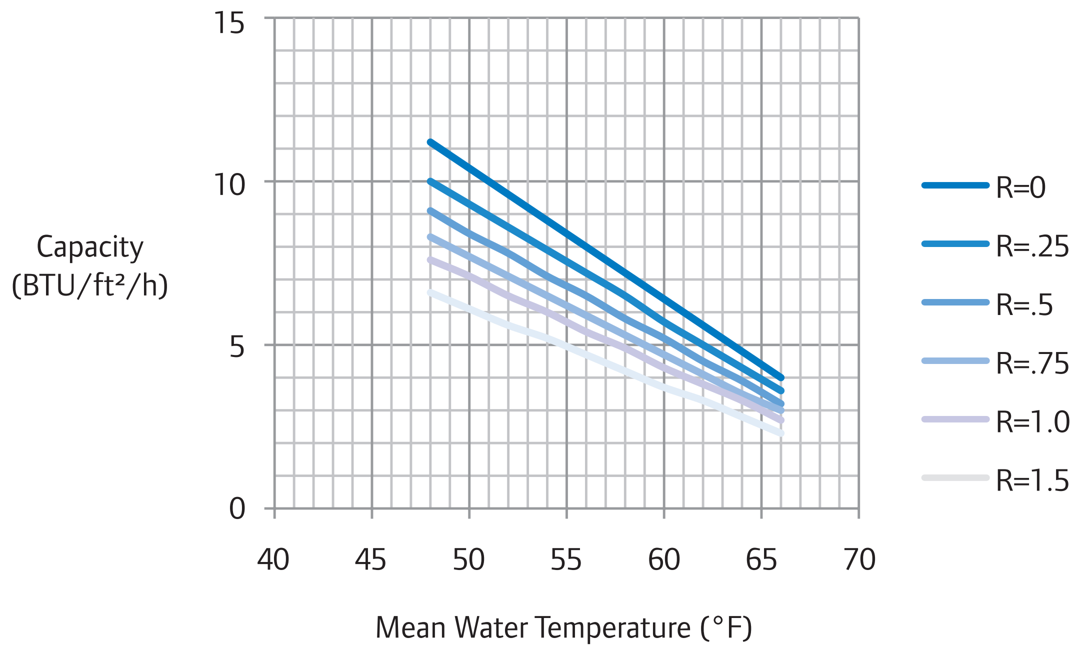
6" O.C. Mean Water Temperature and Mean Surface Temperature Charts

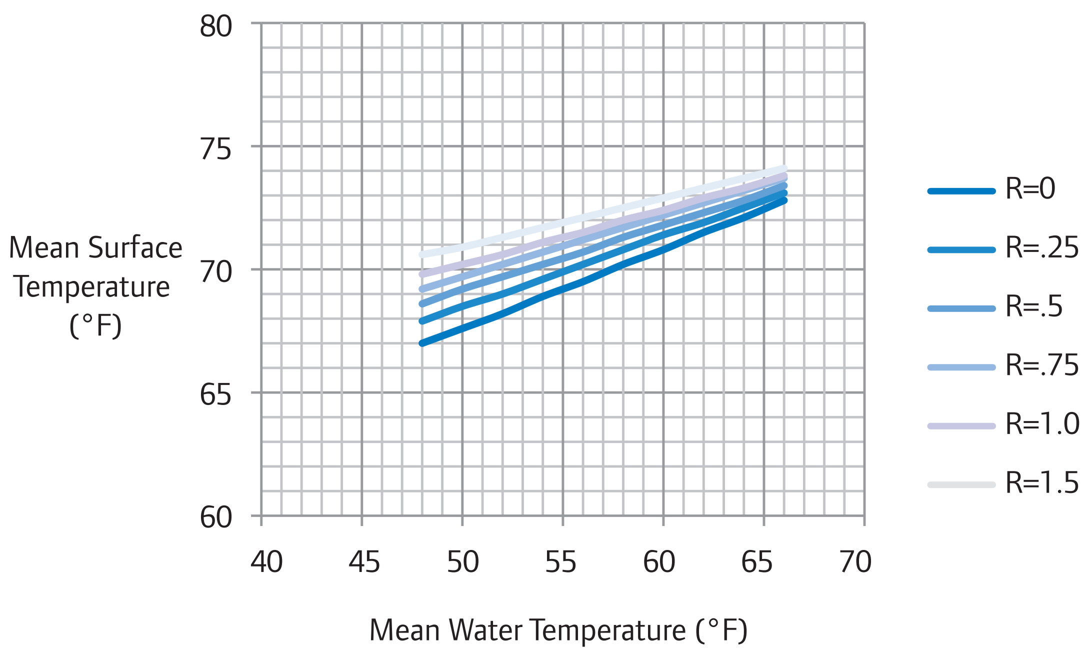




Note: For other tubing on-center spacing and R-value data, contact Uponor Technical Services at 888.594.7726 or technical.services@uponor.com.

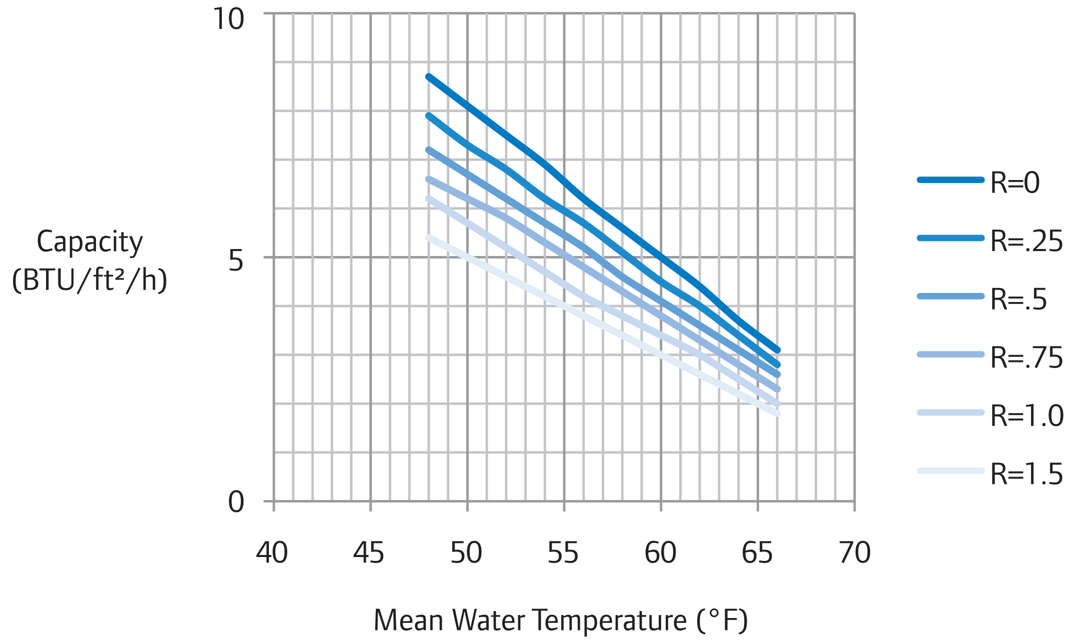
9" O.C. Mean Water Temperature and Mean Surface Temperature Charts

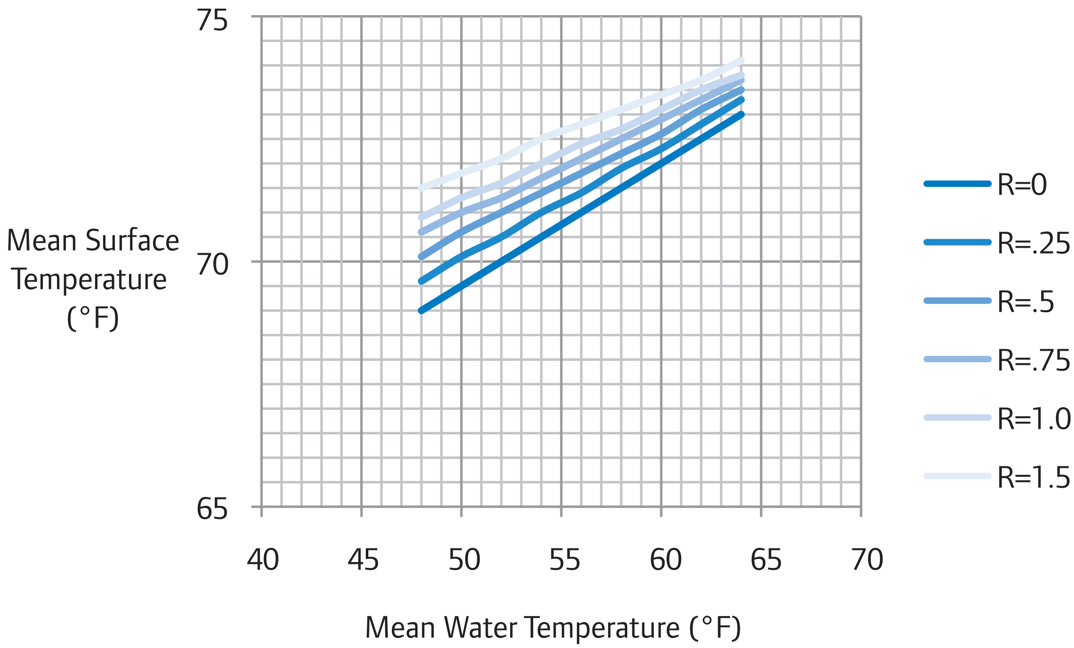




Note: For other tubing on-center spacing and R-value data, contact Uponor Technical Services at 888.594.7726 or technical.services@uponor.com.

12" O.C. Mean Water Temperature and Mean Surface Temperature Charts





Note: For other tubing on-center spacing and R-value data, contact Uponor Technical Services at 888.594.7726 or technical.services@uponor.com.

Appendix E
R-value Charts

Construction Materials

Construction Materials	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"
Plywood (Douglas fir)		0.31	0.47	0.62	0.77	0.93
Oriented strand board (OSB)		0.31	0.47	0.62	0.78	0.94
Asbestos-cement board	0.03	0.06	0.09			
Particle board (underlayment)	0.17	0.33	0.49	0.66	0.82	

Sheet Goods

Sheet Goods	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"
Vinyl	0.20					
Linoleum (uninsulated)	0.20					
Linoleum (insulated)		0.40				

Tiles and Stone

Tiles and Stone	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"
Ceramic tile		0.23	0.34	0.45	0.57	0.68
Cork tile	0.28	0.56	0.84			
Limestone			0.38	0.50	0.63	0.76
Quarried stone			0.30	0.40	0.50	0.60
Marble		0.20	0.30	0.40	0.50	0.60
Brick			0.38	0.50	0.63	0.76

Carpeting

Carpeting	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"
Commercial glue down		0.60	0.90			
Acrylic level loop		1.04	1.56	2.08	2.60	3.12
Acrylic plush		0.83	1.25	1.66	2.08	2.49
Polyester plush		0.96	1.44	1.92	2.40	2.88
Nylon saxony		0.88	1.32	1.76	2.20	2.64
Nylon shag		0.54	0.81	1.08	1.35	1.62
Wool plush		1.10	1.65	2.20	2.75	3.30

Carpet Pads

Carpet Pads	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"
Rubber (solid)		0.31	0.47	0.62	0.78	0.93
Rubber (waffled)		0.62	0.93	1.24	1.55	1.86
Hair and jute		0.98	1.47	1.96	2.45	2.94
Prime urethane (2-lb. density)		1.08	1.62	2.16	2.70	3.24
Bonded urethane (4-lb. density)		1.04	1.56	2.08	2.60	3.12
Bonded urethane (8-lb. density)		1.10	1.65	2.20	2.75	3.30

Wood Flooring

Wood Flooring	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"
Ash			0.35	0.47	0.59	0.71
Cherry			0.35	0.46	0.58	0.69
Elm			0.33	0.45	0.56	0.67
Redwood			0.51	0.68	0.84	1.01
Maple			0.35	0.46	0.58	0.69
Oak			0.33	0.45	0.56	0.67
Walnut			0.34	0.45	0.57	0.68
Douglas fir			0.40	0.53	0.66	0.80
Southern pine			0.38	0.50	0.62	0.75
Spruce			0.51	0.68	0.84	1.01
Floating wood floor pad	0.20	0.40				

Windows

Single glass	0.91
Single glass with storm	2.00
Double glazed – 3/16" air space	1.61
Double glazed – 1/4" air space	1.69
Double glazed – 1/2" air space	2.04
Double glazed – 3/4" air space	2.38
Double glazed – with suspended film	2.77
Double glazed – with 2 suspended films	3.85
Low-E	3.13
Low-E – with suspended film	4.05
Low-E – with 2 suspended films	5.05

R to RSI (R-value Système International) Conversion:

R x 0.176 = RSI

RSI x 5.68 = R

Note: The R-values depicted in this chart are representative and may vary by manufacturer. For specific R-values, check with the appropriate floor covering manufacturer.

Appendix F

Calculations

Commercial Radiant Heating and Cooling

Quick-reference Guide

www.uponorengineering.com

The information in this document assumes typical construction methods used in commercial radiant heating and cooling installations.

Quick-quote Procedure

1. Determine parameters (A), (B).
2. For each area, calculate total tubing (D).
3. Based on tubing required, estimate the number of loops (E). Make sure to account for leader lengths.
4. Based on number of loops, determine number of manifolds (F). Make sure to check flow rates.
5. Determine coils to minimize waste (I).
6. Size manifold cabinets (J).
7. Include accessories in quote.

A. Typical Design Parameters — Heating

Floor Capacity (BTUH/SF)	30
Ceiling Capacity (BTUH/SF)	18
Maximum Surface Temperature	84
Average Water Temperature	95-110
Typical Design Delta T	10-20
Typical Room Setpoint	68
Typical Tubing Diameter	½ - ¾
Typical On-center Spacing	9" - 12"

B. Typical Design Parameters — Cooling

Floor Capacity (BTUH/SF)	12
Ceiling Capacity (BTUH/SF)	30
Minimum Surface Temperature	66
Average Water Temperature	55-58
Typical Design Delta T	5-8
Typical Room Setpoint	78
Typical Tubing Diameter	½ - ¾
Typical On-center Spacing	6" - 9"

Notes:
1. Capacities shown assume bare concrete floor. Adjustments required for flooring.
2. Floor-cooling capacity does not include direct solar absorption, which could increase capacity to 31 BTUH/SF.

C. Estimating Capacity

Q (BTU/H) = H x Delta T x Surface Area

H =	Floor	Wall	Ceiling
Cool	1.23	1.40	1.94
Heat	1.94	1.40	1.06

Notes:
1. Delta T = ABS (Space Temperature - Controlled Surface Temperature)
2. Assumes that space temperature is close to or equal to operative temperature
3. Surface area = active area
4. Does not include direct solar absorption

D. Estimating Tubing Required

T = Area x 12/o.c. Spacing

OR T = Area x Multiplier

Spacing	Multiplier	Spacing	Multiplier
6"	2.00	9"	1.33
7"	1.71	12"	1.00
8"	1.50	18"	0.67

E. Determining # of Loops

# of loops = T / loop length

Tubing	Max. Length
⅜"	125-150
½"	250-300
⅝"	350-450
¾"	450 -500

Notes:
1. Maximum loop lengths determined by pressure drop. Goal PD < 10ft.
2. Pressure drops can vary greatly based on operating temperature, flow rate, and glycol percentage.
3. Be sure to include leader tubing

F. Sizing Manifolds

Size manifold based on # of loops and flow

GPM = Q / (500 X Delta T)

Manifold	Max. Loops	Max. GPM
Engineered Polymer (EP)	12	15.4
TruFLOW™ Jr.	12	14
TruFLOW Classic	12	21

G. Radiant Rollout™ Mat Options

Spacing:	9" o.c.	6" o.c.
Width	4.5' or 9'	5' or 10'
Max. Mat Length	165' for ½", 225' for ⅝"	
Diameter	½" or ⅝"	
Tubing	Wirsbo hePEX™	
Header	¾" Reverse Return or None	

H. Uponor PEX-a Properties

200°F	180°F	73.4°F
80 PSI	100 PSI	160 PSI

I. Wirsbo hePEX™ Coils

⅜"	100', 400', 1000'
½"	100', 300', 500', 1000'
⅝"	100', 300', 400', 1000'
¾"	100', 300', 500', 1000'
1"	100', 300', 500'
Custom coils available	

J. Sizing Manifold Cabinets

Loops	TF CL/Jr.	TF w/BV	EP	EP w/BV
2-4	24	24	24	24
5	24	24	24	30.5
6	24	30.5	24	30.5
7	24	30.5	30.5	30.5
8	30.5	30.5	30.5	39
9	n/a	n/a	30.5	39
10	30.5	39	30.5	39
11-12	39	39	39	39

For further guidance, please contact your local Uponor representative or Uponor Design Services at 888.594.7726

Appendix G
Hydronic Friction Loss Tables

Note: For additional data, refer to the Uponor Pipe Sizing Calculator at www.uponorpro.com/calculator.

5⁄16" Uponor PEX-a — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.10	0.00908	0.00873	0.00841	0.00814	0.00789	0.00767	0.00747	0.00729	0.00712	0.00697	0.00683	0.00670	0.00659
0.6	0.13	0.01230	0.01183	0.01141	0.01105	0.01072	0.01043	0.01016	0.00992	0.00970	0.00950	0.00931	0.00914	0.00899
0.7	0.15	0.01591	0.01531	0.01479	0.01433	0.01391	0.01354	0.01320	0.01289	0.01261	0.01235	0.01212	0.01190	0.01170
0.8	0.17	0.01990	0.01917	0.01852	0.01795	0.01744	0.01698	0.01657	0.01619	0.01584	0.01552	0.01523	0.01496	0.01471
0.9	0.19	0.02426	0.02338	0.02261	0.02192	0.02131	0.02075	0.02025	0.01979	0.01938	0.01899	0.01864	0.01832	0.01802
1.0	0.21	0.02898	0.02795	0.02703	0.02622	0.02550	0.02484	0.02425	0.02371	0.02322	0.02276	0.02235	0.02197	0.02161
1.1	0.23	0.03405	0.03285	0.03179	0.03085	0.03000	0.02924	0.02856	0.02793	0.02735	0.02682	0.02634	0.02589	0.02548
1.2	0.25	0.03946	0.03808	0.03687	0.03579	0.03482	0.03395	0.03316	0.03243	0.03178	0.03116	0.03061	0.03010	0.02962
1.3	0.27	0.04520	0.04364	0.04226	0.04104	0.03994	0.03895	0.03805	0.03723	0.03648	0.03579	0.03516	0.03458	0.03404
1.4	0.29	0.05127	0.04952	0.04797	0.04660	0.04536	0.04424	0.04324	0.04231	0.04147	0.04068	0.03998	0.03932	0.03871
1.5	0.31	0.05767	0.05572	0.05399	0.05246	0.05107	0.04983	0.04870	0.04767	0.04673	0.04585	0.04506	0.04433	0.04365
1.6	0.33	0.06438	0.06222	0.06031	0.05861	0.05707	0.05569	0.05445	0.05330	0.05226	0.05128	0.05041	0.04959	0.04884
1.7	0.35	0.07141	0.06903	0.06692	0.06505	0.06336	0.06184	0.06047	0.05920	0.05805	0.05698	0.05601	0.05512	0.05428
1.8	0.38	0.07874	0.07614	0.07383	0.07178	0.06993	0.06826	0.06676	0.06537	0.06411	0.06293	0.06187	0.06089	0.05997
1.9	0.40	0.08638	0.08355	0.08103	0.07880	0.07678	0.07496	0.07332	0.07180	0.07043	0.06914	0.06799	0.06692	0.06592
2.0	0.42	0.09433	0.09125	0.08852	0.08609	0.08390	0.08193	0.08014	0.07850	0.07701	0.07561	0.07435	0.07319	0.07210
2.1	0.44	0.10257	0.09924	0.09629	0.09367	0.09130	0.08916	0.08723	0.08545	0.08384	0.08233	0.08097	0.07970	0.07853
2.2	0.46	0.11110	0.10752	0.10434	0.10152	0.09896	0.09666	0.09458	0.09266	0.09092	0.08929	0.08782	0.08646	0.08519
2.3	0.48	0.11993	0.11609	0.11267	0.10964	0.10689	0.10442	0.10219	0.10013	0.09826	0.09650	0.09493	0.09346	0.09210
2.4	0.50	0.12905	0.12494	0.12128	0.11803	0.11509	0.11244	0.11005	0.10784	0.10584	0.10396	0.10227	0.10070	0.09924
2.5	0.52	0.13845	0.13406	0.13015	0.12669	0.12355	0.12072	0.11816	0.11580	0.11367	0.11165	0.10985	0.10817	0.10661
2.6	0.54	0.14814	0.14346	0.13930	0.13561	0.13226	0.12925	0.12653	0.12401	0.12174	0.11959	0.11767	0.11588	0.11422
2.7	0.56	0.15811	0.15314	0.14872	0.14480	0.14124	0.13804	0.13514	0.13247	0.13005	0.12777	0.12572	0.12382	0.12205
2.8	0.58	0.16836	0.16309	0.15841	0.15424	0.15047	0.14708	0.14400	0.14117	0.13860	0.13618	0.13401	0.13199	0.13011
2.9	0.61			0.16835	0.16395	0.15996	0.15636	0.15311	0.15011	0.14739	0.14483	0.14253	0.14039	0.13840
3.0	0.63					0.16970	0.16590	0.16246	0.15929	0.15641	0.15371	0.15128	0.14902	0.14692
3.1	0.65								0.16871	0.16568	0.16282	0.16026	0.15788	0.15566
3.2	0.67											0.16947	0.16696	0.16462

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

5⁄16" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.10	0.01357	0.01267	0.01191	0.01126	0.01071	0.01023	0.00980	0.00947	0.00914	0.00884	0.00859	0.00835	0.00817
0.6	0.13	0.01820	0.01702	0.01603	0.01517	0.01446	0.01383	0.01326	0.01281	0.01238	0.01198	0.01166	0.01133	0.01110
0.7	0.15	0.02336	0.02188	0.02063	0.01955	0.01865	0.01785	0.01713	0.01657	0.01602	0.01552	0.01510	0.01469	0.01439
0.8	0.17	0.02903	0.02722	0.02569	0.02438	0.02327	0.02229	0.02141	0.02072	0.02004	0.01943	0.01892	0.01841	0.01804
0.9	0.19	0.03519	0.03303	0.03121	0.02963	0.02831	0.02714	0.02609	0.02525	0.02444	0.02370	0.02309	0.02248	0.02203
1.0	0.21	0.04182	0.03930	0.03716	0.03531	0.03375	0.03238	0.03114	0.03016	0.02920	0.02833	0.02760	0.02689	0.02636
1.1	0.23	0.04892	0.04600	0.04353	0.04139	0.03959	0.03800	0.03656	0.03542	0.03432	0.03330	0.03246	0.03163	0.03102
1.2	0.25	0.05647	0.05314	0.05032	0.04788	0.04582	0.04399	0.04235	0.04105	0.03978	0.03861	0.03765	0.03670	0.03599
1.3	0.27	0.06446	0.06070	0.05751	0.05475	0.05242	0.05036	0.04849	0.04701	0.04558	0.04425	0.04316	0.04208	0.04128
1.4	0.29	0.07289	0.06868	0.06510	0.06201	0.05939	0.05707	0.05498	0.05332	0.05171	0.05022	0.04899	0.04778	0.04687
1.5	0.31	0.08174	0.07706	0.07308	0.06964	0.06673	0.06415	0.06182	0.05996	0.05816	0.05650	0.05513	0.05378	0.05277
1.6	0.33	0.09100	0.08584	0.08144	0.07764	0.07442	0.07157	0.06899	0.06694	0.06494	0.06310	0.06159	0.06008	0.05897
1.7	0.35	0.10068	0.09501	0.09018	0.08600	0.08247	0.07933	0.07649	0.07423	0.07204	0.07002	0.06834	0.06669	0.06546
1.8	0.38	0.11076	0.10457	0.09929	0.09473	0.09086	0.08743	0.08432	0.08185	0.07945	0.07723	0.07540	0.07359	0.07224
1.9	0.40	0.12124	0.11451	0.10877	0.10380	0.09959	0.09586	0.09247	0.08978	0.08717	0.08475	0.08275	0.08078	0.07931
2.0	0.42	0.13211	0.12482	0.11861	0.11323	0.10867	0.10462	0.10095	0.09803	0.09519	0.09257	0.09040	0.08825	0.08666
2.1	0.44	0.14337	0.13551	0.12881	0.12300	0.11808	0.11370	0.10974	0.10659	0.10351	0.10068	0.09834	0.09602	0.09429
2.2	0.46	0.15501	0.14657	0.13937	0.13312	0.12782	0.12310	0.11884	0.11545	0.11214	0.10909	0.10656	0.10406	0.10220
2.3	0.48	0.16704	0.15799	0.15027	0.14357	0.13788	0.13283	0.12825	0.12461	0.12106	0.11778	0.11507	0.11238	0.11038
2.4	0.50		0.16977	0.16152	0.15435	0.14827	0.14287	0.13797	0.13407	0.13027	0.12676	0.12386	0.12098	0.11884
2.5	0.52				0.16547	0.15898	0.15322	0.14799	0.14383	0.13977	0.13603	0.13293	0.12985	0.12756
2.6	0.54						0.16387	0.15831	0.15388	0.14956	0.14557	0.14227	0.13900	0.13656
2.7	0.56							0.16893	0.16423	0.15964	0.15540	0.15189	0.14841	0.14582
2.8	0.58									0.17000	0.16550	0.16178	0.15809	0.15534
2.9	0.61												0.16804	0.16513

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

5⁄16" **Uponor PEX-a** — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.10	0.01585	0.01459	0.01357	0.01271	0.01197	0.01135	0.01080	0.01035	0.00997	0.00958	0.00931	0.00899	0.00877
0.6	0.13	0.02117	0.01953	0.01819	0.01707	0.01610	0.01529	0.01457	0.01398	0.01347	0.01297	0.01260	0.01219	0.01189
0.7	0.15	0.02708	0.02503	0.02336	0.02194	0.02072	0.01970	0.01880	0.01805	0.01740	0.01677	0.01630	0.01578	0.01540
0.8	0.17	0.03356	0.03107	0.02903	0.02730	0.02581	0.02456	0.02346	0.02254	0.02175	0.02097	0.02039	0.01975	0.01928
0.9	0.19	0.04059	0.03762	0.03519	0.03314	0.03136	0.02986	0.02853	0.02743	0.02649	0.02555	0.02486	0.02409	0.02353
1.0	0.21	0.04815	0.04467	0.04183	0.03942	0.03733	0.03557	0.03402	0.03272	0.03161	0.03051	0.02970	0.02879	0.02812
1.1	0.23	0.05622	0.05221	0.04893	0.04615	0.04374	0.04170	0.03990	0.03840	0.03712	0.03584	0.03490	0.03384	0.03306
1.2	0.25	0.06479	0.06023	0.05648	0.05331	0.05056	0.04823	0.04618	0.04446	0.04298	0.04152	0.04044	0.03923	0.03834
1.3	0.27	0.07384	0.06871	0.06448	0.06090	0.05779	0.05516	0.05283	0.05088	0.04921	0.04755	0.04633	0.04496	0.04395
1.4	0.29	0.08338	0.07764	0.07291	0.06890	0.06541	0.06246	0.05985	0.05767	0.05579	0.05393	0.05255	0.05101	0.04988
1.5	0.31	0.09339	0.08702	0.08176	0.07731	0.07343	0.07015	0.06724	0.06481	0.06272	0.06064	0.05911	0.05739	0.05612
1.6	0.33	0.10386	0.09683	0.09104	0.08612	0.08183	0.07821	0.07499	0.07230	0.06999	0.06769	0.06599	0.06409	0.06268
1.7	0.35	0.11478	0.10708	0.10072	0.09532	0.09062	0.08663	0.08310	0.08014	0.07760	0.07506	0.07320	0.07110	0.06955
1.8	0.38	0.12615	0.11774	0.11081	0.10491	0.09977	0.09542	0.09155	0.08831	0.08553	0.08276	0.08072	0.07842	0.07673
1.9	0.40	0.13795	0.12883	0.12129	0.11489	0.10930	0.10456	0.10035	0.09683	0.09380	0.09078	0.08855	0.08605	0.08420
2.0	0.42	0.15020	0.14033	0.13218	0.12524	0.11918	0.11405	0.10949	0.10567	0.10239	0.09911	0.09670	0.09398	0.09197
2.1	0.44	0.16287	0.15224	0.14345	0.13597	0.12943	0.12389	0.11897	0.11484	0.11130	0.10775	0.10515	0.10220	0.10004
2.2	0.46		0.16454	0.15510	0.14706	0.14004	0.13408	0.12878	0.12434	0.12052	0.11671	0.11390	0.11073	0.10840
2.3	0.48			0.16713	0.15852	0.15099	0.14460	0.13892	0.13415	0.13006	0.12596	0.12295	0.11955	0.11704
2.4	0.50					0.16229	0.15546	0.14938	0.14429	0.13990	0.13552	0.13230	0.12865	0.12597
2.5	0.52						0.16665	0.16017	0.15474	0.15006	0.14538	0.14194	0.13805	0.13519
2.6	0.54								0.16550	0.16052	0.15554	0.15187	0.14773	0.14468
2.7	0.56										0.16599	0.16209	0.15769	0.15445
2.8	0.58												0.16794	0.16450

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

5⁄16" **Uponor PEX-a** — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.10	0.01852	0.01688	0.01556	0.01445	0.01352	0.01273	0.01205	0.01147	0.01097	0.01051	0.01010	0.00976	0.00944
0.6	0.13	0.02463	0.02252	0.02079	0.01936	0.01814	0.01711	0.01622	0.01545	0.01479	0.01418	0.01365	0.01321	0.01278
0.7	0.15	0.03141	0.02877	0.02661	0.02481	0.02329	0.02199	0.02087	0.01991	0.01907	0.01831	0.01763	0.01707	0.01653
0.8	0.17	0.03881	0.03561	0.03299	0.03080	0.02895	0.02737	0.02600	0.02482	0.02380	0.02286	0.02202	0.02134	0.02068
0.9	0.19	0.04682	0.04303	0.03991	0.03731	0.03510	0.03321	0.03157	0.03016	0.02894	0.02782	0.02682	0.02600	0.02521
1.0	0.21	0.05542	0.05100	0.04736	0.04431	0.04172	0.03951	0.03759	0.03593	0.03450	0.03318	0.03200	0.03104	0.03010
1.1	0.23	0.06459	0.05950	0.05531	0.05180	0.04881	0.04626	0.04404	0.04212	0.04046	0.03893	0.03757	0.03645	0.03537
1.2	0.25	0.07431	0.06852	0.06375	0.05976	0.05635	0.05344	0.05090	0.04871	0.04682	0.04506	0.04350	0.04222	0.04098
1.3	0.27	0.08457	0.07806	0.07268	0.06818	0.06433	0.06104	0.05817	0.05570	0.05355	0.05156	0.04980	0.04835	0.04694
1.4	0.29	0.09536	0.08809	0.08209	0.07705	0.07275	0.06906	0.06585	0.06307	0.06067	0.05844	0.05646	0.05482	0.05324
1.5	0.31	0.10667	0.09862	0.09196	0.08637	0.08159	0.07749	0.07392	0.07083	0.06815	0.06567	0.06346	0.06164	0.05988
1.6	0.33	0.11849	0.10962	0.10228	0.09612	0.09084	0.08632	0.08237	0.07896	0.07600	0.07325	0.07081	0.06879	0.06684
1.7	0.35	0.13081	0.12110	0.11306	0.10630	0.10051	0.09554	0.09121	0.08746	0.08421	0.08118	0.07850	0.07628	0.07413
1.8	0.38	0.14362	0.13304	0.12427	0.11690	0.11058	0.10516	0.10042	0.09633	0.09277	0.08946	0.08653	0.08409	0.08174
1.9	0.40	0.15691	0.14544	0.13592	0.12792	0.12105	0.11516	0.11001	0.10555	0.10167	0.09808	0.09488	0.09223	0.08967
2.0	0.42		0.15829	0.14801	0.13934	0.13191	0.12553	0.11996	0.11513	0.11093	0.10703	0.10356	0.10069	0.09791
2.1	0.44			0.16051	0.15118	0.14317	0.13629	0.13027	0.12506	0.12052	0.11631	0.11256	0.10946	0.10646
2.2	0.46				0.16341	0.15480	0.14741	0.14094	0.13533	0.13045	0.12592	0.12189	0.11854	0.11531
2.3	0.48					0.16682	0.15889	0.15196	0.14595	0.14071	0.13585	0.13152	0.12794	0.12447
2.4	0.50							0.16333	0.15690	0.15131	0.14610	0.14148	0.13763	0.13392
2.5	0.52								0.16819	0.16223	0.15667	0.15174	0.14764	0.14367
2.6	0.54										0.16756	0.16231	0.15794	0.15372
2.7	0.56												0.16854	0.16406

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅜" Uponor PEX-a — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.15	0.00713	0.00685	0.00661	0.00640	0.00621	0.00604	0.00589	0.00575	0.00562	0.00550	0.00540	0.00530	0.00521
0.6	0.18	0.00966	0.00930	0.00899	0.00871	0.00845	0.00823	0.00802	0.00784	0.00767	0.00751	0.00737	0.00724	0.00711
0.7	0.21	0.01252	0.01206	0.01166	0.01130	0.01098	0.01069	0.01043	0.01019	0.00998	0.00977	0.00959	0.00943	0.00927
0.8	0.24	0.01567	0.01511	0.01461	0.01417	0.01378	0.01342	0.01310	0.01281	0.01254	0.01229	0.01207	0.01186	0.01167
0.9	0.27	0.01912	0.01845	0.01785	0.01732	0.01685	0.01642	0.01603	0.01568	0.01535	0.01505	0.01478	0.01453	0.01430
1.0	0.30	0.02286	0.02207	0.02136	0.02074	0.02017	0.01967	0.01921	0.01879	0.01841	0.01805	0.01773	0.01744	0.01716
1.1	0.33	0.02688	0.02595	0.02513	0.02441	0.02375	0.02316	0.02263	0.02214	0.02170	0.02128	0.02091	0.02056	0.02024
1.2	0.36	0.03117	0.03011	0.02917	0.02833	0.02758	0.02690	0.02629	0.02573	0.02522	0.02474	0.02431	0.02392	0.02355
1.3	0.39	0.03572	0.03452	0.03345	0.03251	0.03165	0.03088	0.03019	0.02955	0.02897	0.02843	0.02794	0.02749	0.02706
1.4	0.42	0.04054	0.03919	0.03799	0.03692	0.03596	0.03510	0.03431	0.03359	0.03294	0.03233	0.03178	0.03127	0.03079
1.5	0.45	0.04562	0.04411	0.04277	0.04158	0.04051	0.03954	0.03867	0.03786	0.03713	0.03645	0.03583	0.03526	0.03473
1.6	0.48	0.05095	0.04928	0.04780	0.04648	0.04529	0.04421	0.04324	0.04235	0.04154	0.04078	0.04010	0.03947	0.03888
1.7	0.51	0.05653	0.05469	0.05306	0.05161	0.05029	0.04911	0.04804	0.04706	0.04616	0.04533	0.04457	0.04387	0.04322
1.8	0.54	0.06237	0.06035	0.05856	0.05697	0.05553	0.05423	0.05306	0.05198	0.05100	0.05008	0.04925	0.04848	0.04777
1.9	0.57	0.06844	0.06624	0.06429	0.06255	0.06098	0.05957	0.05829	0.05711	0.05604	0.05504	0.05413	0.05330	0.05252
2.0	0.60	0.07476	0.07237	0.07025	0.06836	0.06666	0.06512	0.06373	0.06245	0.06129	0.06020	0.05922	0.05831	0.05746
2.1	0.63	0.08131	0.07873	0.07644	0.07440	0.07255	0.07089	0.06939	0.06800	0.06674	0.06556	0.06450	0.06351	0.06259
2.2	0.66	0.08810	0.08532	0.08285	0.08065	0.07866	0.07687	0.07525	0.07376	0.07240	0.07112	0.06998	0.06892	0.06792
2.3	0.69	0.09513	0.09214	0.08949	0.08713	0.08499	0.08306	0.08132	0.07971	0.07826	0.07689	0.07565	0.07451	0.07344
2.4	0.72	0.10239	0.09919	0.09635	0.09382	0.09153	0.08946	0.08760	0.08588	0.08431	0.08284	0.08152	0.08030	0.07915
2.5	0.75	0.10987	0.10646	0.10342	0.10072	0.09827	0.09607	0.09408	0.09224	0.09057	0.08899	0.08758	0.08627	0.08505
2.6	0.78	0.11759	0.11395	0.11072	0.10784	0.10523	0.10288	0.10076	0.09879	0.09701	0.09534	0.09384	0.09244	0.09113
2.7	0.81	0.12553	0.12167	0.11823	0.11517	0.11240	0.10990	0.10764	0.10555	0.10366	0.10188	0.10028	0.09879	0.09740
2.8	0.84	0.13369	0.12960	0.12595	0.12270	0.11976	0.11712	0.11472	0.11250	0.11049	0.10860	0.10690	0.10533	0.10385
2.9	0.87	0.14208	0.13775	0.13388	0.13045	0.12734	0.12453	0.12199	0.11965	0.11752	0.11552	0.11372	0.11205	0.11049
3.0	0.90	0.15069	0.14611	0.14203	0.13840	0.13511	0.13215	0.12946	0.12699	0.12474	0.12262	0.12072	0.11895	0.11730
3.1	0.93	0.15951	0.15469	0.15038	0.14656	0.14309	0.13996	0.13713	0.13452	0.13214	0.12991	0.12790	0.12604	0.12430
3.2	0.96	0.16856	0.16348	0.15895	0.15492	0.15127	0.14797	0.14499	0.14224	0.13974	0.13739	0.13527	0.13331	0.13147
3.3	0.99			0.16772	0.16348	0.15964	0.15618	0.15304	0.15015	0.14752	0.14504	0.14282	0.14075	0.13883
3.4	1.02					0.16821	0.16458	0.16129	0.15825	0.15549	0.15289	0.15055	0.14838	0.14636
3.5	1.05							0.16972	0.16653	0.16364	0.16091	0.15846	0.15619	0.15406
3.6	1.08										0.16912	0.16655	0.16417	0.16194
3.7	1.11													0.17000

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅜" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.15	0.01055	0.00986	0.00929	0.00879	0.00838	0.00801	0.00768	0.00742	0.00717	0.00694	0.00675	0.00657	0.00643
0.6	0.18	0.01417	0.01328	0.01252	0.01187	0.01132	0.01084	0.01041	0.01006	0.00973	0.00943	0.00918	0.00893	0.00875
0.7	0.21	0.01822	0.01709	0.01614	0.01532	0.01462	0.01401	0.01347	0.01303	0.01261	0.01222	0.01190	0.01159	0.01135
0.8	0.24	0.02267	0.02129	0.02012	0.01912	0.01827	0.01752	0.01685	0.01631	0.01579	0.01532	0.01492	0.01454	0.01425
0.9	0.27	0.02751	0.02586	0.02447	0.02326	0.02225	0.02135	0.02054	0.01990	0.01928	0.01870	0.01823	0.01776	0.01742
1.0	0.30	0.03273	0.03080	0.02916	0.02774	0.02655	0.02549	0.02454	0.02378	0.02305	0.02237	0.02181	0.02126	0.02085
1.1	0.33	0.03831	0.03608	0.03419	0.03255	0.03117	0.02994	0.02883	0.02795	0.02710	0.02631	0.02567	0.02502	0.02455
1.2	0.36	0.04426	0.04171	0.03955	0.03767	0.03609	0.03469	0.03342	0.03241	0.03143	0.03053	0.02978	0.02905	0.02850
1.3	0.39	0.05056	0.04768	0.04523	0.04311	0.04131	0.03972	0.03829	0.03714	0.03603	0.03501	0.03416	0.03333	0.03270
1.4	0.42	0.05720	0.05397	0.05123	0.04885	0.04683	0.04505	0.04343	0.04215	0.04090	0.03975	0.03880	0.03785	0.03715
1.5	0.45	0.06418	0.06059	0.05754	0.05489	0.05264	0.05065	0.04885	0.04742	0.04603	0.04474	0.04368	0.04263	0.04185
1.6	0.48	0.07150	0.06753	0.06415	0.06122	0.05874	0.05654	0.05454	0.05296	0.05141	0.04999	0.04881	0.04764	0.04678
1.7	0.51	0.07914	0.07478	0.07107	0.06785	0.06512	0.06269	0.06050	0.05875	0.05705	0.05548	0.05419	0.05290	0.05194
1.8	0.54	0.08710	0.08234	0.07828	0.07476	0.07177	0.06912	0.06672	0.06481	0.06294	0.06122	0.05980	0.05839	0.05734
1.9	0.57	0.09538	0.09020	0.08579	0.08195	0.07870	0.07581	0.07319	0.07111	0.06908	0.06721	0.06566	0.06412	0.06297
2.0	0.60	0.10397	0.09837	0.09358	0.08943	0.08590	0.08277	0.07993	0.07767	0.07546	0.07343	0.07174	0.07007	0.06883
2.1	0.63	0.11288	0.10683	0.10167	0.09718	0.09337	0.08998	0.08691	0.08447	0.08209	0.07989	0.07806	0.07626	0.07491
2.2	0.66	0.12209	0.11559	0.11003	0.10520	0.10110	0.09746	0.09415	0.09152	0.08895	0.08658	0.08462	0.08267	0.08122
2.3	0.69	0.13160	0.12463	0.11867	0.11350	0.10910	0.10518	0.10163	0.09881	0.09605	0.09350	0.09139	0.08930	0.08774
2.4	0.72	0.14141	0.13396	0.12760	0.12206	0.11735	0.11316	0.10936	0.10634	0.10339	0.10066	0.09840	0.09616	0.09449
2.5	0.75	0.15152	0.14358	0.13679	0.13088	0.12586	0.12139	0.11734	0.11411	0.11095	0.10804	0.10563	0.10323	0.10145
2.6	0.78	0.16193	0.15348	0.14626	0.13997	0.13463	0.12987	0.12555	0.12211	0.11875	0.11565	0.11308	0.11053	0.10862
2.7	0.81		0.16366	0.15599	0.14932	0.14364	0.13859	0.13400	0.13035	0.12678	0.12348	0.12075	0.11803	0.11601
2.8	0.84			0.16600	0.15893	0.15291	0.14756	0.14269	0.13882	0.13503	0.13153	0.12863	0.12576	0.12361
2.9	0.87				0.16879	0.16243	0.15676	0.15162	0.14752	0.14351	0.13981	0.13674	0.13369	0.13142
3.0	0.90						0.16621	0.16078	0.15644	0.15221	0.14830	0.14506	0.14184	0.13944
3.1	0.93								0.16560	0.16114	0.15701	0.15359	0.15020	0.14767
3.2	0.96										0.16594	0.16234	0.15877	0.15610
3.3	0.99												0.16754	0.16473

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅜" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.15	0.01227	0.01132	0.01054	0.00989	0.00933	0.00886	0.00845	0.00810	0.00781	0.00752	0.00730	0.00706	0.00689
0.6	0.18	0.01642	0.01518	0.01417	0.01332	0.01258	0.01196	0.01141	0.01096	0.01057	0.01019	0.00990	0.00959	0.00935
0.7	0.21	0.02104	0.01949	0.01822	0.01714	0.01621	0.01543	0.01474	0.01417	0.01367	0.01319	0.01283	0.01243	0.01213
0.8	0.24	0.02612	0.02422	0.02267	0.02136	0.02022	0.01926	0.01841	0.01771	0.01710	0.01650	0.01606	0.01557	0.01521
0.9	0.27	0.03162	0.02936	0.02751	0.02594	0.02458	0.02344	0.02242	0.02158	0.02085	0.02013	0.01960	0.01901	0.01857
1.0	0.30	0.03755	0.03490	0.03273	0.03090	0.02930	0.02795	0.02676	0.02576	0.02491	0.02406	0.02343	0.02273	0.02221
1.1	0.33	0.04388	0.04083	0.03832	0.03620	0.03435	0.03279	0.03141	0.03025	0.02926	0.02827	0.02755	0.02673	0.02613
1.2	0.36	0.05061	0.04714	0.04427	0.04185	0.03974	0.03795	0.03637	0.03504	0.03391	0.03278	0.03195	0.03101	0.03032
1.3	0.39	0.05773	0.05381	0.05058	0.04783	0.04544	0.04342	0.04163	0.04013	0.03884	0.03756	0.03662	0.03555	0.03477
1.4	0.42	0.06523	0.06084	0.05722	0.05415	0.05147	0.04920	0.04719	0.04551	0.04406	0.04262	0.04156	0.04036	0.03948
1.5	0.45	0.07310	0.06823	0.06421	0.06079	0.05781	0.05529	0.05305	0.05117	0.04956	0.04795	0.04676	0.04543	0.04445
1.6	0.48	0.08134	0.07597	0.07153	0.06775	0.06446	0.06167	0.05919	0.05711	0.05532	0.05354	0.05223	0.05075	0.04967
1.7	0.51	0.08995	0.08405	0.07918	0.07503	0.07141	0.06834	0.06561	0.06333	0.06136	0.05940	0.05795	0.05633	0.05513
1.8	0.54	0.09890	0.09247	0.08715	0.08262	0.07866	0.07530	0.07232	0.06981	0.06766	0.06552	0.06393	0.06215	0.06084
1.9	0.57	0.10821	0.10122	0.09543	0.09051	0.08620	0.08255	0.07930	0.07657	0.07423	0.07189	0.07016	0.06822	0.06678
2.0	0.60	0.11786	0.11030	0.10404	0.09870	0.09403	0.09007	0.08655	0.08359	0.08105	0.07851	0.07664	0.07453	0.07297
2.1	0.63	0.12786	0.11970	0.11295	0.10719	0.10215	0.09788	0.09407	0.09088	0.08813	0.08538	0.08336	0.08107	0.07939
2.2	0.66	0.13819	0.12943	0.12217	0.11598	0.11056	0.10596	0.10186	0.09842	0.09546	0.09250	0.09032	0.08786	0.08605
2.3	0.69	0.14885	0.13947	0.13169	0.12505	0.11924	0.11431	0.10991	0.10622	0.10304	0.09987	0.09753	0.09488	0.09293
2.4	0.72	0.15985	0.14983	0.14151	0.13442	0.12821	0.12293	0.11822	0.11428	0.11088	0.10747	0.10497	0.10214	0.10005
2.5	0.75		0.16049	0.15163	0.14407	0.13745	0.13181	0.12680	0.12258	0.11895	0.11532	0.11264	0.10962	0.10739
2.6	0.78			0.16205	0.15401	0.14696	0.14097	0.13562	0.13114	0.12727	0.12341	0.12055	0.11733	0.11496
2.7	0.81				0.16422	0.15674	0.15038	0.14471	0.13994	0.13584	0.13173	0.12870	0.12527	0.12275
2.8	0.84					0.16679	0.16005	0.15404	0.14899	0.14464	0.14028	0.13707	0.13344	0.13076
2.9	0.87						0.16998	0.16362	0.15828	0.15368	0.14907	0.14567	0.14182	0.13899
3.0	0.90								0.16782	0.16295	0.15809	0.15449	0.15043	0.14744
3.1	0.93										0.16733	0.16354	0.15926	0.15610
3.2	0.96												0.16831	0.16498

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅜" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.15	0.01428	0.01305	0.01205	0.01122	0.01051	0.00992	0.00940	0.00896	0.00857	0.00822	0.00791	0.00765	0.00741
0.6	0.18	0.01903	0.01744	0.01614	0.01505	0.01413	0.01335	0.01267	0.01208	0.01158	0.01112	0.01071	0.01037	0.01004
0.7	0.21	0.02431	0.02232	0.02069	0.01933	0.01817	0.01718	0.01633	0.01559	0.01495	0.01437	0.01385	0.01342	0.01301
0.8	0.24	0.03009	0.02767	0.02568	0.02402	0.02261	0.02141	0.02036	0.01946	0.01868	0.01796	0.01732	0.01679	0.01628
0.9	0.27	0.03635	0.03347	0.03111	0.02913	0.02744	0.02600	0.02475	0.02367	0.02274	0.02187	0.02111	0.02048	0.01987
1.0	0.30	0.04307	0.03971	0.03695	0.03463	0.03266	0.03097	0.02950	0.02823	0.02713	0.02611	0.02521	0.02446	0.02374
1.1	0.33	0.05024	0.04638	0.04319	0.04052	0.03824	0.03628	0.03458	0.03311	0.03184	0.03066	0.02961	0.02875	0.02791
1.2	0.36	0.05785	0.05346	0.04983	0.04678	0.04418	0.04195	0.04000	0.03832	0.03686	0.03551	0.03431	0.03332	0.03236
1.3	0.39	0.06590	0.06095	0.05685	0.05341	0.05047	0.04795	0.04575	0.04384	0.04219	0.04066	0.03930	0.03818	0.03709
1.4	0.42	0.07436	0.06883	0.06425	0.06040	0.05710	0.05428	0.05181	0.04968	0.04782	0.04610	0.04458	0.04331	0.04209
1.5	0.45	0.08323	0.07710	0.07202	0.06774	0.06408	0.06094	0.05819	0.05581	0.05375	0.05183	0.05013	0.04872	0.04736
1.6	0.48	0.09251	0.08575	0.08015	0.07543	0.07139	0.06791	0.06488	0.06225	0.05997	0.05785	0.05596	0.05440	0.05289
1.7	0.51	0.10219	0.09478	0.08864	0.08346	0.07902	0.07521	0.07187	0.06898	0.06647	0.06414	0.06206	0.06034	0.05868
1.8	0.54	0.11225	0.10418	0.09748	0.09183	0.08698	0.08281	0.07917	0.07601	0.07326	0.07070	0.06843	0.06655	0.06473
1.9	0.57	0.12270	0.11394	0.10667	0.10053	0.09525	0.09072	0.08675	0.08332	0.08032	0.07754	0.07507	0.07301	0.07103
2.0	0.60	0.13354	0.12407	0.11620	0.10955	0.10384	0.09893	0.09464	0.09091	0.08766	0.08464	0.08196	0.07973	0.07758
2.1	0.63	0.14474	0.13455	0.12606	0.11890	0.11274	0.10744	0.10281	0.09878	0.09528	0.09201	0.08912	0.08671	0.08438
2.2	0.66	0.15632	0.14537	0.13626	0.12857	0.12195	0.11625	0.11126	0.10693	0.10316	0.09965	0.09652	0.09393	0.09142
2.3	0.69	0.16826	0.15655	0.14680	0.13855	0.13146	0.12535	0.12000	0.11535	0.11131	0.10754	0.10419	0.10140	0.09871
2.4	0.72		0.16807	0.15765	0.14885	0.14127	0.13474	0.12902	0.12405	0.11972	0.11569	0.11210	0.10912	0.10623
2.5	0.75			0.16883	0.15945	0.15137	0.14441	0.13831	0.13301	0.12839	0.12409	0.12026	0.11708	0.11400
2.6	0.78					0.16178	0.15437	0.14788	0.14224	0.13732	0.13274	0.12867	0.12528	0.12199
2.7	0.81						0.16461	0.15772	0.15174	0.14651	0.14165	0.13732	0.13371	0.13023
2.8	0.84							0.16784	0.16149	0.15596	0.15080	0.14621	0.14239	0.13869
2.9	0.87									0.16565	0.16020	0.15534	0.15130	0.14739
3.0	0.90										0.16984	0.16471	0.16044	0.15631
3.1	0.93												0.16982	0.16546

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" Uponor PEX-a — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.28	0.00626	0.00588	0.00545	0.00532	0.00518	0.00507	0.00495	0.00475	0.00458	0.00442	0.00429	0.00416	0.00405	0.00396	0.00386	0.00378	0.00371	0.00364	0.00357	0.00351
0.6	0.33	0.00846	0.00795	0.00739	0.00721	0.00703	0.00688	0.00672	0.00646	0.00623	0.00602	0.00584	0.00568	0.00553	0.00540	0.00528	0.00517	0.00507	0.00497	0.00489	0.00481
0.7	0.39	0.01091	0.01027	0.00956	0.00934	0.00910	0.00891	0.00872	0.00838	0.00809	0.00783	0.00760	0.00739	0.00720	0.00703	0.00688	0.00674	0.00661	0.00649	0.00638	0.00628
0.8	0.44	0.01362	0.01284	0.01196	0.01169	0.01140	0.01117	0.01093	0.01051	0.01015	0.00983	0.00954	0.00929	0.00906	0.00885	0.00866	0.00848	0.00832	0.00817	0.00804	0.00791
0.9	0.50	0.01658	0.01564	0.01459	0.01426	0.01392	0.01364	0.01334	0.01284	0.01241	0.01202	0.01168	0.01137	0.01109	0.01084	0.01061	0.01040	0.01020	0.01002	0.00986	0.00971
1.0	0.55	0.01977	0.01867	0.01743	0.01704	0.01664	0.01631	0.01596	0.01537	0.01486	0.01440	0.01399	0.01363	0.01330	0.01300	0.01273	0.01248	0.01224	0.01203	0.01184	0.01166
1.1	0.61	0.02320	0.02192	0.02048	0.02003	0.01956	0.01918	0.01878	0.01809	0.01749	0.01696	0.01649	0.01606	0.01568	0.01533	0.01501	0.01472	0.01445	0.01420	0.01398	0.01377
1.2	0.66	0.02685	0.02538	0.02374	0.02323	0.02269	0.02225	0.02179	0.02100	0.02031	0.01970	0.01916	0.01867	0.01823	0.01783	0.01746	0.01712	0.01681	0.01653	0.01627	0.01602
1.3	0.72	0.03073	0.02906	0.02720	0.02662	0.02601	0.02551	0.02498	0.02409	0.02331	0.02262	0.02200	0.02144	0.02094	0.02048	0.02006	0.01968	0.01933	0.01901	0.01871	0.01843
1.4	0.77	0.03482	0.03295	0.03086	0.03020	0.02952	0.02895	0.02837	0.02736	0.02648	0.02570	0.02501	0.02438	0.02381	0.02330	0.02283	0.02240	0.02200	0.02163	0.02130	0.02098
1.5	0.83	0.03913	0.03705	0.03472	0.03398	0.03322	0.03259	0.03193	0.03081	0.02983	0.02896	0.02818	0.02748	0.02684	0.02627	0.02574	0.02526	0.02481	0.02441	0.02403	0.02368
1.6	0.88	0.04365	0.04134	0.03876	0.03795	0.03710	0.03641	0.03568	0.03444	0.03335	0.03238	0.03152	0.03074	0.03003	0.02940	0.02881	0.02828	0.02778	0.02733	0.02691	0.02652
1.7	0.94	0.04837	0.04584	0.04300	0.04211	0.04117	0.04040	0.03960	0.03824	0.03704	0.03597	0.03502	0.03415	0.03338	0.03268	0.03203	0.03144	0.03089	0.03039	0.02993	0.02950
1.8	0.99	0.05330	0.05053	0.04742	0.04644	0.04542	0.04458	0.04370	0.04220	0.04089	0.03971	0.03867	0.03773	0.03688	0.03611	0.03540	0.03475	0.03415	0.03360	0.03309	0.03262
1.9	1.05	0.05843	0.05541	0.05203	0.05096	0.04985	0.04893	0.04798	0.04634	0.04490	0.04362	0.04249	0.04146	0.04053	0.03969	0.03891	0.03821	0.03754	0.03695	0.03639	0.03588
2.0	1.10	0.06376	0.06049	0.05682	0.05566	0.05445	0.05346	0.05242	0.05064	0.04908	0.04769	0.04646	0.04534	0.04433	0.04341	0.04257	0.04180	0.04108	0.04043	0.03983	0.03927
2.1	1.16	0.06929	0.06576	0.06179	0.06054	0.05923	0.05815	0.05703	0.05511	0.05342	0.05192	0.05058	0.04937	0.04827	0.04728	0.04637	0.04554	0.04476	0.04406	0.04341	0.04280
2.2	1.22	0.07501	0.07121	0.06693	0.06559	0.06418	0.06302	0.06181	0.05974	0.05792	0.05630	0.05485	0.05355	0.05237	0.05130	0.05031	0.04942	0.04858	0.04782	0.04711	0.04646
2.3	1.27	0.08093	0.07685	0.07226	0.07081	0.06930	0.06805	0.06675	0.06453	0.06258	0.06083	0.05928	0.05787	0.05661	0.05546	0.05440	0.05343	0.05253	0.05171	0.05096	0.05025
2.4	1.33	0.08703	0.08267	0.07775	0.07621	0.07459	0.07325	0.07186	0.06948	0.06739	0.06552	0.06386	0.06235	0.06099	0.05976	0.05862	0.05759	0.05662	0.05574	0.05493	0.05417
2.5	1.38	0.09333	0.08867	0.08343	0.08177	0.08004	0.07862	0.07713	0.07459	0.07235	0.07036	0.06858	0.06697	0.06552	0.06420	0.06298	0.06188	0.06084	0.05991	0.05904	0.05823
2.6	1.44	0.09981	0.09485	0.08927	0.08751	0.08566	0.08415	0.08257	0.07986	0.07747	0.07534	0.07345	0.07173	0.07019	0.06878	0.06748	0.06631	0.06520	0.06420	0.06328	0.06241
2.7	1.49	0.10648	0.10121	0.09528	0.09341	0.09145	0.08984	0.08816	0.08528	0.08274	0.08048	0.07847	0.07664	0.07499	0.07350	0.07212	0.07087	0.06969	0.06863	0.06764	0.06672
2.8	1.55	0.11333	0.10775	0.10146	0.09948	0.09740	0.09570	0.09391	0.09086	0.08817	0.08577	0.08363	0.08169	0.07994	0.07836	0.07689	0.07556	0.07431	0.07319	0.07214	0.07116
2.9	1.60	0.12036	0.11446	0.10781	0.10571	0.10352	0.10171	0.09982	0.09659	0.09374	0.09120	0.08894	0.08688	0.08503	0.08335	0.08180	0.08039	0.07906	0.07787	0.07676	0.07573
3.0	1.66	0.12758	0.12135	0.11433	0.11211	0.10979	0.10788	0.10589	0.10247	0.09946	0.09677	0.09438	0.09221	0.09025	0.08848	0.08684	0.08535	0.08395	0.08269	0.08151	0.08042
3.1	1.71	0.13497	0.12841	0.12101	0.11867	0.11622	0.11421	0.11211	0.10850	0.10533	0.10250	0.09997	0.09768	0.09562	0.09374	0.09201	0.09044	0.08896	0.08763	0.08639	0.08523
3.2	1.77	0.14255	0.13564	0.12785	0.12539	0.12282	0.12070	0.11848	0.11469	0.11135	0.10836	0.10570	0.10329	0.10111	0.09914	0.09732	0.09566	0.09410	0.09270	0.09139	0.09017
3.3	1.82	0.15030	0.14304	0.13486	0.13228	0.12957	0.12734	0.12501	0.12102	0.11751	0.11437	0.11157	0.10904	0.10675	0.10467	0.10275	0.10101	0.09937	0.09789	0.09652	0.09524
3.4	1.88	0.15823	0.15061	0.14203	0.13932	0.13647	0.13414	0.13169	0.12750	0.12381	0.12052	0.11758	0.11492	0.11252	0.11033	0.10832	0.10649	0.10476	0.10321	0.10177	0.10042
3.5	1.93	0.16633	0.15835	0.14936	0.14652	0.14354	0.14109	0.13853	0.13413	0.13027	0.12681	0.12373	0.12094	0.11842	0.11613	0.11402	0.11210	0.11029	0.10866	0.10714	0.10573
3.6	1.99		0.16626	0.15684	0.15387	0.15075	0.14819	0.14551	0.14091	0.13686	0.13324	0.13002	0.12709	0.12445	0.12205	0.11984	0.11783	0.11593	0.11423	0.11264	0.11116
3.7	2.04			0.16449	0.16138	0.15812	0.15544	0.15264	0.14783	0.14360	0.13981	0.13644	0.13338	0.13062	0.12811	0.12579	0.12369	0.12171	0.11992	0.11826	0.11671
3.8	2.10				0.16905	0.16565	0.16285	0.15992	0.15490	0.15048	0.14652	0.14300	0.13980	0.13692	0.13430	0.13188	0.12968	0.12760	0.12574	0.12400	0.12238

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" Uponor PEX-a — 100% Water — Feet of Head per Foot of Tubing

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Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
3.9	2.15							0.16735	0.16211	0.15750	0.15337	0.14970	0.14636	0.14335	0.14061	0.13808	0.13579	0.13362	0.13168	0.12987	0.12818
4.0	2.21								0.16947	0.16466	0.16036	0.15653	0.15305	0.14990	0.14705	0.14442	0.14203	0.13977	0.13774	0.13585	0.13409
4.1	2.26										0.16748	0.16349	0.15987	0.15659	0.15362	0.15088	0.14839	0.14604	0.14392	0.14195	0.14012
4.2	2.32												0.16682	0.16341	0.16032	0.15747	0.15487	0.15243	0.15022	0.14818	0.14627
4.3	2.38														0.16715	0.16418	0.16148	0.15894	0.15665	0.15452	0.15253
4.4	2.43																0.16821	0.16557	0.16319	0.16098	0.15891
4.5	2.49																		0.16985	0.16756	0.16542

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" **Uponor PEX-a** — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.28	0.00974	0.00928	0.00881	0.00844	0.00806	0.00776	0.00744	0.00693	0.00650	0.00613	0.00582	0.00555	0.00532	0.00511	0.00495	0.00479	0.00464	0.00452	0.00440	0.00431
0.6	0.33	0.01300	0.01242	0.01180	0.01132	0.01082	0.01042	0.01001	0.00933	0.00877	0.00829	0.00787	0.00753	0.00722	0.00694	0.00672	0.00651	0.00631	0.00615	0.00599	0.00587
0.7	0.39	0.01664	0.01590	0.01512	0.01453	0.01390	0.01340	0.01287	0.01203	0.01131	0.01071	0.01018	0.00974	0.00935	0.00900	0.00872	0.00845	0.00820	0.00799	0.00779	0.00764
0.8	0.44	0.02062	0.01972	0.01878	0.01805	0.01729	0.01668	0.01603	0.01500	0.01412	0.01338	0.01274	0.01219	0.01171	0.01128	0.01093	0.01060	0.01029	0.01004	0.00979	0.00960
0.9	0.50	0.02493	0.02387	0.02274	0.02188	0.02097	0.02024	0.01947	0.01823	0.01718	0.01629	0.01552	0.01487	0.01429	0.01377	0.01336	0.01295	0.01258	0.01228	0.01197	0.01175
1.0	0.55	0.02957	0.02833	0.02701	0.02600	0.02493	0.02408	0.02317	0.02172	0.02049	0.01944	0.01854	0.01777	0.01709	0.01647	0.01598	0.01551	0.01507	0.01471	0.01435	0.01408
1.1	0.61	0.03453	0.03309	0.03157	0.03041	0.02918	0.02819	0.02715	0.02547	0.02404	0.02283	0.02177	0.02088	0.02009	0.01938	0.01881	0.01825	0.01774	0.01732	0.01690	0.01659
1.2	0.66	0.03979	0.03816	0.03643	0.03510	0.03369	0.03257	0.03137	0.02946	0.02782	0.02643	0.02523	0.02421	0.02330	0.02248	0.02183	0.02119	0.02060	0.02012	0.01964	0.01928
1.3	0.72	0.04535	0.04351	0.04156	0.04006	0.03848	0.03720	0.03585	0.03368	0.03184	0.03026	0.02890	0.02774	0.02671	0.02578	0.02504	0.02431	0.02365	0.02310	0.02255	0.02214
1.4	0.77	0.05121	0.04915	0.04697	0.04529	0.04352	0.04209	0.04058	0.03815	0.03608	0.03431	0.03277	0.03147	0.03032	0.02927	0.02843	0.02762	0.02687	0.02625	0.02563	0.02517
1.5	0.83	0.05735	0.05507	0.05265	0.05079	0.04881	0.04723	0.04555	0.04284	0.04054	0.03857	0.03686	0.03541	0.03411	0.03294	0.03201	0.03111	0.03027	0.02957	0.02889	0.02837
1.6	0.88	0.06378	0.06126	0.05859	0.05654	0.05436	0.05261	0.05075	0.04776	0.04521	0.04303	0.04114	0.03953	0.03810	0.03681	0.03578	0.03477	0.03384	0.03307	0.03231	0.03174
1.7	0.94	0.07048	0.06773	0.06480	0.06254	0.06016	0.05823	0.05619	0.05291	0.05010	0.04771	0.04563	0.04386	0.04228	0.04085	0.03972	0.03861	0.03758	0.03673	0.03589	0.03526
1.8	0.99	0.07746	0.07446	0.07126	0.06880	0.06619	0.06409	0.06187	0.05827	0.05521	0.05259	0.05031	0.04837	0.04664	0.04508	0.04383	0.04262	0.04149	0.04056	0.03964	0.03895
1.9	1.05	0.08471	0.08145	0.07798	0.07530	0.07247	0.07018	0.06777	0.06386	0.06052	0.05767	0.05518	0.05307	0.05119	0.04948	0.04812	0.04680	0.04557	0.04455	0.04355	0.04279
2.0	1.10	0.09223	0.08870	0.08494	0.08205	0.07898	0.07651	0.07389	0.06966	0.06604	0.06294	0.06025	0.05796	0.05592	0.05406	0.05259	0.05115	0.04981	0.04871	0.04761	0.04680
2.1	1.16	0.10001	0.09620	0.09216	0.08904	0.08573	0.08306	0.08024	0.07567	0.07176	0.06842	0.06551	0.06303	0.06082	0.05882	0.05722	0.05566	0.05422	0.05302	0.05184	0.05095
2.2	1.22	0.10805	0.10396	0.09961	0.09626	0.09271	0.08984	0.08680	0.08189	0.07768	0.07408	0.07095	0.06828	0.06590	0.06375	0.06202	0.06034	0.05879	0.05750	0.05622	0.05526
2.3	1.27	0.11634	0.11197	0.10731	0.10373	0.09992	0.09684	0.09358	0.08831	0.08381	0.07994	0.07658	0.07372	0.07116	0.06884	0.06699	0.06519	0.06352	0.06213	0.06075	0.05973
2.4	1.33	0.12489	0.12022	0.11525	0.11142	0.10735	0.10406	0.10058	0.09495	0.09013	0.08599	0.08239	0.07933	0.07659	0.07411	0.07213	0.07019	0.06840	0.06692	0.06544	0.06434
2.5	1.38	0.13369	0.12872	0.12342	0.11934	0.11501	0.11150	0.10779	0.10178	0.09664	0.09223	0.08839	0.08512	0.08220	0.07954	0.07743	0.07536	0.07345	0.07186	0.07028	0.06911
2.6	1.44	0.14274	0.13745	0.13183	0.12749	0.12289	0.11916	0.11521	0.10882	0.10335	0.09866	0.09457	0.09108	0.08797	0.08514	0.08289	0.08068	0.07864	0.07695	0.07527	0.07402
2.7	1.49	0.15203	0.14643	0.14047	0.13587	0.13098	0.12703	0.12284	0.11606	0.11025	0.10527	0.10092	0.09722	0.09391	0.09091	0.08851	0.08617	0.08400	0.08220	0.08041	0.07908
2.8	1.55	0.16157	0.15565	0.14934	0.14447	0.13930	0.13511	0.13068	0.12350	0.11734	0.11206	0.10745	0.10353	0.10002	0.09684	0.09429	0.09181	0.08951	0.08760	0.08570	0.08429
2.9	1.60		0.16509	0.15843	0.15329	0.14783	0.14341	0.13872	0.13113	0.12462	0.11903	0.11416	0.11001	0.10630	0.10293	0.10024	0.09760	0.09517	0.09315	0.09114	0.08964
3.0	1.66			0.16776	0.16233	0.15657	0.15191	0.14697	0.13896	0.13209	0.12619	0.12105	0.11666	0.11274	0.10918	0.10634	0.10355	0.10098	0.09884	0.09672	0.09513
3.1	1.71					0.16553	0.16062	0.15542	0.14698	0.13974	0.13353	0.12810	0.12348	0.11935	0.11559	0.11259	0.10966	0.10694	0.10469	0.10245	0.10077
3.2	1.77						0.16954	0.16406	0.15519	0.14758	0.14104	0.13533	0.13046	0.12612	0.12216	0.11900	0.11591	0.11305	0.11068	0.10832	0.10655
3.3	1.82								0.16359	0.15560	0.14873	0.14273	0.13762	0.13305	0.12889	0.12557	0.12232	0.11931	0.11681	0.11433	0.11248
3.4	1.88									0.16380	0.15660	0.15030	0.14493	0.14014	0.13578	0.13229	0.12888	0.12572	0.12310	0.12049	0.11854
3.5	1.93										0.16464	0.15804	0.15242	0.14739	0.14282	0.13916	0.13559	0.13227	0.12952	0.12679	0.12474
3.6	1.99											0.16595	0.16006	0.15480	0.15001	0.14619	0.14244	0.13897	0.13609	0.13323	0.13109
3.7	2.04												0.16787	0.16237	0.15736	0.15336	0.14945	0.14582	0.14280	0.13981	0.13757
3.8	2.10														0.16487	0.16069	0.15660	0.15281	0.14966	0.14653	0.14419
3.9	2.15															0.16816	0.16389	0.15994	0.15665	0.15339	0.15094
4.0	2.21																	0.16721	0.16379	0.16038	0.15784
4.1	2.26																			0.16752	0.16486

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.28	0.01222	0.01151	0.01076	0.01021	0.00963	0.00919	0.00873	0.00801	0.00741	0.00693	0.00652	0.00616	0.00586	0.00560	0.00538	0.00519	0.00501	0.00487	0.00472	0.00460
0.6	0.33	0.01623	0.01531	0.01433	0.01362	0.01287	0.01230	0.01170	0.01075	0.00997	0.00933	0.00880	0.00833	0.00793	0.00759	0.00730	0.00705	0.00680	0.00662	0.00642	0.00627
0.7	0.39	0.02066	0.01951	0.01830	0.01741	0.01647	0.01575	0.01500	0.01381	0.01283	0.01203	0.01135	0.01076	0.01026	0.00982	0.00945	0.00913	0.00882	0.00859	0.00833	0.00814
0.8	0.44	0.02549	0.02411	0.02263	0.02155	0.02041	0.01954	0.01863	0.01718	0.01598	0.01500	0.01417	0.01344	0.01283	0.01229	0.01183	0.01145	0.01106	0.01077	0.01045	0.01022
0.9	0.50	0.03072	0.02908	0.02733	0.02605	0.02469	0.02366	0.02257	0.02084	0.01941	0.01824	0.01724	0.01637	0.01564	0.01499	0.01444	0.01397	0.01351	0.01317	0.01278	0.01250
1.0	0.55	0.03632	0.03441	0.03237	0.03088	0.02929	0.02809	0.02681	0.02479	0.02311	0.02173	0.02056	0.01954	0.01867	0.01791	0.01726	0.01671	0.01616	0.01576	0.01530	0.01497
1.1	0.61	0.04229	0.04010	0.03775	0.03603	0.03421	0.03282	0.03135	0.02901	0.02708	0.02548	0.02412	0.02294	0.02193	0.02104	0.02030	0.01966	0.01902	0.01855	0.01802	0.01763
1.2	0.66	0.04862	0.04612	0.04346	0.04151	0.03943	0.03785	0.03617	0.03350	0.03130	0.02947	0.02792	0.02656	0.02541	0.02439	0.02354	0.02280	0.02207	0.02153	0.02092	0.02047
1.3	0.72	0.05529	0.05249	0.04949	0.04729	0.04495	0.04316	0.04127	0.03826	0.03577	0.03370	0.03194	0.03041	0.02911	0.02795	0.02698	0.02614	0.02531	0.02470	0.02401	0.02350
1.4	0.77	0.06230	0.05918	0.05583	0.05338	0.05076	0.04876	0.04665	0.04328	0.04048	0.03817	0.03620	0.03447	0.03301	0.03171	0.03062	0.02968	0.02874	0.02805	0.02727	0.02670
1.5	0.83	0.06965	0.06619	0.06248	0.05976	0.05686	0.05464	0.05229	0.04855	0.04544	0.04287	0.04067	0.03875	0.03712	0.03567	0.03445	0.03341	0.03236	0.03159	0.03072	0.03008
1.6	0.88	0.07732	0.07351	0.06944	0.06643	0.06324	0.06080	0.05821	0.05408	0.05064	0.04779	0.04537	0.04324	0.04144	0.03983	0.03848	0.03732	0.03616	0.03531	0.03434	0.03363
1.7	0.94	0.08532	0.08115	0.07669	0.07340	0.06989	0.06722	0.06438	0.05985	0.05607	0.05294	0.05027	0.04794	0.04595	0.04418	0.04270	0.04142	0.04014	0.03920	0.03814	0.03735
1.8	0.99	0.09362	0.08909	0.08423	0.08064	0.07682	0.07390	0.07080	0.06586	0.06174	0.05832	0.05540	0.05284	0.05067	0.04873	0.04710	0.04570	0.04430	0.04327	0.04210	0.04124
1.9	1.05	0.10224	0.09732	0.09205	0.08817	0.08402	0.08085	0.07748	0.07211	0.06763	0.06390	0.06073	0.05794	0.05557	0.05346	0.05169	0.05016	0.04864	0.04751	0.04624	0.04530
2.0	1.10	0.11117	0.10586	0.10017	0.09597	0.09148	0.08806	0.08441	0.07859	0.07374	0.06971	0.06626	0.06325	0.06068	0.05839	0.05646	0.05480	0.05314	0.05192	0.05054	0.04952
2.1	1.16	0.12040	0.11468	0.10856	0.10403	0.09920	0.09551	0.09159	0.08531	0.08008	0.07573	0.07201	0.06875	0.06597	0.06349	0.06141	0.05962	0.05783	0.05650	0.05500	0.05390
2.2	1.22	0.12992	0.12380	0.11722	0.11237	0.10719	0.10322	0.09901	0.09226	0.08663	0.08195	0.07795	0.07444	0.07145	0.06878	0.06654	0.06461	0.06268	0.06125	0.05963	0.05844
2.3	1.27	0.13974	0.13319	0.12616	0.12097	0.11542	0.11118	0.10666	0.09944	0.09341	0.08839	0.08409	0.08033	0.07712	0.07426	0.07185	0.06977	0.06770	0.06616	0.06443	0.06315
2.4	1.33	0.14986	0.14287	0.13538	0.12984	0.12391	0.11938	0.11456	0.10684	0.10040	0.09503	0.09044	0.08641	0.08297	0.07991	0.07733	0.07511	0.07288	0.07124	0.06938	0.06801
2.5	1.38	0.16026	0.15283	0.14485	0.13896	0.13265	0.12783	0.12269	0.11447	0.10760	0.10187	0.09698	0.09268	0.08901	0.08574	0.08299	0.08061	0.07823	0.07648	0.07449	0.07302
2.6	1.44		0.16306	0.15459	0.14833	0.14164	0.13652	0.13106	0.12232	0.11501	0.10892	0.10371	0.09913	0.09523	0.09174	0.08881	0.08628	0.08375	0.08188	0.07976	0.07820
2.7	1.49			0.16460	0.15797	0.15087	0.14544	0.13965	0.13038	0.12263	0.11617	0.11063	0.10577	0.10163	0.09792	0.09481	0.09212	0.08943	0.08744	0.08519	0.08352
2.8	1.55				0.16785	0.16035	0.15460	0.14848	0.13867	0.13045	0.12361	0.11775	0.11260	0.10820	0.10428	0.10098	0.09813	0.09527	0.09316	0.09077	0.08900
2.9	1.60						0.16399	0.15753	0.14717	0.13849	0.13125	0.12505	0.11961	0.11496	0.11081	0.10731	0.10429	0.10127	0.09903	0.09650	0.09464
3.0	1.66							0.16680	0.15588	0.14672	0.13909	0.13255	0.12680	0.12189	0.11750	0.11381	0.11062	0.10743	0.10507	0.10239	0.10042
3.1	1.71								0.16480	0.15516	0.14712	0.14023	0.13417	0.12899	0.12437	0.12048	0.11712	0.11374	0.11125	0.10843	0.10635
3.2	1.77									0.16380	0.15534	0.14809	0.14172	0.13627	0.13141	0.12731	0.12377	0.12022	0.11759	0.11463	0.11243
3.3	1.82										0.16376	0.15614	0.14945	0.14372	0.13861	0.13430	0.13058	0.12685	0.12409	0.12097	0.11866
3.4	1.88											0.16438	0.15735	0.15135	0.14598	0.14146	0.13755	0.13363	0.13074	0.12746	0.12503
3.5	1.93												0.16543	0.15914	0.15351	0.14878	0.14468	0.14057	0.13754	0.13410	0.13156
3.6	1.99													0.16710	0.16121	0.15625	0.15197	0.14767	0.14449	0.14089	0.13822
3.7	2.04														0.16907	0.16389	0.15941	0.15491	0.15159	0.14782	0.14503
3.8	2.10																0.16700	0.16231	0.15883	0.15490	0.15199
3.9	2.15																	0.16985	0.16623	0.16212	0.15909
4.0	2.21																			0.16949	0.16633

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.28	0.01398	0.01312	0.01221	0.01154	0.01083	0.01030	0.00974	0.00887	0.00815	0.00756	0.00707	0.00665	0.00630	0.00599	0.00573	0.00550	0.00529	0.00510	0.00495	0.00480
0.6	0.33	0.01848	0.01737	0.01619	0.01533	0.01441	0.01372	0.01300	0.01186	0.01093	0.01016	0.00952	0.00897	0.00850	0.00810	0.00775	0.00744	0.00717	0.00692	0.00672	0.00652
0.7	0.39	0.02343	0.02205	0.02059	0.01952	0.01838	0.01752	0.01661	0.01519	0.01402	0.01306	0.01225	0.01156	0.01097	0.01046	0.01002	0.00963	0.00928	0.00897	0.00871	0.00846
0.8	0.44	0.02881	0.02716	0.02539	0.02409	0.02271	0.02168	0.02058	0.01885	0.01743	0.01625	0.01526	0.01442	0.01369	0.01307	0.01252	0.01205	0.01162	0.01123	0.01092	0.01062
0.9	0.50	0.03462	0.03266	0.03058	0.02904	0.02740	0.02617	0.02487	0.02282	0.02112	0.01972	0.01854	0.01753	0.01666	0.01591	0.01526	0.01470	0.01418	0.01371	0.01334	0.01297
1.0	0.55	0.04083	0.03856	0.03613	0.03434	0.03244	0.03100	0.02948	0.02708	0.02510	0.02346	0.02207	0.02089	0.01987	0.01899	0.01822	0.01756	0.01695	0.01640	0.01595	0.01552
1.1	0.61	0.04743	0.04483	0.04205	0.03999	0.03781	0.03616	0.03441	0.03165	0.02936	0.02746	0.02586	0.02449	0.02332	0.02229	0.02140	0.02063	0.01992	0.01929	0.01877	0.01826
1.2	0.66	0.05441	0.05146	0.04831	0.04598	0.04350	0.04163	0.03963	0.03649	0.03389	0.03172	0.02989	0.02833	0.02699	0.02581	0.02480	0.02391	0.02310	0.02237	0.02178	0.02120
1.3	0.72	0.06177	0.05846	0.05492	0.05230	0.04951	0.04740	0.04516	0.04162	0.03868	0.03623	0.03417	0.03240	0.03088	0.02955	0.02840	0.02740	0.02647	0.02565	0.02497	0.02431
1.4	0.77	0.06948	0.06580	0.06186	0.05894	0.05583	0.05348	0.05097	0.04702	0.04373	0.04099	0.03868	0.03670	0.03499	0.03350	0.03221	0.03108	0.03004	0.02911	0.02835	0.02761
1.5	0.83	0.07755	0.07348	0.06913	0.06590	0.06246	0.05985	0.05707	0.05268	0.04904	0.04599	0.04342	0.04122	0.03932	0.03766	0.03622	0.03496	0.03380	0.03277	0.03192	0.03109
1.6	0.88	0.08597	0.08150	0.07672	0.07317	0.06938	0.06651	0.06345	0.05862	0.05459	0.05123	0.04839	0.04596	0.04386	0.04202	0.04042	0.03903	0.03775	0.03660	0.03566	0.03475
1.7	0.94	0.09473	0.08985	0.08462	0.08074	0.07659	0.07345	0.07011	0.06481	0.06039	0.05670	0.05359	0.05091	0.04860	0.04658	0.04483	0.04330	0.04189	0.04062	0.03959	0.03858
1.8	0.99	0.10383	0.09852	0.09283	0.08861	0.08410	0.08068	0.07703	0.07125	0.06643	0.06241	0.05900	0.05608	0.05355	0.05134	0.04942	0.04775	0.04620	0.04482	0.04368	0.04258
1.9	1.05	0.11325	0.10751	0.10135	0.09678	0.09188	0.08818	0.08422	0.07795	0.07272	0.06834	0.06464	0.06146	0.05871	0.05630	0.05421	0.05238	0.05070	0.04919	0.04795	0.04675
2.0	1.10	0.12301	0.11682	0.11017	0.10523	0.09995	0.09595	0.09167	0.08489	0.07923	0.07450	0.07049	0.06704	0.06406	0.06145	0.05918	0.05720	0.05537	0.05373	0.05239	0.05109
2.1	1.16	0.13308	0.12643	0.11929	0.11398	0.10830	0.10399	0.09938	0.09208	0.08598	0.08087	0.07655	0.07283	0.06961	0.06679	0.06434	0.06220	0.06023	0.05845	0.05700	0.05559
2.2	1.22	0.14347	0.13635	0.12869	0.12301	0.11691	0.11229	0.10735	0.09951	0.09296	0.08747	0.08282	0.07882	0.07536	0.07232	0.06969	0.06738	0.06525	0.06334	0.06178	0.06026
2.3	1.27	0.15417	0.14657	0.13839	0.13231	0.12580	0.12085	0.11557	0.10718	0.10017	0.09429	0.08930	0.08501	0.08130	0.07804	0.07521	0.07274	0.07045	0.06840	0.06672	0.06509
2.4	1.33	0.16518	0.15708	0.14837	0.14190	0.13495	0.12968	0.12404	0.11509	0.10760	0.10131	0.09599	0.09140	0.08743	0.08395	0.08092	0.07827	0.07583	0.07363	0.07183	0.07008
2.5	1.38		0.16790	0.15864	0.15175	0.14437	0.13876	0.13276	0.12323	0.11525	0.10855	0.10288	0.09799	0.09375	0.09003	0.08680	0.08398	0.08137	0.07902	0.07710	0.07523
2.6	1.44			0.16919	0.16188	0.15404	0.14809	0.14172	0.13160	0.12312	0.11601	0.10997	0.10477	0.10026	0.09630	0.09287	0.08986	0.08707	0.08458	0.08253	0.08053
2.7	1.49					0.16398	0.15767	0.15093	0.14020	0.13121	0.12367	0.11726	0.11174	0.10695	0.10276	0.09910	0.09591	0.09295	0.09029	0.08812	0.08600
2.8	1.55						0.16750	0.16037	0.14903	0.13952	0.13153	0.12475	0.11890	0.11383	0.10938	0.10551	0.10212	0.09899	0.09618	0.09387	0.09162
2.9	1.60								0.15808	0.14804	0.13960	0.13244	0.12625	0.12090	0.11619	0.11210	0.10851	0.10520	0.10222	0.09978	0.09739
3.0	1.66								0.16736	0.15678	0.14788	0.14032	0.13380	0.12814	0.12318	0.11885	0.11507	0.11157	0.10842	0.10584	0.10332
3.1	1.71									0.16572	0.15635	0.14840	0.14152	0.13557	0.13033	0.12578	0.12179	0.11810	0.11478	0.11206	0.10940
3.2	1.77										0.16503	0.15667	0.14944	0.14317	0.13767	0.13287	0.12867	0.12479	0.12129	0.11843	0.11564
3.3	1.82											0.16512	0.15753	0.15095	0.14517	0.14013	0.13572	0.13164	0.12797	0.12496	0.12202
3.4	1.88												0.16581	0.15891	0.15285	0.14756	0.14293	0.13865	0.13479	0.13163	0.12855
3.5	1.93													0.16705	0.16069	0.15516	0.15030	0.14581	0.14177	0.13846	0.13523
3.6	1.99														0.16871	0.16291	0.15784	0.15314	0.14891	0.14544	0.14206
3.7	2.04																0.16553	0.16062	0.15620	0.15257	0.14903
3.8	2.10																	0.16825	0.16364	0.15985	0.15616
3.9	2.15																			0.16728	0.16342

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor PEX-a — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.40	0.00485	0.00456	0.00423	0.00413	0.00403	0.00394	0.00385	0.00370	0.00357	0.00345	0.00335	0.00326	0.00317	0.00310	0.00303	0.00296	0.00290	0.00285	0.00280	0.00276
0.6	0.48	0.00655	0.00617	0.00575	0.00561	0.00547	0.00536	0.00524	0.00504	0.00486	0.00471	0.00457	0.00445	0.00433	0.00423	0.00414	0.00406	0.00398	0.00391	0.00384	0.00378
0.7	0.56	0.00847	0.00799	0.00745	0.00728	0.00710	0.00696	0.00680	0.00655	0.00632	0.00613	0.00595	0.00579	0.00565	0.00552	0.00540	0.00529	0.00519	0.00510	0.00501	0.00494
0.8	0.65	0.01059	0.00999	0.00933	0.00912	0.00890	0.00872	0.00854	0.00822	0.00794	0.00770	0.00748	0.00728	0.00711	0.00695	0.00680	0.00667	0.00654	0.00643	0.00632	0.00623
0.9	0.73	0.01290	0.01218	0.01138	0.01113	0.01087	0.01066	0.01043	0.01005	0.00972	0.00942	0.00916	0.00892	0.00871	0.00852	0.00834	0.00818	0.00802	0.00789	0.00776	0.00764
1.0	0.81	0.01540	0.01455	0.01361	0.01332	0.01301	0.01276	0.01249	0.01204	0.01165	0.01130	0.01099	0.01070	0.01045	0.01022	0.01001	0.00982	0.00964	0.00948	0.00933	0.00919
1.1	0.89	0.01808	0.01710	0.01601	0.01566	0.01531	0.01501	0.01471	0.01418	0.01372	0.01331	0.01295	0.01262	0.01233	0.01206	0.01181	0.01159	0.01138	0.01119	0.01102	0.01085
1.2	0.97	0.02094	0.01982	0.01857	0.01817	0.01776	0.01742	0.01707	0.01647	0.01594	0.01547	0.01506	0.01468	0.01434	0.01403	0.01375	0.01349	0.01325	0.01303	0.01283	0.01264
1.3	1.05	0.02397	0.02271	0.02128	0.02084	0.02037	0.01999	0.01959	0.01890	0.01830	0.01777	0.01730	0.01687	0.01648	0.01613	0.01581	0.01551	0.01524	0.01499	0.01476	0.01454
1.4	1.13	0.02718	0.02576	0.02416	0.02366	0.02313	0.02270	0.02225	0.02148	0.02081	0.02020	0.01967	0.01918	0.01875	0.01835	0.01799	0.01766	0.01735	0.01707	0.01681	0.01657
1.5	1.21	0.03056	0.02897	0.02719	0.02663	0.02604	0.02556	0.02506	0.02420	0.02344	0.02277	0.02217	0.02163	0.02114	0.02070	0.02029	0.01992	0.01958	0.01926	0.01897	0.01870
1.6	1.29	0.03411	0.03235	0.03037	0.02975	0.02910	0.02857	0.02801	0.02706	0.02622	0.02547	0.02481	0.02421	0.02367	0.02317	0.02272	0.02231	0.02192	0.02158	0.02125	0.02095
1.7	1.37	0.03781	0.03588	0.03371	0.03302	0.03230	0.03172	0.03110	0.03005	0.02913	0.02830	0.02757	0.02691	0.02631	0.02577	0.02527	0.02481	0.02439	0.02400	0.02365	0.02331
1.8	1.45	0.04169	0.03957	0.03719	0.03644	0.03565	0.03501	0.03433	0.03318	0.03217	0.03126	0.03046	0.02973	0.02908	0.02848	0.02793	0.02743	0.02696	0.02654	0.02615	0.02578
1.9	1.53	0.04572	0.04341	0.04081	0.04000	0.03914	0.03844	0.03770	0.03644	0.03534	0.03435	0.03348	0.03268	0.03196	0.03131	0.03071	0.03017	0.02966	0.02919	0.02877	0.02837
2.0	1.61	0.04990	0.04740	0.04458	0.04370	0.04277	0.04200	0.04121	0.03984	0.03864	0.03757	0.03661	0.03575	0.03497	0.03426	0.03361	0.03302	0.03246	0.03196	0.03149	0.03106
2.1	1.69	0.05425	0.05154	0.04850	0.04754	0.04653	0.04571	0.04484	0.04337	0.04207	0.04091	0.03987	0.03894	0.03809	0.03733	0.03662	0.03598	0.03537	0.03483	0.03432	0.03385
2.2	1.77	0.05875	0.05583	0.05255	0.05152	0.05044	0.04955	0.04862	0.04702	0.04562	0.04437	0.04325	0.04224	0.04133	0.04051	0.03974	0.03905	0.03840	0.03781	0.03726	0.03675
2.3	1.86	0.06340	0.06027	0.05675	0.05564	0.05447	0.05352	0.05252	0.05081	0.04930	0.04795	0.04676	0.04567	0.04469	0.04380	0.04298	0.04223	0.04153	0.04090	0.04031	0.03976
2.4	1.94	0.06820	0.06485	0.06108	0.05989	0.05865	0.05762	0.05655	0.05472	0.05310	0.05166	0.05038	0.04921	0.04816	0.04721	0.04633	0.04553	0.04477	0.04409	0.04346	0.04288
2.5	2.02	0.07315	0.06958	0.06555	0.06428	0.06295	0.06186	0.06071	0.05875	0.05703	0.05549	0.05411	0.05287	0.05174	0.05072	0.04978	0.04893	0.04812	0.04740	0.04672	0.04609
2.6	2.10	0.07825	0.07445	0.07016	0.06881	0.06739	0.06622	0.06500	0.06291	0.06107	0.05943	0.05797	0.05664	0.05544	0.05435	0.05335	0.05244	0.05158	0.05080	0.05008	0.04941
2.7	2.18	0.08350	0.07946	0.07490	0.07347	0.07196	0.07072	0.06942	0.06720	0.06524	0.06350	0.06194	0.06053	0.05925	0.05809	0.05702	0.05605	0.05514	0.05432	0.05355	0.05284
2.8	2.26	0.08889	0.08461	0.07978	0.07826	0.07666	0.07534	0.07397	0.07161	0.06953	0.06768	0.06603	0.06453	0.06317	0.06194	0.06081	0.05978	0.05881	0.05793	0.05712	0.05636
2.9	2.34	0.09443	0.08990	0.08479	0.08318	0.08148	0.08009	0.07864	0.07614	0.07394	0.07198	0.07023	0.06864	0.06720	0.06590	0.06470	0.06361	0.06258	0.06165	0.06079	0.05998
3.0	2.42	0.10012	0.09533	0.08993	0.08823	0.08644	0.08497	0.08343	0.08079	0.07847	0.07639	0.07454	0.07286	0.07134	0.06997	0.06870	0.06754	0.06645	0.06547	0.06456	0.06371
3.1	2.50	0.10594	0.10090	0.09521	0.09341	0.09152	0.08997	0.08835	0.08556	0.08311	0.08092	0.07897	0.07720	0.07559	0.07414	0.07280	0.07158	0.07043	0.06939	0.06843	0.06753
3.2	2.58	0.11191	0.10660	0.10061	0.09872	0.09673	0.09509	0.09339	0.09046	0.08787	0.08556	0.08351	0.08164	0.07995	0.07842	0.07701	0.07572	0.07451	0.07342	0.07240	0.07146
3.3	2.66	0.11801	0.11244	0.10614	0.10415	0.10206	0.10034	0.09855	0.09547	0.09275	0.09032	0.08816	0.08619	0.08442	0.08281	0.08132	0.07997	0.07869	0.07754	0.07648	0.07548
3.4	2.74	0.12426	0.11841	0.11180	0.10971	0.10752	0.10572	0.10383	0.10060	0.09774	0.09519	0.09292	0.09086	0.08899	0.08730	0.08574	0.08431	0.08297	0.08177	0.08065	0.07960
3.5	2.82	0.13065	0.12452	0.11759	0.11540	0.11310	0.11121	0.10924	0.10584	0.10285	0.10018	0.09779	0.09563	0.09367	0.09190	0.09026	0.08877	0.08736	0.08609	0.08492	0.08382
3.6	2.90	0.13717	0.13076	0.12351	0.12121	0.11881	0.11683	0.11476	0.11121	0.10807	0.10527	0.10278	0.10051	0.09846	0.09660	0.09488	0.09332	0.09184	0.09052	0.08928	0.08813
3.7	2.98	0.14383	0.13713	0.12955	0.12715	0.12464	0.12257	0.12040	0.11669	0.11341	0.11048	0.10787	0.10549	0.10335	0.10140	0.09961	0.09797	0.09643	0.09504	0.09375	0.09254
3.8	3.07	0.15063	0.14363	0.13571	0.13321	0.13059	0.12842	0.12616	0.12228	0.11886	0.11580	0.11307	0.11059	0.10835	0.10631	0.10443	0.10272	0.10111	0.09966	0.09831	0.09705
3.9	3.15	0.15756	0.15026	0.14201	0.13940	0.13666	0.13440	0.13204	0.12799	0.12442	0.12122	0.11837	0.11579	0.11345	0.11132	0.10936	0.10758	0.10589	0.10438	0.10297	0.10165

Continued on next page

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor PEX-a — 100% Water — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	3.23	0.16463	0.15703	0.14842	0.14570	0.14285	0.14050	0.13804	0.13381	0.13009	0.12676	0.12379	0.12109	0.11865	0.11644	0.11439	0.11253	0.11078	0.10920	0.10773	0.10635
4.1	3.31		0.16392	0.15496	0.15213	0.14916	0.14671	0.14415	0.13975	0.13587	0.13241	0.12931	0.12650	0.12396	0.12165	0.11952	0.11758	0.11575	0.11411	0.11258	0.11115
4.2	3.39			0.16163	0.15868	0.15559	0.15304	0.15038	0.14580	0.14177	0.13816	0.13494	0.13202	0.12937	0.12697	0.12475	0.12273	0.12083	0.11912	0.11752	0.11604
4.3	3.47			0.16841	0.16535	0.16214	0.15949	0.15672	0.15197	0.14777	0.14402	0.14068	0.13763	0.13489	0.13239	0.13008	0.12798	0.12600	0.12422	0.12257	0.12102
4.4	3.55					0.16880	0.16606	0.16318	0.15824	0.15389	0.14999	0.14652	0.14336	0.14050	0.13791	0.13551	0.13333	0.13127	0.12942	0.12770	0.12609
4.5	3.63							0.16976	0.16463	0.16011	0.15607	0.15246	0.14918	0.14622	0.14353	0.14104	0.13878	0.13664	0.13472	0.13293	0.13126
4.6	3.71									0.16645	0.16225	0.15851	0.15511	0.15204	0.14925	0.14667	0.14432	0.14210	0.14011	0.13826	0.13652
4.7	3.79										0.16854	0.16467	0.16114	0.15796	0.15506	0.15239	0.14996	0.14766	0.14560	0.14368	0.14188
4.8	3.87												0.16728	0.16398	0.16098	0.15821	0.15569	0.15332	0.15118	0.14919	0.14733
4.9	3.95														0.16700	0.16413	0.16152	0.15907	0.15685	0.15479	0.15287
5.0	4.03																0.16745	0.16491	0.16262	0.16049	0.15850
5.1	4.11																		0.16848	0.16628	0.16422

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" **Uponor PEX-a** — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.40	0.00745	0.00687	0.00654	0.00628	0.00601	0.00579	0.00556	0.00519	0.00489	0.00462	0.00440	0.00420	0.00404	0.00388	0.00376	0.00365	0.00354	0.00345	0.00336	0.00330
0.6	0.48	0.00963	0.00921	0.00877	0.00844	0.00808	0.00779	0.00749	0.00701	0.00661	0.00626	0.00596	0.00571	0.00548	0.00528	0.00512	0.00496	0.00482	0.00470	0.00459	0.00450
0.7	0.56	0.01234	0.01182	0.01127	0.01084	0.01039	0.01004	0.00966	0.00905	0.00853	0.00810	0.00772	0.00740	0.00711	0.00685	0.00665	0.00645	0.00627	0.00612	0.00597	0.00586
0.8	0.65	0.01531	0.01468	0.01401	0.01349	0.01294	0.01250	0.01204	0.01130	0.01067	0.01013	0.00966	0.00926	0.00891	0.00860	0.00835	0.00810	0.00788	0.00769	0.00751	0.00737
0.9	0.73	0.01854	0.01778	0.01698	0.01637	0.01572	0.01519	0.01464	0.01375	0.01299	0.01234	0.01178	0.01131	0.01089	0.01051	0.01020	0.00991	0.00964	0.00941	0.00919	0.00903
1.0	0.81	0.02201	0.02113	0.02019	0.01947	0.01871	0.01809	0.01744	0.01640	0.01551	0.01474	0.01408	0.01352	0.01303	0.01258	0.01222	0.01187	0.01155	0.01128	0.01102	0.01083
1.1	0.89	0.02572	0.02471	0.02363	0.02279	0.02191	0.02120	0.02045	0.01924	0.01820	0.01732	0.01655	0.01591	0.01533	0.01481	0.01439	0.01398	0.01361	0.01330	0.01300	0.01277
1.2	0.97	0.02967	0.02851	0.02728	0.02633	0.02532	0.02451	0.02365	0.02227	0.02108	0.02007	0.01919	0.01845	0.01779	0.01719	0.01671	0.01624	0.01581	0.01546	0.01511	0.01485
1.3	1.05	0.03385	0.03254	0.03115	0.03007	0.02893	0.02802	0.02704	0.02548	0.02414	0.02299	0.02200	0.02115	0.02040	0.01972	0.01917	0.01864	0.01816	0.01775	0.01735	0.01706
1.4	1.13	0.03824	0.03678	0.03523	0.03402	0.03274	0.03172	0.03063	0.02887	0.02737	0.02608	0.02496	0.02401	0.02317	0.02240	0.02179	0.02119	0.02064	0.02018	0.01973	0.01940
1.5	1.21	0.04286	0.04124	0.03951	0.03817	0.03675	0.03561	0.03440	0.03244	0.03077	0.02933	0.02808	0.02702	0.02608	0.02522	0.02454	0.02387	0.02326	0.02275	0.02225	0.02188
1.6	1.29	0.04769	0.04590	0.04400	0.04252	0.04095	0.03969	0.03835	0.03619	0.03433	0.03275	0.03136	0.03019	0.02914	0.02819	0.02743	0.02669	0.02601	0.02545	0.02489	0.02448
1.7	1.37	0.05274	0.05077	0.04868	0.04706	0.04534	0.04395	0.04248	0.04010	0.03807	0.03632	0.03479	0.03350	0.03235	0.03130	0.03047	0.02965	0.02890	0.02828	0.02766	0.02721
1.8	1.45	0.05799	0.05585	0.05356	0.05179	0.04991	0.04840	0.04679	0.04419	0.04196	0.04005	0.03838	0.03696	0.03570	0.03455	0.03364	0.03274	0.03192	0.03124	0.03056	0.03006
1.9	1.53	0.06344	0.06112	0.05864	0.05671	0.05467	0.05302	0.05127	0.04844	0.04601	0.04393	0.04211	0.04057	0.03919	0.03794	0.03694	0.03596	0.03507	0.03432	0.03358	0.03304
2.0	1.61	0.06910	0.06659	0.06390	0.06182	0.05961	0.05782	0.05593	0.05286	0.05023	0.04797	0.04599	0.04432	0.04283	0.04147	0.04038	0.03932	0.03834	0.03753	0.03673	0.03614
2.1	1.69	0.07496	0.07225	0.06936	0.06711	0.06472	0.06280	0.06075	0.05744	0.05460	0.05216	0.05002	0.04821	0.04660	0.04513	0.04395	0.04280	0.04175	0.04087	0.04000	0.03936
2.2	1.77	0.08102	0.07811	0.07500	0.07259	0.07002	0.06795	0.06575	0.06218	0.05912	0.05650	0.05420	0.05225	0.05050	0.04892	0.04765	0.04641	0.04527	0.04433	0.04339	0.04270
2.3	1.86	0.08727	0.08416	0.08082	0.07824	0.07549	0.07327	0.07091	0.06708	0.06380	0.06098	0.05851	0.05642	0.05455	0.05285	0.05148	0.05015	0.04893	0.04791	0.04690	0.04616
2.4	1.94	0.09372	0.09039	0.08683	0.08407	0.08113	0.07876	0.07623	0.07214	0.06863	0.06561	0.06297	0.06073	0.05873	0.05690	0.05544	0.05402	0.05270	0.05161	0.05053	0.04974
2.5	2.02	0.10036	0.09681	0.09302	0.09008	0.08694	0.08441	0.08172	0.07736	0.07362	0.07039	0.06757	0.06518	0.06304	0.06109	0.05953	0.05801	0.05660	0.05544	0.05428	0.05343
2.6	2.10	0.10718	0.10342	0.09939	0.09626	0.09292	0.09023	0.08737	0.08273	0.07875	0.07531	0.07231	0.06976	0.06748	0.06540	0.06374	0.06212	0.06062	0.05938	0.05815	0.05724
2.7	2.18	0.11420	0.11021	0.10593	0.10261	0.09907	0.09622	0.09318	0.08826	0.08402	0.08038	0.07719	0.07448	0.07205	0.06985	0.06808	0.06635	0.06476	0.06344	0.06213	0.06117
2.8	2.26	0.12140	0.11717	0.11265	0.10914	0.10539	0.10237	0.09915	0.09394	0.08945	0.08559	0.08220	0.07933	0.07676	0.07442	0.07254	0.07071	0.06902	0.06762	0.06623	0.06520
2.9	2.34	0.12878	0.12432	0.11954	0.11583	0.11187	0.10868	0.10528	0.09976	0.09502	0.09093	0.08735	0.08431	0.08159	0.07911	0.07713	0.07519	0.07340	0.07191	0.07044	0.06936
3.0	2.42	0.13635	0.13165	0.12661	0.12269	0.11852	0.11515	0.11157	0.10574	0.10073	0.09642	0.09264	0.08943	0.08655	0.08393	0.08184	0.07978	0.07790	0.07632	0.07477	0.07362
3.1	2.50	0.14410	0.13915	0.13384	0.12973	0.12533	0.12178	0.11800	0.11187	0.10659	0.10205	0.09806	0.09468	0.09164	0.08888	0.08667	0.08450	0.08251	0.08085	0.07921	0.07800
3.2	2.58	0.15203	0.14682	0.14125	0.13692	0.13230	0.12857	0.12460	0.11815	0.11259	0.10781	0.10361	0.10005	0.09685	0.09395	0.09162	0.08934	0.08724	0.08549	0.08376	0.08249
3.3	2.66	0.16013	0.15467	0.14883	0.14428	0.13943	0.13552	0.13134	0.12457	0.11874	0.11371	0.10930	0.10555	0.10219	0.09914	0.09669	0.09429	0.09208	0.09024	0.08843	0.08708
3.4	2.74	0.16841	0.16270	0.15657	0.15181	0.14672	0.14262	0.13824	0.13114	0.12502	0.11974	0.11512	0.11119	0.10766	0.10445	0.10188	0.09936	0.09704	0.09511	0.09320	0.09179
3.5	2.82			0.16448	0.15949	0.15417	0.14987	0.14529	0.13785	0.13144	0.12591	0.12106	0.11694	0.11325	0.10988	0.10719	0.10455	0.10212	0.10009	0.09809	0.09661
3.6	2.90				0.16734	0.16178	0.15728	0.15249	0.14471	0.13800	0.13222	0.12714	0.12283	0.11896	0.11544	0.11262	0.10985	0.10730	0.10518	0.10309	0.10153
3.7	2.98					0.16954	0.16484	0.15984	0.15171	0.14470	0.13865	0.13335	0.12884	0.12480	0.12111	0.11816	0.11527	0.11260	0.11038	0.10819	0.10657
3.8	3.07							0.16734	0.15885	0.15153	0.14522	0.13968	0.13498	0.13075	0.12690	0.12382	0.12080	0.11802	0.11570	0.11340	0.11171
3.9	3.15								0.16613	0.15851	0.15192	0.14615	0.14124	0.13683	0.13281	0.12960	0.12644	0.12354	0.12112	0.11873	0.11696

Continued on next page

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	3.23									0.16561	0.15876	0.15274	0.14762	0.14303	0.13884	0.13549	0.13220	0.12917	0.12665	0.12416	0.12231
4.1	3.31										0.16572	0.15946	0.15413	0.14935	0.14499	0.14150	0.13807	0.13492	0.13229	0.12970	0.12777
4.2	3.39											0.16630	0.16076	0.15578	0.15125	0.14762	0.14406	0.14078	0.13804	0.13534	0.13334
4.3	3.47												0.16751	0.16234	0.15763	0.15385	0.15015	0.14674	0.14390	0.14109	0.13901
4.4	3.55													0.16902	0.16412	0.16020	0.15636	0.15282	0.14987	0.14695	0.14479
4.5	3.63															0.16667	0.16268	0.15900	0.15594	0.15291	0.15067
4.6	3.71																0.16910	0.16529	0.16212	0.15898	0.15665
4.7	3.79																		0.16840	0.16515	0.16274
4.8	3.87																				0.16893

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.40	0.00930	0.00877	0.00821	0.00780	0.00737	0.00705	0.00670	0.00616	0.00572	0.00535	0.00504	0.00477	0.00455	0.00435	0.00418	0.00404	0.00390	0.00379	0.00368	0.00359
0.6	0.48	0.01237	0.01169	0.01096	0.01043	0.00987	0.00945	0.00900	0.00829	0.00770	0.00722	0.00682	0.00646	0.00617	0.00590	0.00568	0.00549	0.00530	0.00517	0.00501	0.00490
0.7	0.56	0.01578	0.01493	0.01402	0.01336	0.01266	0.01212	0.01156	0.01067	0.00993	0.00932	0.00881	0.00836	0.00798	0.00765	0.00737	0.00713	0.00689	0.00671	0.00651	0.00637
0.8	0.65	0.01950	0.01847	0.01737	0.01657	0.01571	0.01506	0.01437	0.01328	0.01238	0.01164	0.01101	0.01046	0.00999	0.00958	0.00924	0.00894	0.00864	0.00843	0.00818	0.00800
0.9	0.73	0.02353	0.02231	0.02100	0.02005	0.01903	0.01825	0.01743	0.01613	0.01505	0.01417	0.01341	0.01275	0.01219	0.01170	0.01128	0.01092	0.01057	0.01031	0.01001	0.00979
1.0	0.81	0.02786	0.02643	0.02491	0.02379	0.02260	0.02169	0.02073	0.01921	0.01794	0.01689	0.01601	0.01523	0.01457	0.01399	0.01350	0.01307	0.01265	0.01234	0.01199	0.01174
1.1	0.89	0.03247	0.03083	0.02908	0.02779	0.02642	0.02537	0.02426	0.02250	0.02103	0.01982	0.01879	0.01789	0.01713	0.01645	0.01588	0.01539	0.01490	0.01454	0.01413	0.01383
1.2	0.97	0.03737	0.03550	0.03351	0.03204	0.03047	0.02928	0.02802	0.02600	0.02433	0.02294	0.02176	0.02073	0.01986	0.01908	0.01842	0.01786	0.01730	0.01688	0.01642	0.01607
1.3	1.05	0.04253	0.04043	0.03818	0.03653	0.03477	0.03342	0.03199	0.02972	0.02782	0.02626	0.02492	0.02375	0.02275	0.02187	0.02113	0.02049	0.01985	0.01938	0.01885	0.01846
1.4	1.13	0.04797	0.04562	0.04311	0.04126	0.03929	0.03778	0.03619	0.03364	0.03151	0.02975	0.02825	0.02694	0.02582	0.02483	0.02399	0.02327	0.02255	0.02202	0.02142	0.02098
1.5	1.21	0.05366	0.05106	0.04828	0.04623	0.04404	0.04237	0.04059	0.03776	0.03539	0.03343	0.03176	0.03030	0.02905	0.02794	0.02701	0.02621	0.02540	0.02481	0.02414	0.02365
1.6	1.29	0.05961	0.05675	0.05368	0.05142	0.04901	0.04716	0.04520	0.04207	0.03946	0.03730	0.03544	0.03382	0.03244	0.03121	0.03018	0.02929	0.02840	0.02774	0.02700	0.02645
1.7	1.37	0.06581	0.06268	0.05932	0.05684	0.05419	0.05217	0.05002	0.04658	0.04372	0.04133	0.03930	0.03751	0.03599	0.03464	0.03350	0.03252	0.03153	0.03081	0.02999	0.02939
1.8	1.45	0.07226	0.06885	0.06519	0.06249	0.05960	0.05739	0.05504	0.05129	0.04815	0.04555	0.04332	0.04136	0.03970	0.03821	0.03697	0.03589	0.03481	0.03402	0.03312	0.03246
1.9	1.53	0.07896	0.07526	0.07128	0.06835	0.06521	0.06281	0.06026	0.05618	0.05277	0.04993	0.04750	0.04537	0.04356	0.04194	0.04058	0.03941	0.03823	0.03736	0.03638	0.03566
2.0	1.61	0.08590	0.08190	0.07760	0.07443	0.07104	0.06844	0.06568	0.06126	0.05756	0.05449	0.05185	0.04954	0.04758	0.04582	0.04434	0.04307	0.04179	0.04085	0.03978	0.03899
2.1	1.69	0.09307	0.08876	0.08414	0.08072	0.07707	0.07427	0.07129	0.06652	0.06253	0.05921	0.05637	0.05387	0.05174	0.04984	0.04824	0.04686	0.04548	0.04446	0.04331	0.04246
2.2	1.77	0.10048	0.09586	0.09090	0.08723	0.08330	0.08030	0.07709	0.07196	0.06767	0.06410	0.06104	0.05835	0.05606	0.05401	0.05229	0.05080	0.04931	0.04821	0.04697	0.04605
2.3	1.86	0.10812	0.10318	0.09787	0.09394	0.08974	0.08652	0.08309	0.07759	0.07299	0.06915	0.06587	0.06298	0.06052	0.05832	0.05647	0.05488	0.05327	0.05209	0.05075	0.04976
2.4	1.94	0.11599	0.11072	0.10505	0.10086	0.09637	0.09293	0.08927	0.08339	0.07847	0.07437	0.07086	0.06777	0.06513	0.06278	0.06080	0.05909	0.05737	0.05610	0.05467	0.05361
2.5	2.02	0.12409	0.11848	0.11245	0.10798	0.10320	0.09954	0.09563	0.08937	0.08413	0.07975	0.07600	0.07270	0.06989	0.06738	0.06526	0.06343	0.06160	0.06024	0.05871	0.05757
2.6	2.10	0.13241	0.12645	0.12005	0.11531	0.11023	0.10634	0.10219	0.09553	0.08995	0.08529	0.08130	0.07779	0.07479	0.07211	0.06986	0.06791	0.06595	0.06451	0.06287	0.06167
2.7	2.18	0.14095	0.13464	0.12786	0.12283	0.11745	0.11332	0.10892	0.10185	0.09593	0.09099	0.08675	0.08302	0.07983	0.07699	0.07459	0.07252	0.07044	0.06890	0.06716	0.06588
2.8	2.26	0.14971	0.14305	0.13587	0.13056	0.12486	0.12049	0.11583	0.10835	0.10208	0.09684	0.09235	0.08840	0.08502	0.08200	0.07946	0.07726	0.07505	0.07342	0.07158	0.07021
2.9	2.34	0.15870	0.15166	0.14409	0.13848	0.13246	0.12785	0.12293	0.11502	0.10839	0.10285	0.09810	0.09392	0.09035	0.08715	0.08446	0.08213	0.07980	0.07807	0.07612	0.07467
3.0	2.42	0.16789	0.16048	0.15251	0.14659	0.14025	0.13539	0.13020	0.12186	0.11486	0.10902	0.10400	0.09959	0.09581	0.09244	0.08959	0.08713	0.08467	0.08284	0.08078	0.07925
3.1	2.50		0.16951	0.16112	0.15490	0.14823	0.14311	0.13765	0.12887	0.12150	0.11534	0.11005	0.10540	0.10142	0.09786	0.09486	0.09226	0.08966	0.08774	0.08556	0.08394
3.2	2.58			0.16994	0.16340	0.15639	0.15102	0.14527	0.13604	0.12829	0.12181	0.11625	0.11135	0.10716	0.10341	0.10025	0.09752	0.09478	0.09275	0.09046	0.08876
3.3	2.66					0.16474	0.15910	0.15307	0.14338	0.13524	0.12843	0.12259	0.11744	0.11304	0.10910	0.10578	0.10291	0.10002	0.09789	0.09548	0.09369
3.4	2.74						0.16736	0.16104	0.15088	0.14234	0.13521	0.12908	0.12368	0.11906	0.11492	0.11143	0.10842	0.10539	0.10315	0.10061	0.09874
3.5	2.82							0.16918	0.15854	0.14961	0.14213	0.13571	0.13005	0.12521	0.12087	0.11722	0.11405	0.11088	0.10853	0.10587	0.10390
3.6	2.90								0.16637	0.15702	0.14920	0.14248	0.13656	0.13149	0.12695	0.12313	0.11982	0.11649	0.11403	0.11124	0.10918
3.7	2.98									0.16459	0.15642	0.14940	0.14321	0.13791	0.13316	0.12916	0.12570	0.12222	0.11965	0.11674	0.11458
3.8	3.07										0.16379	0.15646	0.14999	0.14446	0.13951	0.13533	0.13171	0.12808	0.12539	0.12234	0.12009
3.9	3.15											0.16366	0.15692	0.15114	0.14597	0.14161	0.13784	0.13405	0.13124	0.12806	0.12571

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	3.23												0.16397	0.15796	0.15257	0.14803	0.14409	0.14014	0.13722	0.13390	0.13145
4.1	3.31													0.16490	0.15930	0.15456	0.15047	0.14635	0.14331	0.13985	0.13730
4.2	3.39														0.16615	0.16122	0.15696	0.15268	0.14951	0.14592	0.14326
4.3	3.47															0.16801	0.16358	0.15913	0.15584	0.15210	0.14933
4.4	3.55																	0.16569	0.16227	0.15839	0.15552
4.5	3.63																		0.16882	0.16480	0.16182
4.6	3.71																				0.16822

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.40	0.01113	0.01045	0.00973	0.00921	0.00865	0.00823	0.00779	0.00710	0.00653	0.00606	0.00567	0.00534	0.00505	0.00481	0.00459	0.00441	0.00424	0.00409	0.00397	0.00385
0.6	0.48	0.01475	0.01387	0.01294	0.01226	0.01153	0.01099	0.01041	0.00951	0.00877	0.00816	0.00764	0.00721	0.00683	0.00651	0.00623	0.00598	0.00576	0.00556	0.00539	0.00524
0.7	0.56	0.01874	0.01765	0.01649	0.01564	0.01474	0.01405	0.01333	0.01220	0.01127	0.01050	0.00985	0.00930	0.00883	0.00842	0.00806	0.00775	0.00747	0.00721	0.00700	0.00680
0.8	0.65	0.02308	0.02177	0.02037	0.01933	0.01824	0.01741	0.01654	0.01516	0.01402	0.01308	0.01229	0.01161	0.01103	0.01053	0.01009	0.00971	0.00936	0.00905	0.00879	0.00854
0.9	0.73	0.02778	0.02622	0.02456	0.02334	0.02204	0.02105	0.02001	0.01837	0.01702	0.01589	0.01495	0.01414	0.01344	0.01283	0.01231	0.01185	0.01143	0.01105	0.01074	0.01044
1.0	0.81	0.03280	0.03099	0.02906	0.02763	0.02612	0.02497	0.02375	0.02183	0.02024	0.01892	0.01781	0.01686	0.01604	0.01533	0.01471	0.01417	0.01367	0.01322	0.01286	0.01250
1.1	0.89	0.03815	0.03607	0.03385	0.03221	0.03047	0.02915	0.02775	0.02554	0.02370	0.02217	0.02089	0.01978	0.01884	0.01801	0.01729	0.01666	0.01608	0.01556	0.01513	0.01472
1.2	0.97	0.04381	0.04145	0.03893	0.03707	0.03509	0.03359	0.03199	0.02947	0.02738	0.02563	0.02416	0.02290	0.02182	0.02086	0.02004	0.01932	0.01866	0.01806	0.01757	0.01709
1.3	1.05	0.04977	0.04712	0.04429	0.04220	0.03997	0.03828	0.03648	0.03364	0.03127	0.02930	0.02764	0.02621	0.02498	0.02390	0.02296	0.02215	0.02139	0.02072	0.02016	0.01962
1.4	1.13	0.05604	0.05308	0.04993	0.04760	0.04511	0.04322	0.04121	0.03803	0.03538	0.03317	0.03131	0.02970	0.02832	0.02711	0.02606	0.02514	0.02429	0.02353	0.02290	0.02229
1.5	1.21	0.06260	0.05933	0.05584	0.05325	0.05050	0.04840	0.04617	0.04264	0.03969	0.03724	0.03516	0.03338	0.03184	0.03049	0.02932	0.02829	0.02734	0.02649	0.02579	0.02511
1.6	1.29	0.06944	0.06585	0.06201	0.05917	0.05613	0.05382	0.05136	0.04746	0.04421	0.04150	0.03921	0.03723	0.03553	0.03403	0.03274	0.03160	0.03055	0.02961	0.02883	0.02807
1.7	1.37	0.07657	0.07264	0.06844	0.06533	0.06200	0.05947	0.05677	0.05250	0.04894	0.04596	0.04344	0.04126	0.03939	0.03775	0.03632	0.03507	0.03391	0.03287	0.03201	0.03118
1.8	1.45	0.08397	0.07970	0.07513	0.07174	0.06812	0.06535	0.06241	0.05775	0.05386	0.05061	0.04785	0.04547	0.04342	0.04162	0.04005	0.03869	0.03741	0.03628	0.03533	0.03442
1.9	1.53	0.09165	0.08702	0.08207	0.07839	0.07446	0.07147	0.06827	0.06321	0.05898	0.05544	0.05244	0.04985	0.04762	0.04566	0.04395	0.04246	0.04107	0.03983	0.03880	0.03780
2.0	1.61	0.09960	0.09460	0.08926	0.08528	0.08104	0.07780	0.07435	0.06887	0.06429	0.06046	0.05721	0.05440	0.05198	0.04985	0.04800	0.04638	0.04487	0.04353	0.04241	0.04132
2.1	1.69	0.10781	0.10244	0.09669	0.09241	0.08785	0.08436	0.08064	0.07474	0.06979	0.06566	0.06215	0.05912	0.05650	0.05420	0.05220	0.05045	0.04882	0.04736	0.04615	0.04498
2.2	1.77	0.11628	0.11053	0.10436	0.09978	0.09488	0.09113	0.08714	0.08080	0.07548	0.07104	0.06726	0.06400	0.06119	0.05871	0.05655	0.05467	0.05291	0.05134	0.05003	0.04877
2.3	1.86	0.12502	0.11887	0.11227	0.10737	0.10213	0.09812	0.09385	0.08706	0.08136	0.07660	0.07255	0.06905	0.06603	0.06337	0.06105	0.05903	0.05714	0.05546	0.05405	0.05269
2.4	1.94	0.13400	0.12745	0.12042	0.11520	0.10960	0.10533	0.10076	0.09351	0.08743	0.08234	0.07801	0.07426	0.07103	0.06818	0.06570	0.06354	0.06151	0.05971	0.05820	0.05674
2.5	2.02	0.14324	0.13628	0.12880	0.12324	0.11729	0.11274	0.10788	0.10016	0.09368	0.08825	0.08363	0.07964	0.07618	0.07315	0.07050	0.06818	0.06602	0.06409	0.06249	0.06093
2.6	2.10	0.15274	0.14535	0.13742	0.13152	0.12520	0.12036	0.11521	0.10700	0.10011	0.09433	0.08942	0.08517	0.08150	0.07826	0.07544	0.07298	0.07067	0.06862	0.06690	0.06524
2.7	2.18	0.16247	0.15465	0.14626	0.14001	0.13332	0.12819	0.12273	0.11403	0.10672	0.10059	0.09537	0.09086	0.08696	0.08352	0.08053	0.07791	0.07546	0.07327	0.07145	0.06968
2.8	2.26		0.16420	0.15533	0.14872	0.14165	0.13623	0.13045	0.12124	0.11350	0.10701	0.10149	0.09671	0.09257	0.08893	0.08575	0.08298	0.08038	0.07806	0.07613	0.07425
2.9	2.34			0.16462	0.15765	0.15019	0.14447	0.13836	0.12864	0.12047	0.11361	0.10777	0.10272	0.09834	0.09449	0.09112	0.08818	0.08543	0.08298	0.08093	0.07895
3.0	2.42				0.16680	0.15893	0.15291	0.14648	0.13623	0.12761	0.12037	0.11421	0.10888	0.10426	0.10019	0.09663	0.09353	0.09062	0.08803	0.08587	0.08377
3.1	2.50					0.16789	0.16155	0.15478	0.14399	0.13492	0.12730	0.12081	0.11519	0.11032	0.10603	0.10229	0.09901	0.09595	0.09321	0.09093	0.08871
3.2	2.58							0.16328	0.15194	0.14240	0.13439	0.12757	0.12165	0.11653	0.11202	0.10807	0.10463	0.10140	0.09852	0.09611	0.09378
3.3	2.66								0.16007	0.15006	0.14165	0.13448	0.12827	0.12289	0.11814	0.11400	0.11038	0.10698	0.10396	0.10143	0.09897
3.4	2.74								0.16838	0.15789	0.14907	0.14155	0.13504	0.12939	0.12441	0.12007	0.11626	0.11270	0.10952	0.10687	0.10429
3.5	2.82									0.16588	0.15665	0.14878	0.14195	0.13604	0.13082	0.12627	0.12228	0.11854	0.11521	0.11243	0.10973
3.6	2.90										0.16439	0.15616	0.14902	0.14283	0.13737	0.13260	0.12843	0.12452	0.12103	0.11811	0.11528
3.7	2.98											0.16369	0.15623	0.14976	0.14406	0.13907	0.13471	0.13062	0.12697	0.12392	0.12096
3.8	3.07												0.16359	0.15684	0.15088	0.14568	0.14112	0.13685	0.13304	0.12985	0.12676
3.9	3.15													0.16406	0.15784	0.15241	0.14766	0.14320	0.13923	0.13590	0.13267

Continued on next page

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	3.23														0.16494	0.15928	0.15433	0.14968	0.14554	0.14207	0.13871
4.1	3.31															0.16628	0.16112	0.15629	0.15197	0.14836	0.14486
4.2	3.39																0.16805	0.16302	0.15853	0.15477	0.15113
4.3	3.47																	0.16987	0.16521	0.16130	0.15751
4.4	3.55																			0.16795	0.16402

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor PEX-a — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.55	0.00393	0.00370	0.00344	0.00336	0.00328	0.00321	0.00314	0.00302	0.00291	0.00282	0.00274	0.00266	0.00259	0.00253	0.00248	0.00243	0.00238	0.00234	0.00230	0.00226
0.6	0.66	0.00532	0.00502	0.00468	0.00457	0.00446	0.00437	0.00427	0.00411	0.00397	0.00385	0.00374	0.00364	0.00355	0.00347	0.00339	0.00332	0.00326	0.00320	0.00315	0.00310
0.7	0.77	0.00688	0.00650	0.00606	0.00593	0.00579	0.00567	0.00555	0.00535	0.00517	0.00501	0.00487	0.00474	0.00462	0.00452	0.00442	0.00434	0.00426	0.00418	0.00412	0.00405
0.8	0.88	0.00861	0.00813	0.00760	0.00744	0.00726	0.00712	0.00697	0.00672	0.00650	0.00630	0.00612	0.00597	0.00582	0.00570	0.00558	0.00547	0.00537	0.00528	0.00519	0.00511
0.9	0.99	0.01050	0.00993	0.00929	0.00909	0.00888	0.00871	0.00853	0.00822	0.00795	0.00772	0.00750	0.00731	0.00714	0.00699	0.00684	0.00671	0.00659	0.00648	0.00638	0.00628
1.0	1.10	0.01254	0.01187	0.01111	0.01088	0.01063	0.01043	0.01022	0.00985	0.00954	0.00925	0.00900	0.00878	0.00857	0.00839	0.00822	0.00806	0.00792	0.00779	0.00767	0.00755
1.1	1.21	0.01473	0.01395	0.01308	0.01280	0.01251	0.01228	0.01203	0.01161	0.01124	0.01091	0.01062	0.01036	0.01012	0.00990	0.00970	0.00952	0.00935	0.00920	0.00906	0.00893
1.2	1.32	0.01707	0.01618	0.01517	0.01486	0.01453	0.01426	0.01397	0.01349	0.01307	0.01269	0.01235	0.01205	0.01177	0.01152	0.01130	0.01109	0.01089	0.01072	0.01055	0.01040
1.3	1.43	0.01956	0.01854	0.01740	0.01704	0.01667	0.01636	0.01604	0.01549	0.01501	0.01458	0.01419	0.01385	0.01354	0.01325	0.01299	0.01276	0.01253	0.01233	0.01215	0.01197
1.4	1.54	0.02218	0.02104	0.01976	0.01936	0.01894	0.01859	0.01823	0.01761	0.01706	0.01658	0.01615	0.01576	0.01541	0.01509	0.01479	0.01452	0.01427	0.01405	0.01384	0.01364
1.5	1.65	0.02495	0.02368	0.02225	0.02180	0.02133	0.02094	0.02054	0.01984	0.01924	0.01869	0.01821	0.01777	0.01738	0.01702	0.01669	0.01639	0.01611	0.01586	0.01562	0.01540
1.6	1.76	0.02786	0.02645	0.02486	0.02436	0.02384	0.02341	0.02296	0.02219	0.02152	0.02092	0.02038	0.01990	0.01946	0.01906	0.01869	0.01836	0.01805	0.01777	0.01751	0.01726
1.7	1.87	0.03090	0.02934	0.02760	0.02705	0.02647	0.02600	0.02550	0.02466	0.02391	0.02325	0.02266	0.02212	0.02164	0.02120	0.02079	0.02043	0.02008	0.01977	0.01948	0.01921
1.8	1.98	0.03407	0.03237	0.03046	0.02985	0.02922	0.02870	0.02816	0.02723	0.02642	0.02569	0.02504	0.02445	0.02392	0.02344	0.02299	0.02259	0.02221	0.02187	0.02155	0.02125
1.9	2.09	0.03737	0.03552	0.03344	0.03278	0.03209	0.03152	0.03093	0.02992	0.02903	0.02823	0.02752	0.02688	0.02630	0.02577	0.02529	0.02485	0.02443	0.02406	0.02371	0.02338
2.0	2.20	0.04081	0.03880	0.03654	0.03582	0.03507	0.03446	0.03382	0.03271	0.03174	0.03088	0.03011	0.02941	0.02878	0.02821	0.02768	0.02720	0.02674	0.02634	0.02596	0.02561
2.1	2.31	0.04437	0.04220	0.03975	0.03898	0.03817	0.03751	0.03681	0.03562	0.03457	0.03363	0.03280	0.03204	0.03135	0.03073	0.03016	0.02964	0.02915	0.02871	0.02830	0.02792
2.2	2.43	0.04807	0.04573	0.04309	0.04225	0.04138	0.04066	0.03991	0.03863	0.03750	0.03648	0.03558	0.03477	0.03403	0.03336	0.03274	0.03218	0.03165	0.03117	0.03073	0.03032
2.3	2.54	0.05188	0.04937	0.04654	0.04564	0.04470	0.04393	0.04313	0.04174	0.04053	0.03944	0.03847	0.03759	0.03680	0.03608	0.03541	0.03481	0.03424	0.03373	0.03325	0.03280
2.4	2.65	0.05583	0.05314	0.05010	0.04914	0.04814	0.04731	0.04645	0.04497	0.04366	0.04250	0.04146	0.04051	0.03966	0.03889	0.03818	0.03753	0.03692	0.03637	0.03586	0.03538
2.5	2.76	0.05989	0.05702	0.05378	0.05276	0.05168	0.05080	0.04988	0.04829	0.04690	0.04565	0.04454	0.04353	0.04262	0.04180	0.04103	0.04034	0.03968	0.03910	0.03855	0.03804
2.6	2.87	0.06408	0.06102	0.05757	0.05648	0.05534	0.05439	0.05341	0.05172	0.05023	0.04891	0.04772	0.04665	0.04567	0.04479	0.04398	0.04324	0.04254	0.04191	0.04133	0.04078
2.7	2.98	0.06839	0.06514	0.06147	0.06031	0.05910	0.05810	0.05705	0.05525	0.05367	0.05226	0.05100	0.04985	0.04882	0.04788	0.04702	0.04623	0.04548	0.04482	0.04419	0.04361
2.8	3.09	0.07283	0.06938	0.06549	0.06426	0.06297	0.06190	0.06079	0.05889	0.05721	0.05571	0.05437	0.05316	0.05206	0.05106	0.05014	0.04930	0.04852	0.04781	0.04714	0.04653
2.9	3.20	0.07738	0.07373	0.06961	0.06831	0.06694	0.06582	0.06464	0.06262	0.06085	0.05926	0.05784	0.05655	0.05539	0.05433	0.05336	0.05247	0.05163	0.05088	0.05018	0.04953
3.0	3.31	0.08205	0.07820	0.07384	0.07247	0.07102	0.06983	0.06859	0.06646	0.06458	0.06290	0.06140	0.06004	0.05881	0.05769	0.05666	0.05572	0.05484	0.05404	0.05330	0.05261
3.1	3.42	0.08683	0.08277	0.07818	0.07673	0.07521	0.07396	0.07265	0.07040	0.06841	0.06664	0.06506	0.06362	0.06232	0.06114	0.06005	0.05906	0.05813	0.05729	0.05650	0.05577
3.2	3.53	0.09174	0.08747	0.08263	0.08110	0.07950	0.07818	0.07680	0.07443	0.07234	0.07047	0.06880	0.06729	0.06592	0.06468	0.06353	0.06248	0.06150	0.06061	0.05979	0.05902
3.3	3.64	0.09676	0.09227	0.08719	0.08558	0.08390	0.08251	0.08106	0.07856	0.07636	0.07440	0.07264	0.07105	0.06961	0.06830	0.06709	0.06600	0.06496	0.06403	0.06316	0.06235
3.4	3.75	0.10190	0.09718	0.09185	0.09016	0.08839	0.08694	0.08541	0.08279	0.08048	0.07842	0.07658	0.07490	0.07339	0.07202	0.07075	0.06959	0.06850	0.06752	0.06661	0.06576
3.5	3.86	0.10715	0.10221	0.09662	0.09485	0.09299	0.09147	0.08987	0.08712	0.08470	0.08253	0.08060	0.07884	0.07726	0.07582	0.07448	0.07327	0.07213	0.07110	0.07014	0.06925
3.6	3.97	0.11252	0.10734	0.10149	0.09964	0.09770	0.09610	0.09442	0.09155	0.08901	0.08674	0.08472	0.08288	0.08121	0.07970	0.07831	0.07704	0.07584	0.07476	0.07376	0.07282
3.7	4.08	0.11799	0.11259	0.10647	0.10453	0.10250	0.10083	0.09908	0.09607	0.09341	0.09104	0.08892	0.08700	0.08526	0.08368	0.08221	0.08089	0.07963	0.07850	0.07745	0.07647
3.8	4.19	0.12359	0.11794	0.11155	0.10953	0.10741	0.10566	0.10383	0.10069	0.09791	0.09543	0.09322	0.09121	0.08939	0.08773	0.08621	0.08482	0.08351	0.08233	0.08123	0.08020

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor PEX-a — 100% Water — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
3.9	4.30	0.12929	0.12340	0.11674	0.11463	0.11241	0.11059	0.10868	0.10540	0.10250	0.09991	0.09760	0.09550	0.09360	0.09188	0.09028	0.08883	0.08746	0.08623	0.08509	0.08401
4.0	4.41	0.13511	0.12897	0.12203	0.11983	0.11752	0.11562	0.11363	0.11021	0.10719	0.10449	0.10208	0.09989	0.09791	0.09611	0.09444	0.09293	0.09150	0.09022	0.08902	0.08790
4.1	4.52	0.14103	0.13465	0.12742	0.12513	0.12272	0.12074	0.11867	0.11511	0.11196	0.10915	0.10664	0.10436	0.10230	0.10042	0.09869	0.09711	0.09562	0.09429	0.09304	0.09187
4.2	4.63	0.14707	0.14043	0.13291	0.13053	0.12803	0.12596	0.12381	0.12010	0.11683	0.11391	0.11129	0.10892	0.10677	0.10482	0.10302	0.10137	0.09983	0.09843	0.09713	0.09592
4.3	4.74	0.15322	0.14632	0.13850	0.13603	0.13343	0.13129	0.12904	0.12519	0.12179	0.11875	0.11603	0.11356	0.11133	0.10930	0.10743	0.10572	0.10411	0.10266	0.10131	0.10005
4.4	4.85	0.15947	0.15231	0.14420	0.14163	0.13893	0.13670	0.13438	0.13038	0.12684	0.12368	0.12086	0.11829	0.11597	0.11387	0.11192	0.11014	0.10847	0.10696	0.10556	0.10425
4.5	4.96	0.16584	0.15841	0.14999	0.14733	0.14452	0.14222	0.13980	0.13565	0.13198	0.12870	0.12578	0.12311	0.12070	0.11852	0.11649	0.11465	0.11291	0.11135	0.10989	0.10853
4.6	5.07		0.16462	0.15589	0.15312	0.15022	0.14783	0.14532	0.14102	0.13722	0.13381	0.13078	0.12801	0.12552	0.12325	0.12115	0.11924	0.11744	0.11581	0.11430	0.11289
4.7	5.18			0.16188	0.15902	0.15601	0.15353	0.15094	0.14648	0.14254	0.13901	0.13587	0.13300	0.13041	0.12806	0.12589	0.12391	0.12204	0.12036	0.11879	0.11733
4.8	5.29			0.16798	0.16501	0.16190	0.15933	0.15664	0.15203	0.14795	0.14430	0.14104	0.13807	0.13539	0.13296	0.13070	0.12865	0.12672	0.12498	0.12336	0.12184
4.9	5.40					0.16788	0.16523	0.16245	0.15767	0.15345	0.14967	0.14630	0.14323	0.14046	0.13794	0.13560	0.13348	0.13148	0.12968	0.12800	0.12643
5.0	5.51							0.16834	0.16340	0.15904	0.15513	0.15165	0.14847	0.14560	0.14300	0.14058	0.13839	0.13632	0.13445	0.13272	0.13109
5.1	5.62								0.16923	0.16472	0.16068	0.15708	0.15380	0.15083	0.14814	0.14564	0.14337	0.14123	0.13931	0.13751	0.13584
5.2	5.73										0.16631	0.16259	0.15921	0.15614	0.15336	0.15078	0.14844	0.14623	0.14424	0.14239	0.14065
5.3	5.84											0.16819	0.16470	0.16154	0.15866	0.15600	0.15358	0.15130	0.14925	0.14733	0.14555
5.4	5.95													0.16701	0.16405	0.16130	0.15881	0.15645	0.15433	0.15236	0.15051
5.5	6.06														0.16951	0.16668	0.16411	0.16168	0.15949	0.15746	0.15556
5.6	6.17																0.16949	0.16699	0.16473	0.16263	0.16067
5.7	6.28																			0.16789	0.16587

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.55	0.00599	0.00572	0.00544	0.00523	0.00500	0.00482	0.00463	0.00433	0.00407	0.00385	0.00367	0.00351	0.00337	0.00324	0.00314	0.00304	0.00295	0.00288	0.00280	0.00275
0.6	0.66	0.00803	0.00768	0.00732	0.00704	0.00674	0.00650	0.00625	0.00585	0.00551	0.00523	0.00498	0.00477	0.00458	0.00441	0.00428	0.00415	0.00403	0.00393	0.00383	0.00376
0.7	0.77	0.01030	0.00987	0.00941	0.00905	0.00868	0.00838	0.00807	0.00756	0.00713	0.00677	0.00645	0.00618	0.00595	0.00573	0.00556	0.00539	0.00524	0.00512	0.00499	0.00490
0.8	0.88	0.01280	0.01227	0.01171	0.01128	0.01082	0.01046	0.01007	0.00945	0.00892	0.00847	0.00808	0.00775	0.00746	0.00720	0.00698	0.00678	0.00659	0.00643	0.00628	0.00616
0.9	0.99	0.01551	0.01488	0.01421	0.01370	0.01315	0.01271	0.01225	0.01151	0.01088	0.01034	0.00987	0.00947	0.00912	0.00880	0.00855	0.00830	0.00807	0.00788	0.00769	0.00755
1.0	1.10	0.01843	0.01769	0.01691	0.01631	0.01567	0.01515	0.01461	0.01373	0.01299	0.01235	0.01180	0.01133	0.01092	0.01054	0.01024	0.00995	0.00968	0.00945	0.00923	0.00907
1.1	1.21	0.02156	0.02070	0.01980	0.01910	0.01836	0.01777	0.01714	0.01612	0.01526	0.01452	0.01388	0.01334	0.01285	0.01241	0.01206	0.01172	0.01141	0.01115	0.01089	0.01069
1.2	1.32	0.02488	0.02391	0.02287	0.02208	0.02123	0.02055	0.01983	0.01867	0.01768	0.01684	0.01610	0.01548	0.01492	0.01441	0.01401	0.01362	0.01326	0.01296	0.01266	0.01244
1.3	1.43	0.02840	0.02730	0.02613	0.02523	0.02428	0.02351	0.02269	0.02138	0.02026	0.01930	0.01846	0.01775	0.01712	0.01655	0.01609	0.01564	0.01523	0.01489	0.01455	0.01430
1.4	1.54	0.03211	0.03088	0.02957	0.02856	0.02749	0.02663	0.02571	0.02424	0.02298	0.02190	0.02096	0.02016	0.01945	0.01880	0.01829	0.01778	0.01732	0.01693	0.01655	0.01627
1.5	1.65	0.03600	0.03464	0.03318	0.03206	0.03087	0.02991	0.02889	0.02725	0.02584	0.02464	0.02359	0.02270	0.02190	0.02118	0.02060	0.02004	0.01952	0.01909	0.01866	0.01835
1.6	1.76	0.04008	0.03857	0.03696	0.03572	0.03441	0.03335	0.03222	0.03040	0.02885	0.02751	0.02635	0.02536	0.02448	0.02368	0.02304	0.02242	0.02184	0.02136	0.02089	0.02053
1.7	1.87	0.04434	0.04268	0.04092	0.03956	0.03811	0.03694	0.03571	0.03371	0.03199	0.03052	0.02925	0.02816	0.02718	0.02630	0.02560	0.02491	0.02427	0.02374	0.02322	0.02283
1.8	1.98	0.04878	0.04697	0.04504	0.04355	0.04197	0.04070	0.03934	0.03715	0.03528	0.03367	0.03227	0.03107	0.03001	0.02904	0.02827	0.02751	0.02681	0.02623	0.02566	0.02523
1.9	2.09	0.05339	0.05142	0.04932	0.04771	0.04599	0.04460	0.04313	0.04074	0.03870	0.03695	0.03542	0.03412	0.03295	0.03190	0.03105	0.03023	0.02947	0.02883	0.02820	0.02773
2.0	2.20	0.05817	0.05604	0.05377	0.05202	0.05016	0.04865	0.04706	0.04447	0.04225	0.04035	0.03869	0.03728	0.03602	0.03487	0.03395	0.03306	0.03223	0.03154	0.03085	0.03034
2.1	2.31	0.06312	0.06083	0.05838	0.05649	0.05448	0.05285	0.05113	0.04834	0.04594	0.04389	0.04209	0.04056	0.03920	0.03795	0.03696	0.03599	0.03509	0.03435	0.03361	0.03305
2.2	2.43	0.06825	0.06578	0.06315	0.06111	0.05895	0.05720	0.05535	0.05234	0.04976	0.04755	0.04562	0.04397	0.04249	0.04115	0.04008	0.03904	0.03807	0.03726	0.03646	0.03587
2.3	2.54	0.07354	0.07089	0.06807	0.06589	0.06357	0.06170	0.05971	0.05648	0.05371	0.05134	0.04926	0.04749	0.04591	0.04447	0.04332	0.04219	0.04115	0.04028	0.03942	0.03878
2.4	2.65	0.07899	0.07616	0.07315	0.07082	0.06834	0.06634	0.06421	0.06076	0.05779	0.05525	0.05302	0.05113	0.04943	0.04789	0.04666	0.04545	0.04433	0.04340	0.04248	0.04179
2.5	2.76	0.08461	0.08160	0.07838	0.07590	0.07326	0.07112	0.06885	0.06517	0.06200	0.05928	0.05691	0.05488	0.05307	0.05142	0.05010	0.04881	0.04762	0.04663	0.04564	0.04490
2.6	2.87	0.09039	0.08718	0.08377	0.08113	0.07832	0.07604	0.07363	0.06970	0.06634	0.06344	0.06091	0.05875	0.05682	0.05506	0.05366	0.05228	0.05101	0.04995	0.04890	0.04811
2.7	2.98	0.09632	0.09293	0.08930	0.08650	0.08352	0.08110	0.07854	0.07437	0.07080	0.06772	0.06503	0.06274	0.06068	0.05881	0.05732	0.05586	0.05450	0.05338	0.05226	0.05142
2.8	3.09	0.10242	0.09883	0.09499	0.09202	0.08887	0.08631	0.08359	0.07917	0.07538	0.07212	0.06927	0.06683	0.06466	0.06267	0.06109	0.05953	0.05810	0.05690	0.05571	0.05482
2.9	3.20	0.10868	0.10488	0.10082	0.09769	0.09435	0.09164	0.08877	0.08410	0.08009	0.07664	0.07362	0.07104	0.06874	0.06664	0.06496	0.06331	0.06179	0.06052	0.05926	0.05832
3.0	3.31	0.11509	0.11108	0.10681	0.10350	0.09998	0.09712	0.09409	0.08916	0.08492	0.08128	0.07809	0.07536	0.07293	0.07071	0.06893	0.06720	0.06558	0.06424	0.06291	0.06192
3.1	3.42	0.12165	0.11744	0.11293	0.10945	0.10574	0.10273	0.09954	0.09434	0.08988	0.08603	0.08267	0.07980	0.07723	0.07488	0.07301	0.07118	0.06948	0.06806	0.06666	0.06560
3.2	3.53	0.12837	0.12394	0.11920	0.11554	0.11164	0.10848	0.10512	0.09965	0.09495	0.09091	0.08737	0.08434	0.08163	0.07917	0.07719	0.07526	0.07347	0.07198	0.07050	0.06939
3.3	3.64	0.13524	0.13059	0.12562	0.12177	0.11768	0.11436	0.11083	0.10508	0.10015	0.09589	0.09217	0.08899	0.08615	0.08355	0.08148	0.07944	0.07756	0.07599	0.07443	0.07326
3.4	3.75	0.14226	0.13739	0.13218	0.12815	0.12385	0.12037	0.11666	0.11064	0.10546	0.10100	0.09709	0.09375	0.09076	0.08804	0.08586	0.08373	0.08174	0.08010	0.07846	0.07723
3.5	3.86	0.14943	0.14433	0.13888	0.13466	0.13016	0.12651	0.12263	0.11632	0.11089	0.10622	0.10212	0.09862	0.09549	0.09263	0.09035	0.08811	0.08603	0.08430	0.08258	0.08130
3.6	3.97	0.15675	0.15142	0.14572	0.14131	0.13660	0.13279	0.12873	0.12213	0.11645	0.11155	0.10726	0.10360	0.10032	0.09732	0.09493	0.09258	0.09041	0.08860	0.08680	0.08545
3.7	4.08	0.16422	0.15866	0.15270	0.14809	0.14318	0.13919	0.13495	0.12805	0.12211	0.11700	0.11252	0.10868	0.10525	0.10212	0.09961	0.09716	0.09488	0.09299	0.09111	0.08970
3.8	4.19		0.16603	0.15982	0.15501	0.14989	0.14572	0.14130	0.13410	0.12790	0.12255	0.11788	0.11387	0.11028	0.10701	0.10440	0.10183	0.09945	0.09748	0.09551	0.09403
3.9	4.30			0.16708	0.16207	0.15672	0.15239	0.14777	0.14027	0.13380	0.12823	0.12334	0.11916	0.11542	0.11201	0.10928	0.10660	0.10412	0.10206	0.10000	0.09846

Continued on next page

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	4.41				0.16926	0.16369	0.15918	0.15437	0.14655	0.13982	0.13401	0.12892	0.12456	0.12067	0.11711	0.11426	0.11147	0.10888	0.10673	0.10458	0.10298
4.1	4.52						0.16609	0.16110	0.15296	0.14595	0.13990	0.13461	0.13007	0.12601	0.12230	0.11934	0.11643	0.11373	0.11149	0.10926	0.10758
4.2	4.63							0.16794	0.15948	0.15219	0.14590	0.14040	0.13568	0.13145	0.12760	0.12451	0.12149	0.11868	0.11635	0.11402	0.11228
4.3	4.74								0.16612	0.15855	0.15202	0.14629	0.14139	0.13700	0.13299	0.12979	0.12664	0.12372	0.12129	0.11888	0.11707
4.4	4.85									0.16502	0.15824	0.15230	0.14721	0.14265	0.13849	0.13515	0.13189	0.12885	0.12633	0.12382	0.12194
4.5	4.96										0.16457	0.15841	0.15312	0.14839	0.14408	0.14062	0.13723	0.13408	0.13146	0.12886	0.12690
4.6	5.07											0.16462	0.15914	0.15424	0.14976	0.14618	0.14266	0.13940	0.13668	0.13398	0.13195
4.7	5.18												0.16527	0.16018	0.15555	0.15183	0.14819	0.14481	0.14199	0.13919	0.13709
4.8	5.29													0.16623	0.16143	0.15758	0.15381	0.15031	0.14739	0.14449	0.14232
4.9	5.40														0.16740	0.16342	0.15952	0.15590	0.15288	0.14988	0.14763
5.0	5.51															0.16936	0.16533	0.16158	0.15846	0.15535	0.15303
5.1	5.62																	0.16735	0.16413	0.16092	0.15851
5.2	5.73																		0.16988	0.16657	0.16408
5.3	5.84																				0.16974

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.55	0.00743	0.00702	0.00658	0.00626	0.00593	0.00567	0.00540	0.00497	0.00462	0.00433	0.00409	0.00387	0.00369	0.00354	0.00340	0.00329	0.00318	0.00309	0.00300	0.00293
0.6	0.66	0.00991	0.00937	0.00881	0.00839	0.00795	0.00761	0.00726	0.00670	0.00624	0.00586	0.00553	0.00525	0.00501	0.00480	0.00463	0.00448	0.00433	0.00422	0.00409	0.00400
0.7	0.77	0.01266	0.01199	0.01128	0.01076	0.01020	0.00978	0.00934	0.00863	0.00805	0.00756	0.00716	0.00680	0.00650	0.00623	0.00601	0.00581	0.00562	0.00548	0.00532	0.00521
0.8	0.88	0.01566	0.01485	0.01399	0.01335	0.01268	0.01217	0.01162	0.01076	0.01004	0.00945	0.00895	0.00851	0.00814	0.00781	0.00754	0.00730	0.00706	0.00689	0.00669	0.00655
0.9	0.99	0.01892	0.01796	0.01693	0.01618	0.01537	0.01476	0.01411	0.01308	0.01222	0.01151	0.01091	0.01039	0.00994	0.00954	0.00921	0.00892	0.00864	0.00843	0.00819	0.00802
1.0	1.10	0.02242	0.02130	0.02010	0.01921	0.01827	0.01755	0.01679	0.01558	0.01458	0.01374	0.01303	0.01241	0.01189	0.01142	0.01103	0.01069	0.01035	0.01010	0.00982	0.00961
1.1	1.21	0.02616	0.02486	0.02348	0.02246	0.02137	0.02055	0.01967	0.01827	0.01710	0.01613	0.01531	0.01459	0.01398	0.01344	0.01298	0.01259	0.01219	0.01190	0.01158	0.01134
1.2	1.32	0.03012	0.02865	0.02707	0.02591	0.02467	0.02373	0.02272	0.02112	0.01979	0.01869	0.01774	0.01692	0.01622	0.01559	0.01507	0.01461	0.01416	0.01383	0.01345	0.01318
1.3	1.43	0.03431	0.03265	0.03087	0.02956	0.02817	0.02710	0.02597	0.02415	0.02265	0.02139	0.02033	0.01939	0.01859	0.01788	0.01729	0.01677	0.01626	0.01588	0.01545	0.01514
1.4	1.54	0.03872	0.03686	0.03488	0.03341	0.03185	0.03065	0.02938	0.02735	0.02566	0.02426	0.02305	0.02200	0.02111	0.02031	0.01964	0.01906	0.01848	0.01805	0.01757	0.01722
1.5	1.65	0.04334	0.04128	0.03908	0.03745	0.03572	0.03439	0.03298	0.03072	0.02883	0.02727	0.02593	0.02475	0.02376	0.02286	0.02211	0.02147	0.02082	0.02035	0.01981	0.01941
1.6	1.76	0.04817	0.04590	0.04348	0.04168	0.03976	0.03830	0.03674	0.03424	0.03216	0.03043	0.02895	0.02765	0.02654	0.02555	0.02472	0.02400	0.02328	0.02275	0.02216	0.02171
1.7	1.87	0.05321	0.05073	0.04806	0.04610	0.04399	0.04239	0.04067	0.03793	0.03564	0.03373	0.03210	0.03067	0.02945	0.02836	0.02745	0.02666	0.02587	0.02528	0.02462	0.02413
1.8	1.98	0.05845	0.05574	0.05284	0.05070	0.04840	0.04664	0.04477	0.04178	0.03927	0.03719	0.03540	0.03383	0.03249	0.03130	0.03030	0.02943	0.02856	0.02792	0.02720	0.02666
1.9	2.09	0.06389	0.06096	0.05781	0.05547	0.05298	0.05107	0.04904	0.04578	0.04305	0.04078	0.03883	0.03712	0.03567	0.03436	0.03327	0.03232	0.03138	0.03068	0.02988	0.02930
2.0	2.20	0.06953	0.06636	0.06295	0.06043	0.05773	0.05566	0.05346	0.04993	0.04698	0.04451	0.04240	0.04055	0.03896	0.03755	0.03636	0.03533	0.03430	0.03354	0.03268	0.03204
2.1	2.31	0.07537	0.07195	0.06828	0.06556	0.06265	0.06042	0.05805	0.05424	0.05105	0.04838	0.04610	0.04410	0.04239	0.04086	0.03957	0.03846	0.03734	0.03652	0.03559	0.03490
2.2	2.43	0.08140	0.07773	0.07379	0.07087	0.06774	0.06535	0.06279	0.05869	0.05526	0.05239	0.04994	0.04778	0.04593	0.04428	0.04290	0.04170	0.04050	0.03961	0.03860	0.03786
2.3	2.54	0.08762	0.08369	0.07947	0.07635	0.07300	0.07043	0.06769	0.06330	0.05961	0.05654	0.05390	0.05158	0.04960	0.04783	0.04634	0.04505	0.04376	0.04280	0.04172	0.04092
2.4	2.65	0.09402	0.08984	0.08533	0.08199	0.07842	0.07567	0.07275	0.06805	0.06411	0.06082	0.05800	0.05551	0.05339	0.05150	0.04990	0.04852	0.04713	0.04611	0.04495	0.04409
2.5	2.76	0.10062	0.09616	0.09137	0.08781	0.08400	0.08108	0.07796	0.07295	0.06874	0.06523	0.06222	0.05957	0.05730	0.05528	0.05357	0.05209	0.05061	0.04952	0.04828	0.04736
2.6	2.87	0.10740	0.10266	0.09757	0.09379	0.08974	0.08663	0.08332	0.07799	0.07352	0.06978	0.06657	0.06375	0.06133	0.05917	0.05735	0.05578	0.05420	0.05303	0.05171	0.05073
2.7	2.98	0.11436	0.10934	0.10394	0.09994	0.09564	0.09235	0.08883	0.08317	0.07842	0.07446	0.07105	0.06805	0.06548	0.06319	0.06125	0.05958	0.05790	0.05666	0.05525	0.05421
2.8	3.09	0.12150	0.11620	0.11049	0.10625	0.10170	0.09821	0.09449	0.08850	0.08347	0.07926	0.07565	0.07247	0.06975	0.06731	0.06526	0.06348	0.06170	0.06038	0.05889	0.05779
2.9	3.20	0.12882	0.12322	0.11719	0.11272	0.10792	0.10423	0.10029	0.09396	0.08864	0.08420	0.08038	0.07701	0.07413	0.07155	0.06938	0.06750	0.06561	0.06421	0.06263	0.06146
3.0	3.31	0.13632	0.13042	0.12407	0.11935	0.11429	0.11040	0.10625	0.09957	0.09396	0.08926	0.08523	0.08167	0.07863	0.07590	0.07361	0.07162	0.06962	0.06815	0.06648	0.06524
3.1	3.42	0.14399	0.13779	0.13111	0.12614	0.12081	0.11672	0.11235	0.10531	0.09940	0.09445	0.09020	0.08645	0.08324	0.08037	0.07794	0.07585	0.07374	0.07218	0.07042	0.06911
3.2	3.53	0.15184	0.14533	0.13831	0.13309	0.12749	0.12319	0.11859	0.11120	0.10497	0.09977	0.09529	0.09134	0.08797	0.08494	0.08239	0.08018	0.07796	0.07632	0.07446	0.07308
3.3	3.64	0.15986	0.15304	0.14567	0.14020	0.13432	0.12981	0.12498	0.11721	0.11068	0.10521	0.10050	0.09636	0.09281	0.08962	0.08694	0.08462	0.08229	0.08056	0.07860	0.07715
3.4	3.75	0.16806	0.16091	0.15319	0.14746	0.14130	0.13657	0.13151	0.12337	0.11651	0.11077	0.10584	0.10148	0.09776	0.09442	0.09160	0.08916	0.08671	0.08490	0.08284	0.08132
3.5	3.86		0.16895	0.16087	0.15488	0.14843	0.14348	0.13818	0.12965	0.12247	0.11646	0.11129	0.10673	0.10282	0.09932	0.09637	0.09381	0.09124	0.08934	0.08718	0.08558
3.6	3.97			0.16871	0.16245	0.15571	0.15053	0.14499	0.13608	0.12857	0.12227	0.11686	0.11209	0.10800	0.10433	0.10124	0.09856	0.09587	0.09388	0.09162	0.08994
3.7	4.08					0.16314	0.15773	0.15195	0.14263	0.13478	0.12821	0.12255	0.11756	0.11328	0.10945	0.10621	0.10341	0.10060	0.09851	0.09615	0.09440
3.8	4.19						0.16507	0.15904	0.14932	0.14113	0.13426	0.12836	0.12314	0.11868	0.11467	0.11129	0.10837	0.10543	0.10325	0.10078	0.09895
3.9	4.30							0.16626	0.15613	0.14760	0.14044	0.13428	0.12884	0.12418	0.12000	0.11648	0.11342	0.11035	0.10808	0.10550	0.10359

Continued on next page

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	4.41								0.16308	0.15419	0.14674	0.14032	0.13465	0.12980	0.12544	0.12177	0.11858	0.11538	0.11301	0.11032	0.10833
4.1	4.52									0.16091	0.15315	0.14647	0.14057	0.13552	0.13098	0.12716	0.12384	0.12051	0.11804	0.11524	0.11316
4.2	4.63									0.16775	0.15968	0.15274	0.14661	0.14135	0.13663	0.13265	0.12920	0.12573	0.12316	0.12025	0.11809
4.3	4.74										0.16634	0.15912	0.15275	0.14729	0.14238	0.13824	0.13466	0.13105	0.12838	0.12535	0.12311
4.4	4.85											0.16562	0.15900	0.15333	0.14824	0.14394	0.14022	0.13647	0.13370	0.13055	0.12822
4.5	4.96												0.16536	0.15948	0.15420	0.14974	0.14587	0.14199	0.13911	0.13584	0.13342
4.6	5.07													0.16573	0.16026	0.15563	0.15163	0.14760	0.14461	0.14122	0.13871
4.7	5.18														0.16642	0.16163	0.15748	0.15330	0.15021	0.14670	0.14410
4.8	5.29															0.16773	0.16343	0.15911	0.15590	0.15227	0.14957
4.9	5.40																0.16948	0.16500	0.16169	0.15793	0.15514
5.0	5.51																		0.16757	0.16368	0.16079
5.1	5.62																			0.16952	0.16654

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.55	0.00886	0.00834	0.00777	0.00736	0.00693	0.00660	0.00625	0.00571	0.00526	0.00489	0.00458	0.00432	0.00410	0.00390	0.00373	0.00358	0.00345	0.00333	0.00323	0.00313
0.6	0.66	0.01176	0.01108	0.01035	0.00982	0.00925	0.00883	0.00837	0.00766	0.00708	0.00659	0.00619	0.00584	0.00554	0.00529	0.00506	0.00487	0.00469	0.00453	0.00440	0.00427
0.7	0.77	0.01497	0.01412	0.01321	0.01255	0.01184	0.01130	0.01074	0.00985	0.00911	0.00850	0.00799	0.00755	0.00717	0.00684	0.00656	0.00631	0.00609	0.00588	0.00572	0.00555
0.8	0.88	0.01847	0.01744	0.01634	0.01553	0.01467	0.01402	0.01333	0.01225	0.01135	0.01060	0.00997	0.00943	0.00897	0.00857	0.00822	0.00792	0.00763	0.00738	0.00718	0.00698
0.9	0.99	0.02225	0.02103	0.01973	0.01877	0.01775	0.01697	0.01615	0.01486	0.01378	0.01289	0.01214	0.01149	0.01094	0.01045	0.01003	0.00967	0.00933	0.00903	0.00878	0.00853
1.0	1.10	0.02630	0.02488	0.02336	0.02224	0.02105	0.02015	0.01918	0.01767	0.01641	0.01536	0.01448	0.01372	0.01306	0.01249	0.01200	0.01157	0.01117	0.01081	0.01051	0.01023
1.1	1.21	0.03062	0.02898	0.02724	0.02595	0.02458	0.02354	0.02243	0.02068	0.01922	0.01801	0.01699	0.01611	0.01535	0.01468	0.01411	0.01361	0.01314	0.01273	0.01238	0.01205
1.2	1.32	0.03519	0.03334	0.03136	0.02989	0.02833	0.02714	0.02588	0.02388	0.02222	0.02083	0.01966	0.01865	0.01779	0.01703	0.01636	0.01579	0.01525	0.01478	0.01438	0.01400
1.3	1.43	0.04001	0.03793	0.03570	0.03405	0.03229	0.03095	0.02953	0.02727	0.02539	0.02382	0.02250	0.02136	0.02037	0.01951	0.01876	0.01811	0.01750	0.01696	0.01651	0.01607
1.4	1.54	0.04508	0.04276	0.04027	0.03843	0.03646	0.03497	0.03337	0.03085	0.02874	0.02698	0.02550	0.02421	0.02311	0.02214	0.02130	0.02056	0.01988	0.01927	0.01876	0.01827
1.5	1.65	0.05039	0.04781	0.04506	0.04302	0.04084	0.03918	0.03741	0.03461	0.03226	0.03031	0.02865	0.02722	0.02599	0.02491	0.02397	0.02315	0.02238	0.02170	0.02114	0.02059
1.6	1.76	0.05593	0.05310	0.05007	0.04782	0.04542	0.04359	0.04164	0.03854	0.03595	0.03379	0.03196	0.03038	0.02902	0.02782	0.02677	0.02587	0.02502	0.02426	0.02363	0.02302
1.7	1.87	0.06170	0.05861	0.05529	0.05283	0.05020	0.04819	0.04605	0.04265	0.03981	0.03744	0.03542	0.03368	0.03218	0.03086	0.02971	0.02871	0.02778	0.02694	0.02625	0.02558
1.8	1.98	0.06770	0.06433	0.06072	0.05804	0.05517	0.05298	0.05064	0.04694	0.04383	0.04124	0.03903	0.03713	0.03548	0.03404	0.03278	0.03168	0.03066	0.02974	0.02898	0.02825
1.9	2.09	0.07393	0.07027	0.06636	0.06345	0.06033	0.05795	0.05542	0.05139	0.04801	0.04519	0.04279	0.04072	0.03893	0.03735	0.03598	0.03478	0.03366	0.03267	0.03184	0.03103
2.0	2.20	0.08037	0.07643	0.07220	0.06905	0.06569	0.06312	0.06037	0.05601	0.05236	0.04930	0.04669	0.04445	0.04250	0.04079	0.03931	0.03800	0.03679	0.03571	0.03480	0.03393
2.1	2.31	0.08704	0.08279	0.07824	0.07485	0.07123	0.06846	0.06550	0.06080	0.05686	0.05355	0.05074	0.04831	0.04621	0.04437	0.04276	0.04135	0.04003	0.03886	0.03788	0.03694
2.2	2.43	0.09391	0.08936	0.08448	0.08085	0.07696	0.07398	0.07081	0.06575	0.06151	0.05796	0.05493	0.05232	0.05006	0.04807	0.04633	0.04482	0.04340	0.04213	0.04108	0.04006
2.3	2.54	0.10100	0.09614	0.09092	0.08703	0.08287	0.07968	0.07628	0.07087	0.06632	0.06251	0.05927	0.05646	0.05403	0.05190	0.05003	0.04840	0.04688	0.04552	0.04439	0.04329
2.4	2.65	0.10830	0.10312	0.09755	0.09340	0.08896	0.08556	0.08192	0.07614	0.07128	0.06721	0.06374	0.06074	0.05814	0.05585	0.05385	0.05211	0.05048	0.04902	0.04780	0.04663
2.5	2.76	0.11581	0.11029	0.10437	0.09996	0.09523	0.09161	0.08774	0.08158	0.07640	0.07205	0.06835	0.06515	0.06237	0.05993	0.05780	0.05593	0.05419	0.05263	0.05133	0.05007
2.6	2.87	0.12352	0.11767	0.11138	0.10670	0.10167	0.09783	0.09372	0.08717	0.08166	0.07704	0.07310	0.06969	0.06673	0.06413	0.06186	0.05987	0.05801	0.05636	0.05497	0.05363
2.7	2.98	0.13143	0.12524	0.11858	0.11362	0.10830	0.10422	0.09986	0.09291	0.08707	0.08216	0.07798	0.07436	0.07122	0.06846	0.06604	0.06393	0.06195	0.06019	0.05872	0.05729
2.8	3.09	0.13955	0.13300	0.12597	0.12072	0.11509	0.11078	0.10617	0.09882	0.09263	0.08743	0.08300	0.07916	0.07583	0.07290	0.07034	0.06810	0.06600	0.06413	0.06257	0.06105
2.9	3.20	0.14786	0.14096	0.13354	0.12800	0.12206	0.11751	0.11264	0.10487	0.09833	0.09284	0.08815	0.08409	0.08057	0.07747	0.07476	0.07239	0.07017	0.06819	0.06653	0.06492
3.0	3.31	0.15637	0.14911	0.14129	0.13546	0.12920	0.12440	0.11927	0.11108	0.10418	0.09838	0.09344	0.08915	0.08543	0.08216	0.07929	0.07679	0.07444	0.07235	0.07060	0.06890
3.1	3.42	0.16508	0.15744	0.14922	0.14309	0.13651	0.13146	0.12606	0.11744	0.11017	0.10406	0.09885	0.09433	0.09042	0.08696	0.08394	0.08130	0.07882	0.07661	0.07477	0.07298
3.2	3.53		0.16597	0.15734	0.15090	0.14398	0.13868	0.13300	0.12394	0.11630	0.10988	0.10440	0.09965	0.09552	0.09189	0.08871	0.08592	0.08332	0.08099	0.07904	0.07716
3.3	3.64			0.16563	0.15888	0.15163	0.14606	0.14011	0.13060	0.12258	0.11583	0.11008	0.10508	0.10075	0.09693	0.09359	0.09066	0.08792	0.08547	0.08342	0.08144
3.4	3.75				0.16703	0.15943	0.15360	0.14737	0.13740	0.12899	0.12192	0.11588	0.11064	0.10610	0.10208	0.09858	0.09551	0.09263	0.09006	0.08791	0.08582
3.5	3.86					0.16741	0.16131	0.15478	0.14435	0.13555	0.12814	0.12182	0.11633	0.11156	0.10736	0.10368	0.10046	0.09744	0.09475	0.09249	0.09031
3.6	3.97						0.16917	0.16235	0.15145	0.14224	0.13450	0.12788	0.12213	0.11715	0.11275	0.10890	0.10553	0.10237	0.09954	0.09718	0.09489
3.7	4.08								0.15869	0.14907	0.14098	0.13407	0.12806	0.12285	0.11825	0.11423	0.11070	0.10739	0.10444	0.10197	0.09958
3.8	4.19								0.16607	0.15604	0.14760	0.14038	0.13411	0.12867	0.12387	0.11966	0.11598	0.11253	0.10944	0.10686	0.10436
3.9	4.30									0.16315	0.15434	0.14682	0.14028	0.13461	0.12960	0.12521	0.12137	0.11777	0.11455	0.11185	0.10924

Continued on next page

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	4.41										0.16122	0.15338	0.14658	0.14066	0.13544	0.13087	0.12687	0.12311	0.11976	0.11695	0.11422
4.1	4.52										0.16822	0.16007	0.15299	0.14683	0.14140	0.13664	0.13247	0.12856	0.12506	0.12214	0.11930
4.2	4.63											0.16688	0.15951	0.15312	0.14746	0.14251	0.13818	0.13411	0.13047	0.12743	0.12447
4.3	4.74												0.16616	0.15951	0.15364	0.14850	0.14399	0.13976	0.13598	0.13282	0.12974
4.4	4.85													0.16602	0.15993	0.15459	0.14991	0.14551	0.14159	0.13830	0.13511
4.5	4.96														0.16632	0.16079	0.15593	0.15137	0.14730	0.14389	0.14058
4.6	5.07															0.16709	0.16205	0.15733	0.15311	0.14957	0.14614
4.7	5.18																0.16828	0.16339	0.15901	0.15535	0.15179
4.8	5.29																	0.16955	0.16502	0.16122	0.15754
4.9	5.40																			0.16720	0.16338
5.0	5.51																				0.16932

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

1" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	2.73	1.81	1.72	1.62	1.58	1.55	1.52	1.49	1.45	1.40	1.36	1.33	1.30	1.27	1.25	1.22	1.20	1.18	1.16	1.15	1.13
1.6	2.91	2.02	1.92	1.81	1.77	1.73	1.70	1.67	1.62	1.57	1.53	1.49	1.45	1.42	1.40	1.37	1.35	1.32	1.30	1.28	1.27
1.7	3.09	2.24	2.13	2.01	1.97	1.93	1.89	1.86	1.80	1.75	1.70	1.66	1.62	1.58	1.55	1.52	1.50	1.47	1.45	1.43	1.41
1.8	3.27	2.47	2.35	2.21	2.17	2.13	2.09	2.05	1.99	1.93	1.88	1.83	1.79	1.75	1.72	1.68	1.66	1.63	1.60	1.58	1.56
1.9	3.46	2.71	2.58	2.43	2.39	2.34	2.30	2.26	2.18	2.12	2.06	2.01	1.97	1.93	1.89	1.85	1.82	1.79	1.77	1.74	1.72
2.0	3.64	2.96	2.82	2.66	2.61	2.56	2.51	2.47	2.39	2.32	2.26	2.20	2.15	2.11	2.07	2.03	2.00	1.96	1.93	1.91	1.88
2.1	3.82	3.22	3.07	2.89	2.84	2.78	2.74	2.69	2.60	2.53	2.46	2.40	2.35	2.30	2.25	2.21	2.18	2.14	2.11	2.08	2.05
2.2	4.00	3.49	3.32	3.14	3.08	3.02	2.97	2.91	2.82	2.74	2.67	2.61	2.55	2.49	2.45	2.40	2.36	2.32	2.29	2.26	2.23
2.3	4.18	3.77	3.59	3.39	3.33	3.26	3.21	3.15	3.05	2.96	2.89	2.82	2.75	2.70	2.65	2.60	2.56	2.51	2.48	2.44	2.41
2.4	4.37	4.06	3.87	3.65	3.58	3.51	3.45	3.39	3.29	3.19	3.11	3.04	2.97	2.91	2.85	2.80	2.76	2.71	2.67	2.64	2.60
2.5	4.55	4.35	4.15	3.92	3.85	3.77	3.71	3.64	3.53	3.43	3.34	3.26	3.19	3.13	3.07	3.01	2.96	2.92	2.87	2.83	2.80
2.6	4.73	4.66	4.44	4.20	4.12	4.04	3.97	3.90	3.78	3.68	3.58	3.50	3.42	3.35	3.29	3.23	3.18	3.13	3.08	3.04	3.00
2.7	4.91	4.97	4.74	4.48	4.40	4.32	4.24	4.17	4.04	3.93	3.83	3.74	3.66	3.58	3.52	3.45	3.40	3.34	3.30	3.25	3.21
2.8	5.09	5.30	5.05	4.78	4.69	4.60	4.52	4.44	4.31	4.19	4.08	3.99	3.90	3.82	3.75	3.68	3.62	3.57	3.52	3.47	3.42
2.9	5.28	5.63	5.37	5.08	4.99	4.89	4.81	4.73	4.58	4.46	4.34	4.24	4.15	4.07	3.99	3.92	3.86	3.80	3.74	3.69	3.65
3.0	5.46	5.97	5.70	5.39	5.29	5.19	5.11	5.02	4.87	4.73	4.61	4.50	4.41	4.32	4.24	4.16	4.10	4.03	3.98	3.92	3.87
3.1	5.64	6.32	6.03	5.71	5.61	5.50	5.41	5.31	5.15	5.01	4.89	4.77	4.67	4.58	4.49	4.41	4.34	4.28	4.22	4.16	4.11
3.2	5.82	6.68	6.38	6.03	5.93	5.81	5.72	5.62	5.45	5.30	5.17	5.05	4.94	4.84	4.75	4.67	4.60	4.53	4.46	4.40	4.35
3.3	6.00	7.05	6.73	6.37	6.25	6.13	6.04	5.93	5.75	5.60	5.46	5.33	5.22	5.11	5.02	4.93	4.86	4.78	4.71	4.65	4.59
3.4	6.19	7.42	7.09	6.71	6.59	6.46	6.36	6.25	6.07	5.90	5.75	5.62	5.50	5.39	5.29	5.20	5.12	5.04	4.97	4.91	4.85
3.5	6.37	7.81	7.46	7.06	6.93	6.80	6.69	6.58	6.38	6.21	6.06	5.92	5.79	5.68	5.58	5.48	5.39	5.31	5.24	5.17	5.10
3.6	6.55	8.20	7.83	7.42	7.29	7.15	7.03	6.91	6.71	6.53	6.37	6.22	6.09	5.97	5.86	5.76	5.67	5.58	5.51	5.43	5.37
3.7	6.73	8.60	8.22	7.78	7.65	7.50	7.38	7.26	7.04	6.85	6.68	6.53	6.39	6.27	6.16	6.05	5.95	5.86	5.78	5.71	5.64
3.8	6.91	9.01	8.61	8.16	8.01	7.86	7.74	7.61	7.38	7.18	7.01	6.85	6.70	6.57	6.45	6.34	6.25	6.15	6.07	5.99	5.91
3.9	7.09	9.43	9.01	8.54	8.39	8.23	8.10	7.96	7.73	7.52	7.34	7.17	7.02	6.88	6.76	6.65	6.54	6.44	6.35	6.27	6.19
4.0	7.28	9.85	9.42	8.93	8.77	8.60	8.47	8.33	8.08	7.87	7.67	7.50	7.34	7.20	7.07	6.95	6.84	6.74	6.65	6.56	6.48
4.1	7.46	10.29	9.84	9.32	9.16	8.99	8.85	8.70	8.44	8.22	8.02	7.84	7.67	7.53	7.39	7.27	7.15	7.05	6.95	6.86	6.78
4.2	7.64	10.73	10.26	9.72	9.55	9.38	9.23	9.08	8.81	8.58	8.37	8.18	8.01	7.86	7.72	7.59	7.47	7.36	7.26	7.16	7.08
4.3	7.82	11.18	10.69	10.14	9.96	9.77	9.62	9.46	9.19	8.94	8.72	8.53	8.35	8.19	8.05	7.91	7.79	7.67	7.57	7.47	7.38
4.4	8.00	11.64	11.13	10.55	10.37	10.18	10.02	9.85	9.57	9.31	9.09	8.89	8.70	8.54	8.38	8.24	8.12	8.00	7.89	7.79	7.69
4.5	8.19	12.11	11.58	10.98	10.79	10.59	10.42	10.25	9.96	9.69	9.46	9.25	9.06	8.88	8.73	8.58	8.45	8.32	8.21	8.11	8.01
4.6	8.37	12.58	12.03	11.41	11.22	11.01	10.84	10.66	10.35	10.08	9.83	9.62	9.42	9.24	9.08	8.93	8.79	8.66	8.54	8.43	8.33
4.7	8.55	13.06	12.50	11.85	11.65	11.43	11.26	11.07	10.75	10.47	10.22	9.99	9.79	9.60	9.43	9.28	9.13	9.00	8.88	8.76	8.66
4.8	8.73	13.55	12.97	12.30	12.09	11.87	11.68	11.49	11.16	10.87	10.61	10.37	10.16	9.97	9.79	9.63	9.48	9.34	9.22	9.10	8.99
4.9	8.91	14.05	13.45	12.76	12.54	12.31	12.12	11.92	11.58	11.28	11.00	10.76	10.54	10.34	10.16	9.99	9.84	9.70	9.57	9.45	9.33

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	9.10	14.56	13.93	13.22	12.99	12.75	12.56	12.35	12.00	11.69	11.41	11.16	10.93	10.72	10.54	10.36	10.20	10.05	9.92	9.80	9.68
5.1	9.28	15.07	14.42	13.69	13.45	13.21	13.01	12.79	12.43	12.11	11.82	11.56	11.32	11.11	10.92	10.74	10.57	10.42	10.28	10.15	10.03
5.2	9.46	15.59	14.93	14.17	13.92	13.67	13.46	13.24	12.86	12.53	12.23	11.96	11.72	11.50	11.30	11.12	10.95	10.79	10.64	10.51	10.39
5.3	9.64	16.12	15.43	14.65	14.40	14.14	13.92	13.70	13.31	12.96	12.65	12.38	12.13	11.90	11.69	11.50	11.33	11.16	11.01	10.88	10.75
5.4	9.82	16.66	15.95	15.14	14.88	14.61	14.39	14.16	13.76	13.40	13.08	12.80	12.54	12.30	12.09	11.89	11.71	11.54	11.39	11.25	11.12
5.5	10.01	17.21	16.47	15.64	15.37	15.10	14.87	14.63	14.21	13.85	13.52	13.22	12.96	12.71	12.49	12.29	12.11	11.93	11.77	11.63	11.49
5.6	10.19	17.76	17.00	16.14	15.87	15.59	15.35	15.10	14.67	14.30	13.96	13.66	13.38	13.13	12.90	12.69	12.50	12.32	12.16	12.01	11.87
5.7	10.37	18.32	17.54	16.66	16.38	16.08	15.84	15.58	15.14	14.75	14.41	14.09	13.81	13.55	13.32	13.10	12.91	12.72	12.55	12.40	12.25
5.8	10.55	18.89	18.09	17.18	16.89	16.58	16.33	16.07	15.62	15.22	14.86	14.54	14.25	13.98	13.74	13.52	13.32	13.13	12.95	12.79	12.64
5.9	10.73	19.46	18.64	17.70	17.41	17.09	16.84	16.57	16.10	15.69	15.32	14.99	14.69	14.42	14.17	13.94	13.73	13.54	13.36	13.19	13.04
6.0	10.92	20.05	19.20	18.24	17.93	17.61	17.35	17.07	16.59	16.17	15.79	15.45	15.14	14.86	14.60	14.37	14.15	13.95	13.77	13.60	13.44
6.1	11.10	20.64	19.77	18.78	18.46	18.13	17.86	17.58	17.08	16.65	16.26	15.91	15.59	15.30	15.04	14.80	14.58	14.37	14.18	14.01	13.85
6.2	11.28	21.24	20.34	19.33	19.00	18.66	18.38	18.09	17.58	17.14	16.74	16.38	16.05	15.76	15.49	15.24	15.01	14.80	14.61	14.43	14.26
6.3	11.46	21.84	20.93	19.88	19.55	19.20	18.91	18.61	18.09	17.63	17.22	16.85	16.52	16.21	15.94	15.68	15.45	15.23	15.03	14.85	14.68
6.4	11.64	22.46	21.51	20.44	20.10	19.74	19.45	19.14	18.61	18.14	17.71	17.34	16.99	16.68	16.40	16.13	15.89	15.67	15.47	15.28	15.10
6.5	11.82	23.08	22.11	21.01	20.66	20.30	19.99	19.67	19.13	18.64	18.21	17.82	17.47	17.15	16.86	16.59	16.34	16.11	15.90	15.71	15.53
6.6	12.01	23.71	22.71	21.59	21.23	20.85	20.54	20.22	19.66	19.16	18.71	18.32	17.95	17.63	17.33	17.05	16.80	16.56	16.35	16.15	15.96
6.7	12.19	24.34	23.33	22.17	21.80	21.42	21.10	20.76	20.19	19.68	19.22	18.82	18.44	18.11	17.80	17.52	17.26	17.02	16.80	16.59	16.40
6.8	12.37	24.98	23.94	22.76	22.38	21.99	21.66	21.32	20.73	20.21	19.74	19.32	18.94	18.59	18.28	17.99	17.73	17.48	17.25	17.04	16.84
6.9	12.55	25.63	24.57	23.36	22.97	22.56	22.23	21.88	21.27	20.74	20.26	19.83	19.44	19.09	18.77	18.47	18.20	17.94	17.71	17.50	17.29
7.0	12.73	26.29	25.20	23.96	23.56	23.15	22.81	22.45	21.83	21.28	20.79	20.35	19.95	19.59	19.26	18.95	18.68	18.41	18.18	17.96	17.75
7.1	12.92	26.96	25.84	24.57	24.16	23.74	23.39	23.02	22.39	21.83	21.32	20.87	20.46	20.09	19.76	19.44	19.16	18.89	18.65	18.42	18.21
7.2	13.10	27.63	26.49	25.18	24.77	24.34	23.98	23.60	22.95	22.38	21.86	21.40	20.98	20.60	20.26	19.94	19.65	19.37	19.12	18.89	18.68
7.3	13.28	28.31	27.14	25.81	25.38	24.94	24.57	24.19	23.52	22.94	22.41	21.94	21.51	21.12	20.77	20.44	20.14	19.86	19.61	19.37	19.15
7.4	13.46	29.00	27.80	26.44	26.01	25.55	25.17	24.78	24.10	23.50	22.96	22.48	22.04	21.64	21.28	20.95	20.64	20.35	20.09	19.85	19.63
7.5	13.64	29.69	28.47	27.08	26.63	26.17	25.78	25.38	24.68	24.07	23.52	23.03	22.58	22.17	21.80	21.46	21.15	20.85	20.59	20.34	20.11
7.6	13.83	30.39	29.14	27.72	27.27	26.79	26.40	25.98	25.28	24.65	24.08	23.58	23.12	22.70	22.33	21.98	21.66	21.36	21.08	20.83	20.60
7.7	14.01	31.10	29.82	28.37	27.91	27.42	27.02	26.60	25.87	25.23	24.65	24.14	23.67	23.24	22.86	22.50	22.17	21.87	21.59	21.33	21.09
7.8	14.19	31.82	30.51	29.03	28.55	28.06	27.65	27.22	26.47	25.82	25.23	24.70	24.22	23.79	23.39	23.03	22.70	22.38	22.10	21.83	21.59
7.9	14.37	32.54	31.21	29.69	29.21	28.70	28.28	27.84	27.08	26.41	25.81	25.27	24.78	24.34	23.94	23.56	23.22	22.90	22.61	22.34	22.09
8.0	14.55	33.27	31.91	30.36	29.87	29.35	28.92	28.47	27.70	27.01	26.40	25.85	25.35	24.90	24.49	24.10	23.76	23.43	23.13	22.86	22.60

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	2.73	2.58	2.48	2.38	2.30	2.22	2.15	2.08	1.97	1.87	1.78	1.71	1.65	1.59	1.54	1.50	1.46	1.42	1.39	1.36	1.34
1.6	2.91	2.87	2.77	2.66	2.57	2.48	2.40	2.32	2.20	2.09	1.99	1.91	1.84	1.78	1.72	1.68	1.63	1.59	1.56	1.53	1.50
1.7	3.09	3.18	3.06	2.94	2.85	2.75	2.66	2.58	2.44	2.32	2.21	2.12	2.05	1.98	1.92	1.87	1.82	1.77	1.73	1.70	1.67
1.8	3.27	3.50	3.37	3.24	3.14	3.03	2.94	2.84	2.69	2.56	2.44	2.34	2.26	2.18	2.12	2.06	2.01	1.96	1.92	1.88	1.85
1.9	3.46	3.83	3.70	3.55	3.44	3.32	3.22	3.12	2.95	2.81	2.68	2.57	2.48	2.40	2.33	2.27	2.21	2.15	2.11	2.06	2.03
2.0	3.64	4.18	4.03	3.87	3.75	3.62	3.51	3.40	3.22	3.06	2.93	2.81	2.71	2.62	2.54	2.48	2.41	2.36	2.31	2.26	2.22
2.1	3.82	4.54	4.38	4.21	4.07	3.93	3.82	3.70	3.50	3.33	3.19	3.06	2.95	2.86	2.77	2.70	2.63	2.57	2.51	2.46	2.42
2.2	4.00	4.91	4.73	4.55	4.41	4.26	4.14	4.01	3.79	3.61	3.46	3.32	3.20	3.10	3.00	2.93	2.85	2.78	2.73	2.67	2.63
2.3	4.18	5.29	5.11	4.91	4.76	4.59	4.46	4.32	4.10	3.90	3.73	3.59	3.46	3.35	3.25	3.16	3.08	3.01	2.95	2.89	2.84
2.4	4.37	5.68	5.49	5.28	5.11	4.94	4.80	4.65	4.41	4.20	4.02	3.86	3.73	3.61	3.50	3.41	3.32	3.24	3.18	3.11	3.06
2.5	4.55	6.09	5.88	5.66	5.48	5.30	5.15	4.99	4.73	4.51	4.31	4.15	4.00	3.87	3.76	3.66	3.57	3.49	3.41	3.34	3.29
2.6	4.73	6.51	6.29	6.05	5.86	5.67	5.51	5.34	5.06	4.82	4.62	4.44	4.29	4.15	4.02	3.92	3.83	3.73	3.66	3.58	3.53
2.7	4.91	6.94	6.70	6.45	6.25	6.04	5.87	5.69	5.40	5.15	4.93	4.74	4.58	4.43	4.30	4.19	4.09	3.99	3.91	3.83	3.77
2.8	5.09	7.38	7.13	6.86	6.65	6.43	6.25	6.06	5.75	5.48	5.25	5.05	4.88	4.72	4.58	4.47	4.36	4.26	4.17	4.08	4.02
2.9	5.28	7.84	7.57	7.29	7.07	6.83	6.64	6.44	6.11	5.83	5.58	5.37	5.19	5.02	4.87	4.75	4.64	4.53	4.44	4.35	4.28
3.0	5.46	8.30	8.02	7.72	7.49	7.24	7.04	6.83	6.48	6.18	5.92	5.70	5.50	5.33	5.17	5.04	4.92	4.81	4.71	4.61	4.54
3.1	5.64	8.78	8.48	8.17	7.92	7.66	7.45	7.22	6.86	6.54	6.27	6.03	5.83	5.64	5.48	5.34	5.21	5.09	4.99	4.89	4.81
3.2	5.82	9.26	8.95	8.62	8.36	8.09	7.87	7.63	7.25	6.91	6.63	6.38	6.16	5.97	5.79	5.65	5.51	5.39	5.28	5.17	5.09
3.3	6.00	9.76	9.44	9.09	8.82	8.53	8.30	8.05	7.64	7.29	6.99	6.73	6.50	6.30	6.11	5.97	5.82	5.69	5.57	5.46	5.38
3.4	6.19	10.27	9.93	9.57	9.28	8.98	8.73	8.47	8.05	7.68	7.37	7.09	6.85	6.64	6.44	6.29	6.14	5.99	5.88	5.76	5.67
3.5	6.37	10.79	10.44	10.05	9.76	9.44	9.18	8.91	8.46	8.08	7.75	7.46	7.21	6.98	6.78	6.62	6.46	6.31	6.19	6.06	5.97
3.6	6.55	11.33	10.95	10.55	10.24	9.91	9.64	9.35	8.89	8.49	8.14	7.83	7.57	7.34	7.13	6.96	6.79	6.63	6.50	6.37	6.28
3.7	6.73	11.87	11.48	11.06	10.74	10.39	10.11	9.81	9.32	8.90	8.54	8.22	7.95	7.70	7.48	7.30	7.12	6.96	6.83	6.69	6.59
3.8	6.91	12.42	12.01	11.58	11.24	10.88	10.58	10.27	9.76	9.32	8.94	8.61	8.33	8.07	7.84	7.65	7.47	7.30	7.16	7.02	6.91
3.9	7.09	12.99	12.56	12.11	11.75	11.38	11.07	10.75	10.21	9.76	9.36	9.01	8.72	8.45	8.21	8.01	7.82	7.64	7.49	7.35	7.24
4.0	7.28	13.56	13.12	12.64	12.28	11.89	11.57	11.23	10.67	10.20	9.78	9.42	9.11	8.83	8.58	8.38	8.18	7.99	7.84	7.68	7.57
4.1	7.46	14.15	13.69	13.19	12.81	12.40	12.07	11.72	11.14	10.65	10.22	9.84	9.52	9.23	8.96	8.75	8.54	8.35	8.19	8.03	7.91
4.2	7.64	14.74	14.26	13.75	13.36	12.93	12.59	12.22	11.62	11.10	10.66	10.26	9.93	9.63	9.35	9.13	8.92	8.71	8.55	8.38	8.26
4.3	7.82	15.35	14.85	14.32	13.91	13.47	13.11	12.73	12.11	11.57	11.10	10.70	10.35	10.03	9.75	9.52	9.29	9.09	8.91	8.74	8.61
4.4	8.00	15.97	15.45	14.90	14.47	14.01	13.64	13.25	12.60	12.04	11.56	11.14	10.78	10.45	10.15	9.91	9.68	9.46	9.28	9.10	8.97
4.5	8.19	16.59	16.06	15.49	15.04	14.57	14.18	13.77	13.10	12.53	12.03	11.59	11.21	10.87	10.56	10.32	10.07	9.85	9.66	9.47	9.33
4.6	8.37	17.23	16.68	16.09	15.63	15.14	14.74	14.31	13.62	13.02	12.50	12.04	11.65	11.30	10.98	10.73	10.47	10.24	10.05	9.85	9.71
4.7	8.55	17.88	17.31	16.69	16.22	15.71	15.30	14.86	14.14	13.52	12.98	12.51	12.10	11.74	11.41	11.14	10.88	10.64	10.44	10.24	10.09
4.8	8.73	18.54	17.95	17.31	16.82	16.29	15.87	15.41	14.67	14.02	13.47	12.98	12.56	12.18	11.84	11.57	11.30	11.04	10.84	10.63	10.47
4.9	8.91	19.21	18.59	17.94	17.43	16.89	16.44	15.97	15.20	14.54	13.96	13.46	13.02	12.64	12.28	12.00	11.72	11.46	11.24	11.02	10.86

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	9.10	19.89	19.25	18.58	18.05	17.49	17.03	16.54	15.75	15.06	14.47	13.95	13.50	13.10	12.73	12.43	12.14	11.88	11.65	11.43	11.26
5.1	9.28	20.57	19.92	19.22	18.68	18.10	17.63	17.12	16.30	15.59	14.98	14.44	13.98	13.56	13.18	12.88	12.58	12.30	12.07	11.84	11.67
5.2	9.46	21.27	20.60	19.88	19.32	18.72	18.23	17.71	16.87	16.13	15.50	14.94	14.46	14.04	13.64	13.33	13.02	12.73	12.49	12.26	12.08
5.3	9.64	21.98	21.29	20.54	19.97	19.35	18.85	18.31	17.44	16.68	16.03	15.45	14.96	14.52	14.11	13.79	13.47	13.17	12.93	12.68	12.50
5.4	9.82	22.70	21.99	21.22	20.62	19.99	19.47	18.92	18.02	17.24	16.56	15.97	15.46	15.00	14.59	14.25	13.92	13.62	13.36	13.11	12.92
5.5	10.01	23.43	22.69	21.90	21.29	20.64	20.10	19.53	18.60	17.80	17.10	16.49	15.97	15.50	15.07	14.72	14.39	14.07	13.81	13.55	13.35
5.6	10.19	24.17	23.41	22.60	21.97	21.29	20.74	20.16	19.20	18.37	17.66	17.03	16.49	16.00	15.56	15.20	14.85	14.53	14.26	13.99	13.79
5.7	10.37	24.92	24.14	23.30	22.65	21.96	21.39	20.79	19.80	18.95	18.21	17.57	17.01	16.51	16.05	15.69	15.33	14.99	14.72	14.44	14.23
5.8	10.55	25.68	24.87	24.01	23.35	22.63	22.05	21.43	20.42	19.54	18.78	18.11	17.54	17.03	16.56	16.18	15.81	15.47	15.18	14.89	14.68
5.9	10.73	26.44	25.62	24.74	24.05	23.31	22.72	22.08	21.04	20.13	19.35	18.67	18.08	17.55	17.07	16.68	16.30	15.94	15.65	15.35	15.13
6.0	10.92	27.22	26.38	25.47	24.76	24.01	23.39	22.74	21.66	20.74	19.94	19.23	18.62	18.08	17.58	17.18	16.79	16.43	16.12	15.82	15.60
6.1	11.10	28.01	27.14	26.21	25.48	24.71	24.07	23.40	22.30	21.35	20.52	19.80	19.18	18.62	18.11	17.70	17.29	16.92	16.61	16.30	16.06
6.2	11.28	28.81	27.91	26.96	26.21	25.42	24.77	24.08	22.95	21.97	21.12	20.38	19.74	19.16	18.64	18.22	17.80	17.42	17.10	16.78	16.54
6.3	11.46	29.61	28.70	27.71	26.95	26.13	25.47	24.76	23.60	22.59	21.72	20.96	20.30	19.71	19.17	18.74	18.32	17.92	17.59	17.26	17.02
6.4	11.64	30.43	29.49	28.48	27.70	26.86	26.18	25.45	24.26	23.23	22.34	21.55	20.88	20.27	19.72	19.27	18.84	18.43	18.09	17.76	17.50
6.5	11.82	31.26	30.29	29.26	28.46	27.60	26.90	26.15	24.93	23.87	22.95	22.15	21.46	20.84	20.27	19.81	19.37	18.95	18.60	18.26	18.00
6.6	12.01	32.09	31.11	30.05	29.22	28.34	27.62	26.86	25.60	24.52	23.58	22.76	22.05	21.41	20.83	20.36	19.90	19.47	19.12	18.76	18.49
6.7	12.19	32.94	31.93	30.84	30.00	29.09	28.36	27.57	26.29	25.18	24.21	23.37	22.64	21.99	21.39	20.91	20.44	20.00	19.64	19.27	19.00
6.8	12.37	33.79	32.76	31.64	30.78	29.85	29.10	28.30	26.98	25.84	24.86	23.99	23.24	22.57	21.96	21.47	20.99	20.54	20.16	19.79	19.51
6.9	12.55	34.66	33.60	32.46	31.57	30.62	29.85	29.03	27.68	26.51	25.50	24.62	23.85	23.17	22.54	22.04	21.54	21.08	20.70	20.31	20.03
7.0	12.73	35.53	34.44	33.28	32.37	31.40	30.61	29.77	28.39	27.19	26.16	25.25	24.47	23.77	23.12	22.61	22.10	21.63	21.24	20.84	20.55
7.1	12.92	36.41	35.30	34.11	33.18	32.19	31.38	30.52	29.11	27.88	26.82	25.89	25.09	24.37	23.71	23.19	22.67	22.18	21.78	21.38	21.08
7.2	13.10	37.31	36.17	34.95	34.00	32.98	32.16	31.27	29.83	28.58	27.49	26.54	25.72	24.98	24.31	23.77	23.24	22.74	22.33	21.92	21.61
7.3	13.28	38.21	37.05	35.80	34.83	33.79	32.94	32.04	30.56	29.28	28.17	27.20	26.36	25.60	24.92	24.36	23.82	23.31	22.89	22.47	22.15
7.4	13.46	39.12	37.93	36.66	35.66	34.60	33.74	32.81	31.30	29.99	28.86	27.86	27.00	26.23	25.53	24.96	24.40	23.89	23.46	23.02	22.70
7.5	13.64	40.04	38.83	37.52	36.51	35.42	34.54	33.59	32.05	30.71	29.55	28.53	27.65	26.86	26.14	25.56	25.00	24.47	24.03	23.58	23.25
7.6	13.83	40.97	39.73	38.40	37.36	36.25	35.35	34.38	32.80	31.43	30.25	29.21	28.31	27.50	26.77	26.18	25.59	25.05	24.60	24.15	23.81
7.7	14.01	41.91	40.64	39.28	38.22	37.09	36.16	35.18	33.57	32.17	30.96	29.89	28.97	28.15	27.40	26.79	26.20	25.64	25.18	24.72	24.38
7.8	14.19	42.86	41.56	40.17	39.09	37.93	36.99	35.98	34.34	32.91	31.67	30.58	29.65	28.80	28.03	27.42	26.81	26.24	25.77	25.30	24.95
7.9	14.37	43.81	42.49	41.07	39.97	38.79	37.82	36.80	35.11	33.66	32.39	31.28	30.32	29.46	28.68	28.05	27.43	26.85	26.37	25.89	25.53
8.0	14.55	44.78	43.43	41.98	40.86	39.65	38.67	37.62	35.90	34.41	33.12	31.99	31.01	30.13	29.33	28.68	28.05	27.46	26.97	26.48	26.11

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor PEX-a —40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	2.73	3.08	2.94	2.79	2.68	2.56	2.47	2.37	2.21	2.08	1.97	1.88	1.79	1.72	1.66	1.61	1.56	1.52	1.48	1.44	1.42
1.6	2.91	3.43	3.27	3.11	2.98	2.85	2.75	2.64	2.47	2.32	2.20	2.10	2.00	1.93	1.86	1.80	1.75	1.70	1.66	1.62	1.58
1.7	3.09	3.79	3.62	3.44	3.30	3.16	3.04	2.92	2.73	2.57	2.44	2.33	2.22	2.14	2.06	2.00	1.94	1.88	1.84	1.80	1.76
1.8	3.27	4.17	3.98	3.78	3.63	3.47	3.35	3.22	3.01	2.84	2.69	2.57	2.45	2.36	2.28	2.21	2.14	2.08	2.04	1.99	1.95
1.9	3.46	4.56	4.36	4.14	3.98	3.80	3.67	3.53	3.30	3.11	2.95	2.82	2.70	2.59	2.50	2.42	2.36	2.29	2.24	2.18	2.14
2.0	3.64	4.97	4.75	4.51	4.34	4.15	4.00	3.85	3.60	3.40	3.22	3.08	2.94	2.83	2.73	2.65	2.58	2.50	2.45	2.39	2.34
2.1	3.82	5.39	5.15	4.90	4.71	4.50	4.35	4.18	3.92	3.69	3.51	3.35	3.20	3.08	2.97	2.88	2.80	2.73	2.67	2.60	2.55
2.2	4.00	5.82	5.57	5.29	5.09	4.87	4.71	4.53	4.24	4.00	3.80	3.63	3.47	3.34	3.23	3.13	3.04	2.96	2.89	2.82	2.77
2.3	4.18	6.27	6.00	5.70	5.49	5.25	5.07	4.88	4.57	4.32	4.10	3.91	3.75	3.61	3.49	3.38	3.29	3.20	3.13	3.05	2.99
2.4	4.37	6.73	6.44	6.13	5.89	5.65	5.45	5.25	4.92	4.64	4.41	4.21	4.04	3.89	3.75	3.64	3.54	3.44	3.37	3.29	3.23
2.5	4.55	7.20	6.90	6.56	6.32	6.05	5.85	5.63	5.28	4.98	4.73	4.52	4.33	4.17	4.03	3.91	3.80	3.70	3.62	3.53	3.47
2.6	4.73	7.69	7.37	7.01	6.75	6.47	6.25	6.02	5.64	5.33	5.07	4.84	4.64	4.47	4.32	4.19	4.07	3.96	3.88	3.78	3.71
2.7	4.91	8.20	7.85	7.47	7.19	6.89	6.66	6.42	6.02	5.69	5.41	5.17	4.95	4.77	4.61	4.47	4.35	4.23	4.14	4.04	3.97
2.8	5.09	8.71	8.34	7.95	7.65	7.33	7.09	6.83	6.41	6.05	5.76	5.50	5.28	5.08	4.91	4.77	4.64	4.51	4.42	4.31	4.23
2.9	5.28	9.24	8.85	8.43	8.12	7.78	7.53	7.25	6.81	6.43	6.12	5.85	5.61	5.41	5.22	5.07	4.93	4.80	4.70	4.59	4.50
3.0	5.46	9.78	9.37	8.93	8.60	8.25	7.97	7.68	7.21	6.82	6.49	6.20	5.95	5.73	5.54	5.38	5.24	5.09	4.99	4.87	4.78
3.1	5.64	10.34	9.90	9.44	9.09	8.72	8.43	8.13	7.63	7.22	6.87	6.57	6.30	6.07	5.87	5.70	5.55	5.40	5.29	5.16	5.07
3.2	5.82	10.90	10.45	9.96	9.60	9.20	8.90	8.58	8.06	7.62	7.25	6.94	6.66	6.42	6.20	6.02	5.86	5.71	5.59	5.46	5.36
3.3	6.00	11.48	11.01	10.49	10.11	9.70	9.38	9.05	8.50	8.04	7.65	7.32	7.03	6.77	6.55	6.36	6.19	6.02	5.90	5.76	5.66
3.4	6.19	12.07	11.58	11.04	10.64	10.21	9.88	9.52	8.95	8.46	8.06	7.71	7.40	7.14	6.90	6.70	6.52	6.35	6.22	6.07	5.96
3.5	6.37	12.68	12.16	11.60	11.18	10.73	10.38	10.01	9.41	8.90	8.47	8.11	7.79	7.51	7.26	7.05	6.87	6.68	6.55	6.39	6.28
3.6	6.55	13.30	12.75	12.16	11.73	11.25	10.89	10.50	9.87	9.34	8.90	8.52	8.18	7.89	7.63	7.41	7.21	7.02	6.88	6.72	6.60
3.7	6.73	13.93	13.36	12.74	12.29	11.79	11.41	11.01	10.35	9.80	9.33	8.93	8.58	8.27	8.00	7.77	7.57	7.37	7.22	7.05	6.93
3.8	6.91	14.57	13.98	13.34	12.86	12.34	11.95	11.52	10.84	10.26	9.78	9.36	8.99	8.67	8.39	8.14	7.94	7.73	7.57	7.39	7.26
3.9	7.09	15.22	14.61	13.94	13.44	12.91	12.49	12.05	11.34	10.73	10.23	9.79	9.41	9.07	8.78	8.53	8.31	8.09	7.93	7.74	7.60
4.0	7.28	15.89	15.25	14.55	14.03	13.48	13.05	12.59	11.84	11.22	10.69	10.23	9.83	9.49	9.18	8.91	8.69	8.46	8.29	8.10	7.95
4.1	7.46	16.57	15.90	15.18	14.64	14.06	13.61	13.13	12.36	11.71	11.16	10.68	10.27	9.91	9.58	9.31	9.07	8.84	8.66	8.46	8.31
4.2	7.64	17.26	16.56	15.81	15.25	14.65	14.19	13.69	12.89	12.21	11.64	11.14	10.71	10.33	10.00	9.71	9.47	9.22	9.04	8.83	8.67
4.3	7.82	17.96	17.24	16.46	15.88	15.26	14.77	14.26	13.42	12.72	12.12	11.61	11.16	10.77	10.42	10.12	9.87	9.61	9.42	9.20	9.04
4.4	8.00	18.67	17.93	17.12	16.52	15.87	15.37	14.83	13.97	13.23	12.62	12.09	11.62	11.21	10.85	10.54	10.28	10.01	9.81	9.59	9.42
4.5	8.19	19.40	18.63	17.79	17.17	16.49	15.98	15.42	14.52	13.76	13.12	12.57	12.08	11.66	11.29	10.97	10.69	10.42	10.21	9.98	9.80
4.6	8.37	20.14	19.34	18.47	17.82	17.13	16.59	16.02	15.08	14.30	13.64	13.06	12.56	12.12	11.73	11.40	11.12	10.83	10.62	10.37	10.19
4.7	8.55	20.89	20.06	19.16	18.49	17.77	17.22	16.62	15.66	14.84	14.16	13.56	13.04	12.59	12.19	11.84	11.55	11.25	11.03	10.78	10.59
4.8	8.73	21.65	20.79	19.86	19.17	18.43	17.85	17.24	16.24	15.40	14.69	14.07	13.53	13.07	12.65	12.29	11.99	11.68	11.45	11.19	10.99
4.9	8.91	22.42	21.54	20.58	19.86	19.09	18.50	17.86	16.83	15.96	15.22	14.59	14.03	13.55	13.11	12.75	12.43	12.11	11.87	11.60	11.40

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor PEX-a —40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

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Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	9.10	23.20	22.29	21.30	20.56	19.77	19.15	18.50	17.43	16.53	15.77	15.12	14.54	14.04	13.59	13.21	12.88	12.55	12.31	12.03	11.82
5.1	9.28	24.00	23.06	22.04	21.27	20.45	19.82	19.14	18.04	17.11	16.33	15.65	15.05	14.54	14.07	13.68	13.34	13.00	12.75	12.46	12.24
5.2	9.46	24.80	23.83	22.78	22.00	21.15	20.50	19.79	18.66	17.70	16.89	16.19	15.57	15.04	14.56	14.16	13.81	13.46	13.19	12.90	12.67
5.3	9.64	25.62	24.62	23.54	22.73	21.85	21.18	20.46	19.29	18.30	17.46	16.74	16.10	15.56	15.06	14.64	14.28	13.92	13.65	13.34	13.11
5.4	9.82	26.45	25.42	24.30	23.47	22.57	21.88	21.13	19.92	18.90	18.04	17.30	16.64	16.08	15.57	15.14	14.76	14.39	14.11	13.79	13.55
5.5	10.01	27.29	26.23	25.08	24.22	23.29	22.58	21.81	20.57	19.52	18.63	17.87	17.19	16.60	16.08	15.64	15.25	14.86	14.58	14.25	14.01
5.6	10.19	28.14	27.05	25.87	24.98	24.03	23.29	22.50	21.22	20.14	19.23	18.44	17.74	17.14	16.60	16.14	15.75	15.35	15.05	14.71	14.46
5.7	10.37	29.01	27.88	26.66	25.76	24.77	24.02	23.20	21.89	20.77	19.83	19.02	18.30	17.68	17.13	16.66	16.25	15.84	15.53	15.18	14.93
5.8	10.55	29.88	28.73	27.47	26.54	25.53	24.75	23.91	22.56	21.41	20.45	19.61	18.87	18.23	17.66	17.18	16.76	16.33	16.02	15.66	15.39
5.9	10.73	30.76	29.58	28.29	27.33	26.29	25.49	24.63	23.24	22.06	21.07	20.21	19.45	18.79	18.20	17.70	17.27	16.84	16.51	16.14	15.87
6.0	10.92	31.66	30.44	29.12	28.13	27.07	26.25	25.36	23.93	22.72	21.70	20.81	20.03	19.36	18.75	18.24	17.79	17.35	17.01	16.63	16.35
6.1	11.10	32.57	31.32	29.96	28.95	27.85	27.01	26.10	24.63	23.38	22.33	21.43	20.62	19.93	19.31	18.78	18.32	17.86	17.52	17.13	16.84
6.2	11.28	33.48	32.20	30.81	29.77	28.65	27.78	26.85	25.34	24.06	22.98	22.05	21.22	20.51	19.87	19.33	18.86	18.39	18.04	17.64	17.34
6.3	11.46	34.41	33.10	31.67	30.60	29.45	28.56	27.60	26.05	24.74	23.63	22.68	21.83	21.10	20.44	19.89	19.40	18.92	18.56	18.15	17.84
6.4	11.64	35.35	34.00	32.54	31.44	30.26	29.35	28.37	26.78	25.43	24.30	23.31	22.44	21.69	21.02	20.45	19.95	19.45	19.08	18.66	18.35
6.5	11.82	36.30	34.92	33.42	32.29	31.08	30.15	29.14	27.51	26.13	24.97	23.96	23.07	22.30	21.60	21.02	20.51	20.00	19.62	19.19	18.86
6.6	12.01	37.26	35.85	34.31	33.16	31.91	30.96	29.92	28.25	26.84	25.64	24.61	23.69	22.91	22.20	21.60	21.07	20.55	20.16	19.71	19.38
6.7	12.19	38.23	36.78	35.21	34.03	32.76	31.77	30.72	29.00	27.55	26.33	25.27	24.33	23.52	22.80	22.18	21.64	21.11	20.71	20.25	19.91
6.8	12.37	39.22	37.73	36.12	34.91	33.61	32.60	31.52	29.76	28.28	27.02	25.94	24.98	24.15	23.40	22.77	22.22	21.67	21.26	20.79	20.45
6.9	12.55	40.21	38.69	37.04	35.80	34.47	33.44	32.33	30.53	29.01	27.72	26.61	25.63	24.78	24.01	23.37	22.81	22.24	21.82	21.34	20.99
7.0	12.73	41.21	39.66	37.97	36.70	35.34	34.28	33.15	31.31	29.75	28.43	27.30	26.29	25.42	24.63	23.97	23.40	22.82	22.39	21.90	21.53
7.1	12.92	42.23	40.63	38.91	37.61	36.22	35.14	33.98	32.09	30.50	29.15	27.99	26.95	26.06	25.26	24.58	23.99	23.40	22.96	22.46	22.09
7.2	13.10	43.25	41.62	39.85	38.53	37.10	36.00	34.81	32.89	31.25	29.88	28.68	27.63	26.72	25.90	25.20	24.60	23.99	23.54	23.03	22.64
7.3	13.28	44.29	42.62	40.81	39.46	38.00	36.87	35.66	33.69	32.02	30.61	29.39	28.31	27.38	26.54	25.83	25.21	24.59	24.13	23.60	23.21
7.4	13.46	45.33	43.63	41.78	40.40	38.91	37.75	36.51	34.50	32.79	31.35	30.10	29.00	28.04	27.19	26.46	25.83	25.19	24.72	24.18	23.78
7.5	13.64	46.39	44.65	42.76	41.35	39.82	38.64	37.38	35.32	33.57	32.10	30.82	29.69	28.72	27.84	27.10	26.45	25.80	25.32	24.77	24.36
7.6	13.83	47.46	45.68	43.75	42.31	40.75	39.54	38.25	36.15	34.36	32.86	31.55	30.40	29.40	28.50	27.74	27.08	26.42	25.92	25.36	24.94
7.7	14.01	48.53	46.72	44.75	43.28	41.68	40.45	39.13	36.98	35.16	33.62	32.29	31.11	30.09	29.17	28.39	27.72	27.04	26.53	25.96	25.53
7.8	14.19	49.62	47.77	45.76	44.25	42.63	41.37	40.02	37.82	35.96	34.39	33.03	31.82	30.78	29.85	29.05	28.36	27.67	27.15	26.57	26.13
7.9	14.37	50.72	48.83	46.78	45.24	43.58	42.30	40.92	38.68	36.78	35.17	33.78	32.55	31.49	30.53	29.72	29.01	28.30	27.78	27.18	26.73
8.0	14.55	51.83	49.90	47.80	46.24	44.54	43.23	41.82	39.54	37.60	35.96	34.54	33.28	32.20	31.22	30.39	29.67	28.95	28.41	27.80	27.34

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	2.73	3.57	3.39	3.20	3.06	2.91	2.80	2.68	2.48	2.32	2.18	2.07	1.97	1.88	1.80	1.74	1.68	1.63	1.58	1.54	1.50
1.6	2.91	3.96	3.77	3.56	3.41	3.24	3.12	2.98	2.77	2.59	2.44	2.31	2.20	2.10	2.02	1.94	1.88	1.82	1.77	1.72	1.68
1.7	3.09	4.38	4.16	3.94	3.77	3.59	3.45	3.30	3.06	2.87	2.70	2.56	2.44	2.33	2.24	2.16	2.09	2.02	1.96	1.91	1.86
1.8	3.27	4.81	4.57	4.33	4.14	3.94	3.79	3.63	3.37	3.16	2.97	2.82	2.69	2.57	2.47	2.38	2.30	2.23	2.17	2.11	2.06
1.9	3.46	5.25	5.00	4.73	4.53	4.32	4.15	3.97	3.69	3.46	3.26	3.09	2.95	2.82	2.71	2.61	2.53	2.45	2.38	2.32	2.26
2.0	3.64	5.71	5.44	5.15	4.93	4.70	4.52	4.33	4.03	3.77	3.56	3.38	3.22	3.08	2.96	2.86	2.77	2.68	2.60	2.54	2.48
2.1	3.82	6.19	5.90	5.58	5.35	5.10	4.91	4.70	4.38	4.10	3.87	3.67	3.50	3.35	3.22	3.11	3.01	2.92	2.83	2.76	2.70
2.2	4.00	6.68	6.37	6.03	5.78	5.51	5.31	5.09	4.73	4.44	4.19	3.98	3.79	3.63	3.49	3.37	3.26	3.16	3.07	3.00	2.93
2.3	4.18	7.19	6.86	6.50	6.23	5.94	5.72	5.48	5.10	4.79	4.52	4.29	4.10	3.92	3.77	3.64	3.53	3.42	3.32	3.24	3.16
2.4	4.37	7.72	7.36	6.97	6.69	6.38	6.14	5.89	5.49	5.15	4.86	4.62	4.41	4.22	4.06	3.92	3.80	3.68	3.58	3.49	3.41
2.5	4.55	8.26	7.87	7.47	7.16	6.83	6.58	6.31	5.88	5.52	5.21	4.95	4.73	4.53	4.36	4.21	4.08	3.95	3.84	3.75	3.66
2.6	4.73	8.81	8.41	7.97	7.65	7.30	7.03	6.74	6.29	5.90	5.58	5.30	5.06	4.85	4.67	4.51	4.37	4.23	4.12	4.02	3.92
2.7	4.91	9.38	8.95	8.49	8.15	7.78	7.49	7.19	6.70	6.29	5.95	5.66	5.40	5.18	4.98	4.81	4.66	4.52	4.40	4.29	4.19
2.8	5.09	9.96	9.51	9.02	8.66	8.27	7.97	7.65	7.13	6.70	6.33	6.02	5.75	5.52	5.31	5.13	4.97	4.82	4.69	4.57	4.47
2.9	5.28	10.56	10.08	9.57	9.18	8.77	8.45	8.11	7.57	7.11	6.73	6.40	6.11	5.86	5.64	5.45	5.28	5.12	4.98	4.87	4.75
3.0	5.46	11.17	10.67	10.13	9.72	9.29	8.95	8.59	8.02	7.54	7.13	6.78	6.48	6.22	5.99	5.78	5.60	5.44	5.29	5.16	5.04
3.1	5.64	11.80	11.27	10.70	10.27	9.82	9.46	9.09	8.48	7.97	7.54	7.18	6.86	6.58	6.34	6.12	5.94	5.76	5.60	5.47	5.34
3.2	5.82	12.44	11.88	11.29	10.84	10.36	9.99	9.59	8.96	8.42	7.97	7.58	7.25	6.96	6.70	6.47	6.27	6.09	5.92	5.78	5.65
3.3	6.00	13.09	12.51	11.88	11.42	10.91	10.52	10.11	9.44	8.88	8.40	8.00	7.64	7.34	7.07	6.83	6.62	6.43	6.25	6.11	5.96
3.4	6.19	13.76	13.15	12.50	12.00	11.48	11.07	10.63	9.93	9.34	8.85	8.42	8.05	7.73	7.44	7.20	6.98	6.77	6.59	6.44	6.29
3.5	6.37	14.44	13.81	13.12	12.61	12.05	11.63	11.17	10.44	9.82	9.30	8.85	8.47	8.13	7.83	7.57	7.34	7.13	6.93	6.77	6.62
3.6	6.55	15.14	14.48	13.76	13.22	12.64	12.20	11.72	10.96	10.31	9.76	9.30	8.89	8.54	8.22	7.95	7.71	7.49	7.29	7.12	6.95
3.7	6.73	15.85	15.16	14.41	13.85	13.24	12.78	12.28	11.48	10.81	10.24	9.75	9.32	8.95	8.63	8.34	8.09	7.86	7.65	7.47	7.30
3.8	6.91	16.57	15.85	15.07	14.49	13.86	13.37	12.85	12.02	11.31	10.72	10.21	9.77	9.38	9.04	8.74	8.48	8.23	8.01	7.83	7.65
3.9	7.09	17.31	16.56	15.75	15.14	14.48	13.98	13.43	12.57	11.83	11.21	10.68	10.22	9.82	9.46	9.15	8.87	8.62	8.39	8.20	8.01
4.0	7.28	18.06	17.28	16.43	15.80	15.12	14.59	14.03	13.13	12.36	11.71	11.16	10.68	10.26	9.89	9.56	9.28	9.01	8.77	8.57	8.38
4.1	7.46	18.83	18.01	17.13	16.47	15.77	15.22	14.63	13.69	12.90	12.23	11.65	11.15	10.71	10.32	9.99	9.69	9.41	9.16	8.95	8.75
4.2	7.64	19.60	18.76	17.85	17.16	16.43	15.86	15.25	14.27	13.44	12.75	12.15	11.62	11.17	10.77	10.42	10.11	9.82	9.56	9.34	9.13
4.3	7.82	20.39	19.52	18.57	17.86	17.10	16.51	15.88	14.86	14.00	13.28	12.65	12.11	11.64	11.22	10.86	10.54	10.23	9.96	9.74	9.52
4.4	8.00	21.20	20.29	19.31	18.57	17.78	17.17	16.51	15.46	14.57	13.82	13.17	12.61	12.12	11.68	11.30	10.97	10.66	10.38	10.14	9.91
4.5	8.19	22.01	21.07	20.05	19.29	18.47	17.84	17.16	16.07	15.15	14.36	13.69	13.11	12.60	12.15	11.76	11.41	11.09	10.80	10.55	10.32
4.6	8.37	22.84	21.87	20.82	20.03	19.18	18.52	17.82	16.69	15.73	14.92	14.23	13.62	13.10	12.63	12.22	11.86	11.52	11.22	10.97	10.72
4.7	8.55	23.68	22.68	21.59	20.77	19.89	19.22	18.49	17.32	16.33	15.49	14.77	14.14	13.60	13.12	12.69	12.32	11.97	11.66	11.40	11.14
4.8	8.73	24.54	23.50	22.37	21.53	20.62	19.92	19.17	17.96	16.93	16.07	15.32	14.67	14.11	13.61	13.17	12.79	12.42	12.10	11.83	11.56
4.9	8.91	25.40	24.33	23.17	22.30	21.36	20.63	19.86	18.61	17.55	16.65	15.88	15.21	14.63	14.11	13.66	13.26	12.88	12.55	12.27	11.99

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	9.10	26.28	25.18	23.98	23.08	22.11	21.36	20.56	19.27	18.17	17.25	16.45	15.76	15.15	14.62	14.15	13.74	13.35	13.01	12.71	12.43
5.1	9.28	27.18	26.03	24.80	23.87	22.87	22.10	21.27	19.94	18.81	17.85	17.03	16.31	15.69	15.14	14.65	14.23	13.83	13.47	13.17	12.88
5.2	9.46	28.08	26.90	25.63	24.67	23.64	22.84	21.99	20.62	19.45	18.46	17.62	16.88	16.23	15.66	15.16	14.72	14.31	13.94	13.63	13.33
5.3	9.64	29.00	27.79	26.47	25.49	24.42	23.60	22.72	21.31	20.10	19.08	18.21	17.45	16.78	16.19	15.68	15.23	14.80	14.42	14.10	13.79
5.4	9.82	29.93	28.68	27.33	26.31	25.22	24.37	23.46	22.00	20.76	19.71	18.81	18.03	17.34	16.74	16.20	15.74	15.30	14.90	14.57	14.25
5.5	10.01	30.87	29.59	28.19	27.15	26.02	25.15	24.22	22.71	21.44	20.35	19.43	18.62	17.91	17.28	16.74	16.25	15.80	15.39	15.05	14.72
5.6	10.19	31.83	30.50	29.07	28.00	26.84	25.94	24.98	23.43	22.12	21.00	20.05	19.21	18.49	17.84	17.28	16.78	16.31	15.89	15.54	15.20
5.7	10.37	32.79	31.43	29.96	28.85	27.66	26.74	25.75	24.16	22.81	21.66	20.68	19.82	19.07	18.40	17.82	17.31	16.83	16.40	16.04	15.69
5.8	10.55	33.77	32.37	30.86	29.72	28.50	27.55	26.53	24.90	23.50	22.33	21.31	20.43	19.66	18.98	18.38	17.85	17.36	16.91	16.54	16.18
5.9	10.73	34.76	33.33	31.77	30.60	29.34	28.37	27.32	25.64	24.21	23.00	21.96	21.05	20.26	19.56	18.94	18.40	17.89	17.43	17.05	16.68
6.0	10.92	35.77	34.29	32.70	31.50	30.20	29.20	28.13	26.40	24.93	23.68	22.61	21.68	20.87	20.14	19.51	18.95	18.43	17.96	17.57	17.18
6.1	11.10	36.78	35.27	33.63	32.40	31.07	30.04	28.94	27.17	25.66	24.38	23.28	22.32	21.48	20.74	20.09	19.52	18.98	18.49	18.09	17.70
6.2	11.28	37.81	36.26	34.58	33.31	31.95	30.90	29.76	27.94	26.39	25.08	23.95	22.96	22.10	21.34	20.67	20.08	19.53	19.04	18.62	18.22
6.3	11.46	38.85	37.26	35.53	34.24	32.84	31.76	30.59	28.73	27.13	25.79	24.63	23.62	22.73	21.95	21.26	20.66	20.09	19.58	19.16	18.74
6.4	11.64	39.90	38.27	36.50	35.17	33.74	32.63	31.44	29.52	27.89	26.50	25.32	24.28	23.37	22.57	21.86	21.24	20.66	20.14	19.70	19.27
6.5	11.82	40.96	39.29	37.48	36.12	34.65	33.51	32.29	30.32	28.65	27.23	26.01	24.95	24.02	23.19	22.47	21.83	21.24	20.70	20.25	19.81
6.6	12.01	42.04	40.33	38.47	37.07	35.57	34.40	33.15	31.14	29.42	27.97	26.72	25.62	24.67	23.83	23.08	22.43	21.82	21.27	20.81	20.36
6.7	12.19	43.12	41.37	39.47	38.04	36.50	35.31	34.02	31.96	30.20	28.71	27.43	26.31	25.33	24.47	23.71	23.04	22.41	21.84	21.37	20.91
6.8	12.37	44.22	42.43	40.48	39.02	37.44	36.22	34.90	32.79	30.99	29.46	28.15	27.00	26.00	25.11	24.34	23.65	23.00	22.43	21.94	21.47
6.9	12.55	45.33	43.50	41.51	40.01	38.39	37.14	35.80	33.63	31.79	30.22	28.88	27.70	26.68	25.77	24.97	24.27	23.61	23.02	22.52	22.04
7.0	12.73	46.45	44.58	42.54	41.01	39.35	38.07	36.70	34.48	32.59	30.99	29.62	28.41	27.36	26.43	25.61	24.90	24.22	23.61	23.10	22.61
7.1	12.92	47.59	45.67	43.58	42.02	40.32	39.02	37.61	35.34	33.41	31.77	30.36	29.13	28.06	27.10	26.27	25.53	24.84	24.22	23.69	23.19
7.2	13.10	48.73	46.77	44.64	43.04	41.31	39.97	38.53	36.21	34.23	32.56	31.12	29.86	28.76	27.78	26.92	26.17	25.46	24.82	24.29	23.77
7.3	13.28	49.89	47.88	45.71	44.07	42.30	40.93	39.46	37.09	35.07	33.35	31.88	30.59	29.46	28.47	27.59	26.82	26.09	25.44	24.89	24.36
7.4	13.46	51.06	49.01	46.78	45.11	43.30	41.90	40.40	37.97	35.91	34.15	32.65	31.33	30.18	29.16	28.26	27.47	26.73	26.06	25.50	24.96
7.5	13.64	52.24	50.14	47.87	46.16	44.31	42.88	41.35	38.87	36.76	34.97	33.42	32.08	30.90	29.86	28.94	28.13	27.37	26.69	26.12	25.57
7.6	13.83	53.43	51.29	48.97	47.22	45.34	43.88	42.30	39.77	37.62	35.79	34.21	32.83	31.63	30.56	29.63	28.80	28.03	27.33	26.75	26.18
7.7	14.01	54.63	52.45	50.08	48.30	46.37	44.88	43.27	40.69	38.48	36.61	35.00	33.60	32.37	31.28	30.32	29.48	28.68	27.97	27.38	26.79
7.8	14.19	55.85	53.62	51.20	49.38	47.41	45.89	44.25	41.61	39.36	37.45	35.81	34.37	33.11	32.00	31.02	30.16	29.35	28.62	28.01	27.42
7.9	14.37	57.07	54.80	52.33	50.47	48.46	46.91	45.24	42.54	40.24	38.29	36.62	35.15	33.87	32.73	31.73	30.85	30.02	29.28	28.66	28.05
8.0	14.55	58.31	55.99	53.47	51.57	49.53	47.94	46.23	43.48	41.14	39.15	37.43	35.93	34.63	33.46	32.44	31.55	30.70	29.94	29.30	28.69

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1¼" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	4.08	1.39	1.33	1.25	1.23	1.20	1.18	1.16	1.12	1.09	1.06	1.03	1.01	0.99	0.97	0.95	0.94	0.92	0.91	0.89	0.88
1.6	4.35	1.56	1.48	1.40	1.37	1.34	1.32	1.30	1.26	1.22	1.19	1.16	1.13	1.11	1.09	1.07	1.05	1.03	1.02	1.00	0.99
1.7	4.62	1.73	1.65	1.55	1.53	1.49	1.47	1.44	1.40	1.36	1.32	1.29	1.26	1.23	1.21	1.19	1.17	1.15	1.13	1.12	1.10
1.8	4.90	1.91	1.82	1.72	1.69	1.65	1.62	1.59	1.54	1.50	1.46	1.43	1.39	1.36	1.34	1.31	1.29	1.27	1.25	1.24	1.22
1.9	5.17	2.10	2.00	1.89	1.85	1.81	1.78	1.75	1.70	1.65	1.61	1.57	1.53	1.50	1.47	1.45	1.42	1.40	1.38	1.36	1.34
2.0	5.44	2.29	2.18	2.06	2.02	1.98	1.95	1.92	1.86	1.81	1.76	1.72	1.68	1.64	1.61	1.58	1.56	1.53	1.51	1.49	1.47
2.1	5.71	2.49	2.38	2.25	2.20	2.16	2.13	2.09	2.02	1.97	1.92	1.87	1.83	1.79	1.76	1.73	1.70	1.67	1.65	1.63	1.60
2.2	5.98	2.70	2.58	2.44	2.39	2.34	2.31	2.27	2.20	2.13	2.08	2.03	1.99	1.95	1.91	1.88	1.84	1.82	1.79	1.77	1.74
2.3	6.26	2.92	2.79	2.63	2.58	2.53	2.49	2.45	2.37	2.31	2.25	2.20	2.15	2.11	2.07	2.03	2.00	1.97	1.94	1.91	1.89
2.4	6.53	3.14	3.00	2.84	2.78	2.73	2.69	2.64	2.56	2.49	2.42	2.37	2.32	2.27	2.23	2.19	2.15	2.12	2.09	2.06	2.04
2.5	6.80	3.37	3.22	3.05	2.99	2.93	2.89	2.84	2.75	2.67	2.61	2.55	2.49	2.44	2.40	2.35	2.32	2.28	2.25	2.22	2.19
2.6	7.07	3.61	3.45	3.26	3.20	3.14	3.09	3.04	2.95	2.87	2.79	2.73	2.67	2.62	2.57	2.52	2.48	2.44	2.41	2.38	2.35
2.7	7.34	3.86	3.68	3.49	3.42	3.36	3.30	3.25	3.15	3.06	2.99	2.92	2.85	2.80	2.75	2.70	2.66	2.62	2.58	2.54	2.51
2.8	7.62	4.11	3.92	3.71	3.65	3.58	3.52	3.46	3.36	3.27	3.18	3.11	3.04	2.98	2.93	2.88	2.83	2.79	2.75	2.71	2.68
2.9	7.89	4.37	4.17	3.95	3.88	3.81	3.75	3.68	3.57	3.47	3.39	3.31	3.24	3.18	3.12	3.07	3.02	2.97	2.93	2.89	2.85
3.0	8.16	4.63	4.43	4.19	4.12	4.04	3.98	3.91	3.79	3.69	3.60	3.52	3.44	3.37	3.31	3.26	3.20	3.16	3.11	3.07	3.03
3.1	8.43	4.91	4.69	4.44	4.36	4.28	4.21	4.14	4.02	3.91	3.81	3.73	3.65	3.58	3.51	3.45	3.40	3.35	3.30	3.26	3.22
3.2	8.70	5.19	4.96	4.69	4.61	4.53	4.45	4.38	4.25	4.14	4.03	3.94	3.86	3.78	3.72	3.65	3.60	3.54	3.49	3.45	3.40
3.3	8.98	5.47	5.23	4.96	4.87	4.78	4.70	4.62	4.49	4.37	4.26	4.16	4.08	4.00	3.93	3.86	3.80	3.74	3.69	3.64	3.60
3.4	9.25	5.76	5.51	5.22	5.13	5.04	4.96	4.87	4.73	4.60	4.49	4.39	4.30	4.22	4.14	4.07	4.01	3.95	3.89	3.84	3.80
3.5	9.52	6.06	5.80	5.50	5.40	5.30	5.22	5.13	4.98	4.85	4.73	4.62	4.53	4.44	4.36	4.29	4.22	4.16	4.10	4.05	4.00
3.6	9.79	6.37	6.09	5.77	5.67	5.57	5.48	5.39	5.23	5.10	4.97	4.86	4.76	4.67	4.59	4.51	4.44	4.37	4.31	4.26	4.21
3.7	10.06	6.68	6.39	6.06	5.96	5.84	5.75	5.66	5.49	5.35	5.22	5.10	5.00	4.90	4.82	4.73	4.66	4.59	4.53	4.47	4.42
3.8	10.34	7.00	6.70	6.35	6.24	6.13	6.03	5.93	5.76	5.61	5.47	5.35	5.24	5.14	5.05	4.97	4.89	4.82	4.75	4.69	4.63
3.9	10.61	7.33	7.01	6.65	6.53	6.41	6.31	6.21	6.03	5.87	5.73	5.60	5.49	5.38	5.29	5.20	5.12	5.05	4.98	4.91	4.86
4.0	10.88	7.66	7.33	6.95	6.83	6.71	6.60	6.49	6.31	6.14	6.00	5.86	5.74	5.63	5.53	5.44	5.36	5.28	5.21	5.14	5.08
4.1	11.15	8.00	7.65	7.26	7.14	7.01	6.90	6.79	6.59	6.42	6.26	6.13	6.00	5.89	5.78	5.69	5.60	5.52	5.45	5.38	5.31
4.2	11.42	8.34	7.98	7.58	7.45	7.31	7.20	7.08	6.88	6.70	6.54	6.40	6.26	6.15	6.04	5.94	5.85	5.76	5.69	5.61	5.55
4.3	11.70	8.69	8.32	7.90	7.76	7.62	7.50	7.38	7.17	6.99	6.82	6.67	6.53	6.41	6.30	6.20	6.10	6.01	5.93	5.86	5.79
4.4	11.97	9.05	8.66	8.22	8.08	7.94	7.82	7.69	7.47	7.28	7.10	6.95	6.81	6.68	6.56	6.46	6.36	6.27	6.18	6.10	6.03
4.5	12.24	9.42	9.01	8.56	8.41	8.26	8.13	8.00	7.77	7.57	7.39	7.23	7.09	6.95	6.83	6.72	6.62	6.52	6.44	6.36	6.28
4.6	12.51	9.79	9.37	8.90	8.75	8.59	8.46	8.32	8.08	7.88	7.69	7.52	7.37	7.23	7.11	6.99	6.89	6.79	6.70	6.61	6.53
4.7	12.78	10.16	9.73	9.24	9.08	8.92	8.78	8.64	8.40	8.18	7.99	7.82	7.66	7.52	7.39	7.27	7.16	7.05	6.96	6.87	6.79
4.8	13.06	10.55	10.10	9.59	9.43	9.26	9.12	8.97	8.72	8.50	8.29	8.12	7.95	7.80	7.67	7.55	7.43	7.32	7.23	7.14	7.05
4.9	13.33	10.93	10.47	9.95	9.78	9.60	9.46	9.31	9.04	8.81	8.61	8.42	8.25	8.10	7.96	7.83	7.71	7.60	7.50	7.41	7.32

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1¼" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	13.60	11.33	10.85	10.31	10.13	9.95	9.80	9.65	9.38	9.14	8.92	8.73	8.55	8.40	8.25	8.12	8.00	7.88	7.78	7.68	7.59
5.1	13.87	11.73	11.24	10.67	10.50	10.31	10.15	9.99	9.71	9.46	9.24	9.04	8.86	8.70	8.55	8.41	8.29	8.17	8.06	7.96	7.87
5.2	14.14	12.14	11.63	11.05	10.86	10.67	10.51	10.34	10.05	9.80	9.57	9.36	9.18	9.01	8.85	8.71	8.58	8.46	8.35	8.24	8.15
5.3	14.42	12.55	12.03	11.43	11.24	11.04	10.87	10.70	10.40	10.14	9.90	9.69	9.49	9.32	9.16	9.01	8.88	8.75	8.64	8.53	8.43
5.4	14.69	12.97	12.43	11.81	11.61	11.41	11.24	11.06	10.75	10.48	10.23	10.02	9.82	9.64	9.47	9.32	9.18	9.05	8.93	8.83	8.72
5.5	14.96	13.40	12.84	12.20	12.00	11.79	11.61	11.43	11.11	10.83	10.58	10.35	10.15	9.96	9.79	9.63	9.49	9.36	9.24	9.12	9.02
5.6	15.23	13.83	13.25	12.60	12.39	12.17	11.99	11.80	11.47	11.18	10.92	10.69	10.48	10.29	10.11	9.95	9.80	9.67	9.54	9.42	9.31
5.7	15.50	14.27	13.67	13.00	12.78	12.56	12.37	12.17	11.84	11.54	11.27	11.03	10.82	10.62	10.44	10.27	10.12	9.98	9.85	9.73	9.62
5.8	15.78	14.71	14.10	13.40	13.18	12.95	12.76	12.56	12.21	11.90	11.63	11.38	11.16	10.95	10.77	10.60	10.44	10.30	10.16	10.04	9.92
5.9	16.05	15.16	14.53	13.82	13.59	13.35	13.15	12.94	12.59	12.27	11.99	11.74	11.51	11.30	11.11	10.93	10.77	10.62	10.48	10.35	10.23
6.0	16.32	15.62	14.97	14.23	14.00	13.75	13.55	13.34	12.97	12.65	12.36	12.09	11.86	11.64	11.45	11.27	11.10	10.94	10.80	10.67	10.55
6.1	16.59	16.08	15.41	14.66	14.42	14.16	13.95	13.74	13.36	13.03	12.73	12.46	12.21	11.99	11.79	11.61	11.44	11.27	11.13	11.00	10.87
6.2	16.86	16.54	15.86	15.09	14.84	14.58	14.36	14.14	13.75	13.41	13.10	12.83	12.58	12.35	12.14	11.95	11.78	11.61	11.46	11.32	11.19
6.3	17.13	17.02	16.32	15.52	15.27	15.00	14.78	14.55	14.15	13.80	13.48	13.20	12.94	12.71	12.50	12.30	12.12	11.95	11.80	11.66	11.52
6.4	17.41	17.50	16.78	15.96	15.70	15.43	15.20	14.96	14.55	14.19	13.87	13.58	13.31	13.07	12.85	12.65	12.47	12.29	12.14	11.99	11.85
6.5	17.68	17.98	17.25	16.40	16.14	15.86	15.62	15.38	14.96	14.59	14.26	13.96	13.69	13.44	13.22	13.01	12.82	12.64	12.48	12.33	12.19
6.6	17.95	18.47	17.72	16.86	16.58	16.29	16.05	15.81	15.38	14.99	14.65	14.35	14.07	13.82	13.59	13.37	13.18	13.00	12.83	12.68	12.53
6.7	18.22	18.97	18.20	17.31	17.03	16.73	16.49	16.23	15.79	15.40	15.05	14.74	14.45	14.19	13.96	13.74	13.54	13.35	13.18	13.03	12.88
6.8	18.49	19.47	18.68	17.77	17.48	17.18	16.93	16.67	16.22	15.82	15.46	15.14	14.84	14.58	14.34	14.11	13.91	13.72	13.54	13.38	13.23
6.9	18.77	19.98	19.17	18.24	17.94	17.63	17.38	17.11	16.65	16.24	15.87	15.54	15.24	14.97	14.72	14.49	14.28	14.08	13.90	13.74	13.58
7.0	19.04	20.50	19.66	18.71	18.41	18.09	17.83	17.55	17.08	16.66	16.28	15.94	15.64	15.36	15.10	14.87	14.65	14.45	14.27	14.10	13.94
7.1	19.31	21.02	20.16	19.19	18.88	18.55	18.28	18.00	17.52	17.09	16.70	16.35	16.04	15.75	15.49	15.25	15.03	14.83	14.64	14.47	14.30
7.2	19.58	21.54	20.67	19.67	19.36	19.02	18.75	18.46	17.96	17.52	17.12	16.77	16.45	16.16	15.89	15.64	15.42	15.21	15.02	14.84	14.67
7.3	19.85	22.07	21.18	20.16	19.84	19.49	19.21	18.92	18.41	17.96	17.55	17.19	16.86	16.56	16.29	16.04	15.81	15.59	15.39	15.21	15.04
7.4	20.13	22.61	21.70	20.65	20.32	19.97	19.68	19.38	18.86	18.40	17.99	17.62	17.28	16.97	16.69	16.44	16.20	15.98	15.78	15.59	15.42
7.5	20.40	23.15	22.22	21.15	20.81	20.46	20.16	19.85	19.32	18.85	18.42	18.05	17.70	17.39	17.10	16.84	16.60	16.37	16.17	15.97	15.80
7.6	20.67	23.70	22.75	21.66	21.31	20.95	20.64	20.33	19.78	19.30	18.87	18.48	18.13	17.81	17.52	17.25	17.00	16.77	16.56	16.36	16.18
7.7	20.94	24.26	23.28	22.17	21.81	21.44	21.13	20.81	20.25	19.76	19.32	18.92	18.56	18.23	17.93	17.66	17.41	17.17	16.95	16.75	16.57
7.8	21.21	24.82	23.82	22.68	22.32	21.94	21.62	21.29	20.72	20.22	19.77	19.36	18.99	18.66	18.36	18.07	17.82	17.57	17.35	17.15	16.96
7.9	21.49	25.38	24.36	23.20	22.83	22.44	22.12	21.78	21.20	20.69	20.22	19.81	19.43	19.09	18.78	18.49	18.23	17.98	17.76	17.55	17.36
8.0	21.76	25.95	24.91	23.73	23.35	22.95	22.62	22.28	21.68	21.16	20.69	20.26	19.88	19.53	19.21	18.92	18.65	18.40	18.17	17.96	17.76

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1¼" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	4.08	1.98	1.90	1.83	1.77	1.71	1.66	1.60	1.52	1.44	1.38	1.32	1.28	1.23	1.20	1.16	1.13	1.11	1.08	1.06	1.04
1.6	4.35	2.20	2.12	2.04	1.98	1.91	1.85	1.79	1.70	1.61	1.54	1.48	1.43	1.38	1.34	1.30	1.27	1.24	1.21	1.19	1.17
1.7	4.62	2.44	2.35	2.26	2.19	2.11	2.05	1.99	1.88	1.79	1.71	1.65	1.59	1.53	1.49	1.45	1.41	1.38	1.35	1.32	1.30
1.8	4.90	2.69	2.59	2.49	2.41	2.33	2.26	2.19	2.08	1.98	1.89	1.82	1.75	1.70	1.64	1.60	1.56	1.52	1.49	1.46	1.44
1.9	5.17	2.94	2.84	2.73	2.65	2.56	2.48	2.41	2.28	2.17	2.08	2.00	1.93	1.86	1.81	1.76	1.72	1.68	1.64	1.61	1.58
2.0	5.44	3.21	3.10	2.98	2.89	2.79	2.71	2.63	2.49	2.37	2.27	2.18	2.11	2.04	1.98	1.93	1.88	1.83	1.80	1.76	1.73
2.1	5.71	3.49	3.37	3.24	3.14	3.03	2.95	2.86	2.71	2.58	2.47	2.37	2.29	2.22	2.15	2.10	2.05	2.00	1.96	1.92	1.89
2.2	5.98	3.77	3.64	3.51	3.40	3.28	3.19	3.09	2.93	2.80	2.68	2.58	2.49	2.41	2.34	2.28	2.22	2.17	2.12	2.08	2.05
2.3	6.26	4.07	3.93	3.78	3.67	3.54	3.45	3.34	3.17	3.02	2.89	2.78	2.69	2.60	2.52	2.46	2.40	2.34	2.30	2.25	2.22
2.4	6.53	4.37	4.22	4.07	3.94	3.81	3.71	3.59	3.41	3.25	3.12	3.00	2.90	2.80	2.72	2.65	2.59	2.53	2.48	2.43	2.39
2.5	6.80	4.69	4.53	4.36	4.23	4.09	3.98	3.86	3.66	3.49	3.35	3.22	3.11	3.01	2.92	2.85	2.78	2.72	2.66	2.61	2.57
2.6	7.07	5.01	4.84	4.66	4.52	4.38	4.25	4.13	3.92	3.74	3.58	3.45	3.33	3.23	3.13	3.05	2.98	2.91	2.85	2.80	2.75
2.7	7.34	5.34	5.17	4.97	4.83	4.67	4.54	4.40	4.18	3.99	3.83	3.68	3.56	3.45	3.35	3.26	3.19	3.11	3.05	2.99	2.94
2.8	7.62	5.69	5.50	5.29	5.14	4.97	4.83	4.69	4.45	4.25	4.08	3.92	3.79	3.67	3.57	3.48	3.40	3.32	3.25	3.19	3.14
2.9	7.89	6.04	5.84	5.62	5.46	5.28	5.14	4.98	4.73	4.52	4.33	4.17	4.03	3.91	3.79	3.70	3.61	3.53	3.46	3.39	3.34
3.0	8.16	6.40	6.19	5.96	5.78	5.60	5.45	5.28	5.02	4.79	4.60	4.43	4.28	4.15	4.03	3.93	3.84	3.75	3.68	3.60	3.55
3.1	8.43	6.76	6.54	6.30	6.12	5.92	5.76	5.59	5.32	5.08	4.87	4.69	4.53	4.39	4.27	4.16	4.07	3.97	3.89	3.82	3.76
3.2	8.70	7.14	6.91	6.66	6.46	6.26	6.09	5.91	5.62	5.37	5.15	4.96	4.79	4.65	4.51	4.41	4.30	4.20	4.12	4.04	3.98
3.3	8.98	7.53	7.28	7.02	6.82	6.60	6.42	6.23	5.93	5.66	5.43	5.23	5.06	4.91	4.76	4.65	4.54	4.44	4.35	4.27	4.20
3.4	9.25	7.92	7.67	7.39	7.18	6.95	6.76	6.57	6.24	5.96	5.72	5.51	5.33	5.17	5.02	4.90	4.79	4.68	4.59	4.50	4.43
3.5	9.52	8.33	8.06	7.77	7.54	7.31	7.11	6.90	6.57	6.27	6.02	5.80	5.61	5.44	5.29	5.16	5.04	4.92	4.83	4.74	4.67
3.6	9.79	8.74	8.46	8.15	7.92	7.67	7.47	7.25	6.90	6.59	6.33	6.09	5.90	5.72	5.56	5.42	5.30	5.18	5.08	4.98	4.91
3.7	10.06	9.16	8.86	8.55	8.30	8.04	7.83	7.60	7.23	6.91	6.64	6.40	6.19	6.00	5.83	5.69	5.56	5.44	5.33	5.23	5.15
3.8	10.34	9.59	9.28	8.95	8.70	8.42	8.20	7.96	7.58	7.24	6.96	6.70	6.48	6.29	6.11	5.97	5.83	5.70	5.59	5.48	5.40
3.9	10.61	10.03	9.71	9.36	9.10	8.81	8.58	8.33	7.93	7.58	7.28	7.02	6.79	6.59	6.40	6.25	6.10	5.97	5.85	5.74	5.66
4.0	10.88	10.47	10.14	9.78	9.50	9.21	8.96	8.71	8.29	7.92	7.61	7.33	7.10	6.89	6.69	6.54	6.38	6.24	6.12	6.01	5.92
4.1	11.15	10.93	10.58	10.21	9.92	9.61	9.36	9.09	8.65	8.27	7.95	7.66	7.41	7.19	6.99	6.83	6.67	6.52	6.40	6.28	6.18
4.2	11.42	11.39	11.03	10.64	10.34	10.02	9.76	9.48	9.02	8.63	8.29	7.99	7.74	7.51	7.30	7.13	6.96	6.81	6.68	6.55	6.46
4.3	11.70	11.86	11.48	11.08	10.77	10.44	10.16	9.88	9.40	8.99	8.64	8.33	8.06	7.82	7.61	7.43	7.26	7.10	6.97	6.83	6.73
4.4	11.97	12.34	11.95	11.53	11.21	10.86	10.58	10.28	9.79	9.36	9.00	8.67	8.40	8.15	7.92	7.74	7.56	7.39	7.26	7.12	7.01
4.5	12.24	12.82	12.42	11.99	11.65	11.29	11.00	10.69	10.18	9.74	9.36	9.03	8.74	8.48	8.24	8.05	7.87	7.70	7.55	7.41	7.30
4.6	12.51	13.32	12.90	12.45	12.11	11.73	11.43	11.11	10.58	10.12	9.73	9.38	9.08	8.82	8.57	8.38	8.18	8.00	7.85	7.71	7.59
4.7	12.78	13.82	13.39	12.93	12.57	12.18	11.87	11.53	10.99	10.51	10.10	9.74	9.44	9.16	8.90	8.70	8.50	8.32	8.16	8.01	7.89
4.8	13.06	14.33	13.89	13.41	13.03	12.63	12.31	11.96	11.40	10.91	10.49	10.11	9.79	9.51	9.24	9.03	8.83	8.63	8.47	8.31	8.19
4.9	13.33	14.85	14.39	13.89	13.51	13.10	12.76	12.40	11.82	11.31	10.87	10.49	10.16	9.86	9.59	9.37	9.16	8.96	8.79	8.62	8.50

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1¼" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	13.60	15.38	14.90	14.39	13.99	13.56	13.22	12.85	12.24	11.72	11.27	10.87	10.53	10.22	9.94	9.71	9.49	9.28	9.11	8.94	8.81
5.1	13.87	15.91	15.42	14.89	14.48	14.04	13.68	13.30	12.67	12.13	11.67	11.25	10.90	10.58	10.29	10.06	9.83	9.62	9.44	9.26	9.13
5.2	14.14	16.46	15.95	15.40	14.98	14.52	14.15	13.76	13.11	12.56	12.07	11.65	11.28	10.95	10.65	10.41	10.18	9.96	9.77	9.59	9.45
5.3	14.42	17.01	16.48	15.92	15.48	15.01	14.63	14.22	13.56	12.98	12.48	12.05	11.67	11.33	11.02	10.77	10.53	10.30	10.11	9.92	9.78
5.4	14.69	17.56	17.02	16.44	15.99	15.51	15.12	14.70	14.01	13.42	12.90	12.45	12.06	11.71	11.39	11.14	10.88	10.65	10.45	10.26	10.11
5.5	14.96	18.13	17.57	16.98	16.51	16.01	15.61	15.18	14.47	13.86	13.33	12.86	12.46	12.10	11.77	11.51	11.25	11.00	10.80	10.60	10.45
5.6	15.23	18.70	18.13	17.52	17.04	16.52	16.11	15.66	14.93	14.30	13.76	13.28	12.86	12.49	12.15	11.88	11.61	11.36	11.16	10.95	10.79
5.7	15.50	19.29	18.70	18.06	17.57	17.04	16.61	16.15	15.41	14.76	14.19	13.70	13.27	12.89	12.54	12.26	11.99	11.73	11.52	11.30	11.14
5.8	15.78	19.88	19.27	18.62	18.11	17.57	17.13	16.65	15.88	15.21	14.64	14.13	13.69	13.30	12.94	12.65	12.36	12.10	11.88	11.66	11.49
5.9	16.05	20.47	19.85	19.18	18.66	18.10	17.65	17.16	16.37	15.68	15.08	14.56	14.11	13.71	13.34	13.04	12.75	12.47	12.25	12.02	11.85
6.0	16.32	21.08	20.44	19.75	19.21	18.64	18.17	17.67	16.86	16.15	15.54	15.00	14.54	14.12	13.74	13.43	13.13	12.85	12.62	12.39	12.21
6.1	16.59	21.69	21.03	20.32	19.77	19.18	18.70	18.19	17.35	16.63	16.00	15.45	14.97	14.54	14.15	13.84	13.53	13.24	13.00	12.76	12.58
6.2	16.86	22.31	21.63	20.91	20.34	19.74	19.24	18.72	17.86	17.11	16.47	15.90	15.41	14.97	14.57	14.24	13.93	13.63	13.38	13.14	12.95
6.3	17.13	22.94	22.24	21.50	20.92	20.30	19.79	19.25	18.37	17.60	16.94	16.35	15.85	15.40	14.99	14.65	14.33	14.02	13.77	13.52	13.33
6.4	17.41	23.57	22.86	22.09	21.50	20.86	20.34	19.79	18.88	18.10	17.42	16.82	16.30	15.84	15.41	15.07	14.74	14.43	14.17	13.91	13.71
6.5	17.68	24.21	23.48	22.70	22.09	21.44	20.90	20.34	19.40	18.60	17.90	17.28	16.75	16.28	15.84	15.49	15.15	14.83	14.56	14.30	14.10
6.6	17.95	24.86	24.12	23.31	22.69	22.02	21.47	20.89	19.93	19.11	18.39	17.76	17.22	16.73	16.28	15.92	15.57	15.24	14.97	14.69	14.49
6.7	18.22	25.52	24.75	23.93	23.29	22.60	22.04	21.45	20.47	19.62	18.88	18.24	17.68	17.18	16.72	16.35	15.99	15.66	15.38	15.10	14.89
6.8	18.49	26.19	25.40	24.56	23.90	23.20	22.62	22.01	21.01	20.14	19.39	18.72	18.15	17.64	17.17	16.79	16.42	16.08	15.79	15.50	15.29
6.9	18.77	26.86	26.05	25.19	24.52	23.80	23.21	22.58	21.56	20.67	19.89	19.21	18.63	18.10	17.62	17.24	16.86	16.50	16.21	15.91	15.69
7.0	19.04	27.54	26.71	25.83	25.14	24.40	23.80	23.16	22.11	21.20	20.41	19.71	19.11	18.57	18.08	17.68	17.30	16.93	16.63	16.33	16.10
7.1	19.31	28.22	27.38	26.48	25.77	25.02	24.40	23.74	22.67	21.73	20.93	20.21	19.60	19.05	18.54	18.14	17.74	17.37	17.06	16.75	16.52
7.2	19.58	28.92	28.06	27.13	26.41	25.64	25.01	24.33	23.23	22.28	21.45	20.72	20.09	19.53	19.01	18.60	18.19	17.81	17.49	17.18	16.94
7.3	19.85	29.62	28.74	27.79	27.05	26.26	25.62	24.93	23.80	22.83	21.98	21.23	20.59	20.01	19.49	19.06	18.64	18.25	17.93	17.61	17.36
7.4	20.13	30.33	29.43	28.46	27.70	26.90	26.24	25.53	24.38	23.38	22.52	21.75	21.10	20.51	19.96	19.53	19.10	18.70	18.37	18.04	17.79
7.5	20.40	31.04	30.12	29.13	28.36	27.54	26.86	26.14	24.97	23.94	23.06	22.28	21.61	21.00	20.45	20.00	19.57	19.16	18.82	18.48	18.23
7.6	20.67	31.77	30.83	29.81	29.03	28.18	27.50	26.76	25.56	24.51	23.61	22.81	22.12	21.50	20.94	20.48	20.04	19.62	19.27	18.93	18.67
7.7	20.94	32.50	31.54	30.50	29.70	28.84	28.13	27.38	26.15	25.08	24.16	23.34	22.64	22.01	21.43	20.97	20.51	20.09	19.73	19.38	19.11
7.8	21.21	33.24	32.25	31.20	30.38	29.50	28.78	28.01	26.75	25.66	24.72	23.88	23.17	22.52	21.93	21.46	20.99	20.56	20.19	19.83	19.56
7.9	21.49	33.98	32.98	31.90	31.06	30.16	29.43	28.65	27.36	26.25	25.28	24.43	23.70	23.04	22.44	21.95	21.47	21.03	20.66	20.29	20.01
8.0	21.76	34.73	33.71	32.61	31.75	30.84	30.09	29.29	27.98	26.84	25.85	24.98	24.23	23.56	22.95	22.45	21.96	21.51	21.13	20.75	20.47

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1¼" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	4.08	2.35	2.25	2.13	2.05	1.96	1.89	1.82	1.70	1.60	1.52	1.45	1.39	1.33	1.29	1.25	1.21	1.18	1.15	1.12	1.10
1.6	4.35	2.62	2.50	2.38	2.29	2.19	2.11	2.03	1.90	1.79	1.70	1.62	1.55	1.49	1.44	1.39	1.36	1.32	1.29	1.26	1.23
1.7	4.62	2.90	2.77	2.63	2.53	2.42	2.34	2.25	2.11	1.98	1.88	1.80	1.72	1.66	1.60	1.55	1.51	1.46	1.43	1.40	1.37
1.8	4.90	3.19	3.05	2.90	2.79	2.67	2.58	2.48	2.32	2.19	2.08	1.98	1.90	1.83	1.77	1.71	1.66	1.62	1.58	1.54	1.52
1.9	5.17	3.49	3.34	3.17	3.05	2.92	2.82	2.72	2.55	2.40	2.28	2.18	2.09	2.01	1.94	1.88	1.83	1.78	1.74	1.70	1.67
2.0	5.44	3.80	3.63	3.46	3.33	3.19	3.08	2.96	2.78	2.62	2.49	2.38	2.28	2.20	2.12	2.06	2.00	1.95	1.90	1.86	1.82
2.1	5.71	4.12	3.95	3.76	3.61	3.46	3.35	3.22	3.02	2.85	2.71	2.59	2.48	2.39	2.31	2.24	2.18	2.12	2.08	2.02	1.99
2.2	5.98	4.46	4.27	4.06	3.91	3.75	3.62	3.49	3.27	3.09	2.94	2.81	2.69	2.59	2.50	2.43	2.36	2.30	2.25	2.20	2.16
2.3	6.26	4.80	4.60	4.38	4.22	4.04	3.91	3.76	3.53	3.34	3.17	3.03	2.91	2.80	2.71	2.63	2.56	2.49	2.43	2.38	2.33
2.4	6.53	5.16	4.94	4.70	4.53	4.34	4.20	4.05	3.80	3.59	3.42	3.26	3.13	3.02	2.92	2.83	2.75	2.68	2.62	2.56	2.51
2.5	6.80	5.52	5.29	5.04	4.86	4.66	4.50	4.34	4.07	3.85	3.67	3.50	3.36	3.24	3.13	3.04	2.96	2.88	2.82	2.75	2.70
2.6	7.07	5.90	5.65	5.39	5.19	4.98	4.82	4.64	4.36	4.12	3.92	3.75	3.60	3.47	3.35	3.26	3.17	3.08	3.02	2.95	2.90
2.7	7.34	6.28	6.02	5.74	5.53	5.31	5.14	4.95	4.65	4.40	4.19	4.01	3.84	3.71	3.58	3.48	3.39	3.30	3.23	3.15	3.10
2.8	7.62	6.68	6.41	6.11	5.89	5.65	5.47	5.27	4.95	4.69	4.46	4.27	4.10	3.95	3.82	3.71	3.61	3.51	3.44	3.36	3.30
2.9	7.89	7.09	6.80	6.48	6.25	6.00	5.80	5.60	5.26	4.98	4.74	4.54	4.36	4.20	4.06	3.94	3.84	3.74	3.66	3.58	3.51
3.0	8.16	7.51	7.20	6.87	6.62	6.36	6.15	5.93	5.58	5.28	5.03	4.81	4.62	4.46	4.31	4.19	4.08	3.97	3.89	3.80	3.73
3.1	8.43	7.93	7.61	7.26	7.00	6.72	6.51	6.28	5.90	5.59	5.32	5.10	4.89	4.72	4.57	4.43	4.32	4.21	4.12	4.02	3.95
3.2	8.70	8.37	8.03	7.67	7.39	7.10	6.87	6.63	6.24	5.90	5.63	5.39	5.17	4.99	4.83	4.69	4.57	4.45	4.36	4.26	4.18
3.3	8.98	8.82	8.46	8.08	7.79	7.48	7.24	6.99	6.58	6.23	5.93	5.68	5.46	5.27	5.09	4.95	4.82	4.70	4.60	4.50	4.42
3.4	9.25	9.28	8.90	8.50	8.20	7.87	7.62	7.36	6.92	6.56	6.25	5.99	5.75	5.55	5.37	5.22	5.08	4.95	4.85	4.74	4.66
3.5	9.52	9.74	9.35	8.93	8.62	8.28	8.01	7.73	7.28	6.90	6.57	6.30	6.05	5.84	5.65	5.49	5.35	5.21	5.11	4.99	4.90
3.6	9.79	10.22	9.81	9.37	9.04	8.69	8.41	8.12	7.64	7.24	6.91	6.61	6.36	6.14	5.94	5.77	5.62	5.48	5.37	5.24	5.15
3.7	10.06	10.71	10.28	9.82	9.48	9.10	8.82	8.51	8.02	7.60	7.24	6.94	6.67	6.44	6.23	6.05	5.90	5.75	5.63	5.51	5.41
3.8	10.34	11.20	10.76	10.28	9.92	9.53	9.23	8.91	8.39	7.96	7.59	7.27	6.99	6.75	6.53	6.35	6.19	6.03	5.91	5.77	5.67
3.9	10.61	11.71	11.25	10.74	10.37	9.97	9.65	9.32	8.78	8.32	7.94	7.61	7.31	7.06	6.84	6.64	6.48	6.31	6.19	6.04	5.94
4.0	10.88	12.22	11.74	11.22	10.83	10.41	10.09	9.74	9.18	8.70	8.30	7.95	7.65	7.38	7.15	6.95	6.77	6.60	6.47	6.32	6.21
4.1	11.15	12.75	12.25	11.70	11.30	10.86	10.52	10.16	9.58	9.08	8.66	8.30	7.99	7.71	7.47	7.26	7.08	6.89	6.76	6.61	6.49
4.2	11.42	13.28	12.76	12.20	11.78	11.32	10.97	10.59	9.99	9.47	9.04	8.66	8.33	8.05	7.79	7.57	7.38	7.19	7.05	6.89	6.78
4.3	11.70	13.82	13.28	12.70	12.26	11.79	11.42	11.03	10.40	9.87	9.42	9.03	8.68	8.39	8.12	7.89	7.70	7.50	7.36	7.19	7.07
4.4	11.97	14.38	13.82	13.21	12.75	12.27	11.89	11.48	10.83	10.27	9.80	9.40	9.04	8.73	8.46	8.22	8.02	7.81	7.66	7.49	7.36
4.5	12.24	14.94	14.36	13.73	13.26	12.75	12.36	11.94	11.26	10.68	10.20	9.78	9.40	9.09	8.80	8.55	8.34	8.13	7.97	7.79	7.66
4.6	12.51	15.51	14.91	14.25	13.77	13.24	12.84	12.40	11.70	11.10	10.60	10.16	9.78	9.44	9.15	8.89	8.67	8.45	8.29	8.10	7.97
4.7	12.78	16.09	15.47	14.79	14.29	13.74	13.32	12.87	12.14	11.52	11.00	10.55	10.15	9.81	9.50	9.24	9.01	8.78	8.61	8.42	8.28
4.8	13.06	16.68	16.03	15.33	14.81	14.25	13.82	13.35	12.59	11.95	11.41	10.95	10.54	10.18	9.86	9.59	9.35	9.12	8.94	8.74	8.59
4.9	13.33	17.27	16.61	15.89	15.35	14.77	14.32	13.84	13.05	12.39	11.83	11.35	10.92	10.56	10.23	9.95	9.70	9.46	9.28	9.07	8.92

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1¼" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	13.60	17.88	17.19	16.45	15.89	15.29	14.83	14.33	13.52	12.84	12.26	11.76	11.32	10.94	10.60	10.31	10.06	9.80	9.62	9.40	9.24
5.1	13.87	18.50	17.79	17.02	16.44	15.82	15.34	14.83	14.00	13.29	12.69	12.18	11.72	11.33	10.98	10.68	10.42	10.15	9.96	9.74	9.57
5.2	14.14	19.12	18.39	17.60	17.00	16.36	15.87	15.34	14.48	13.75	13.13	12.60	12.13	11.72	11.36	11.05	10.78	10.51	10.31	10.08	9.91
5.3	14.42	19.75	19.00	18.18	17.57	16.91	16.40	15.85	14.97	14.21	13.58	13.03	12.54	12.13	11.75	11.43	11.15	10.87	10.67	10.43	10.25
5.4	14.69	20.40	19.62	18.78	18.15	17.47	16.94	16.38	15.46	14.69	14.03	13.47	12.96	12.53	12.14	11.81	11.53	11.24	11.03	10.78	10.60
5.5	14.96	21.05	20.25	19.38	18.73	18.03	17.49	16.91	15.97	15.17	14.49	13.91	13.39	12.95	12.54	12.21	11.91	11.61	11.39	11.14	10.96
5.6	15.23	21.71	20.88	19.99	19.32	18.60	18.04	17.45	16.48	15.65	14.96	14.36	13.82	13.36	12.95	12.60	12.30	11.99	11.76	11.51	11.31
5.7	15.50	22.37	21.53	20.61	19.92	19.18	18.61	17.99	16.99	16.14	15.43	14.81	14.26	13.79	13.36	13.00	12.69	12.38	12.14	11.87	11.68
5.8	15.78	23.05	22.18	21.24	20.53	19.77	19.18	18.54	17.52	16.64	15.91	15.27	14.71	14.22	13.78	13.41	13.09	12.76	12.52	12.25	12.05
5.9	16.05	23.74	22.84	21.87	21.15	20.36	19.75	19.10	18.05	17.15	16.39	15.74	15.16	14.66	14.21	13.82	13.49	13.16	12.91	12.63	12.42
6.0	16.32	24.43	23.51	22.51	21.77	20.96	20.34	19.67	18.58	17.66	16.88	16.21	15.61	15.10	14.64	14.24	13.90	13.56	13.30	13.01	12.80
6.1	16.59	25.13	24.19	23.17	22.40	21.57	20.93	20.24	19.13	18.18	17.38	16.69	16.08	15.55	15.07	14.67	14.32	13.96	13.70	13.40	13.18
6.2	16.86	25.84	24.88	23.82	23.04	22.19	21.53	20.83	19.68	18.71	17.89	17.18	16.54	16.00	15.51	15.10	14.74	14.37	14.10	13.80	13.57
6.3	17.13	26.56	25.57	24.49	23.69	22.81	22.14	21.41	20.24	19.24	18.40	17.67	17.02	16.46	15.96	15.53	15.16	14.79	14.51	14.20	13.96
6.4	17.41	27.29	26.27	25.17	24.34	23.45	22.75	22.01	20.80	19.78	18.91	18.16	17.50	16.93	16.41	15.97	15.59	15.21	14.93	14.60	14.36
6.5	17.68	28.03	26.98	25.85	25.00	24.08	23.37	22.61	21.37	20.32	19.44	18.67	17.99	17.40	16.87	16.42	16.03	15.64	15.35	15.01	14.77
6.6	17.95	28.77	27.70	26.54	25.67	24.73	24.00	23.22	21.95	20.88	19.97	19.18	18.48	17.87	17.33	16.87	16.47	16.07	15.77	15.43	15.18
6.7	18.22	29.53	28.43	27.24	26.35	25.39	24.64	23.84	22.54	21.43	20.50	19.69	18.98	18.36	17.80	17.33	16.92	16.51	16.20	15.85	15.59
6.8	18.49	30.29	29.17	27.95	27.03	26.05	25.28	24.46	23.13	22.00	21.04	20.21	19.48	18.85	18.28	17.79	17.37	16.95	16.63	16.27	16.01
6.9	18.77	31.06	29.91	28.66	27.73	26.72	25.93	25.09	23.73	22.57	21.59	20.74	19.99	19.34	18.76	18.26	17.83	17.39	17.07	16.70	16.43
7.0	19.04	31.84	30.66	29.38	28.43	27.39	26.59	25.73	24.33	23.15	22.14	21.28	20.50	19.84	19.24	18.73	18.29	17.85	17.52	17.14	16.86
7.1	19.31	32.62	31.42	30.11	29.13	28.08	27.26	26.38	24.95	23.73	22.70	21.82	21.03	20.35	19.73	19.21	18.76	18.30	17.97	17.58	17.29
7.2	19.58	33.42	32.19	30.85	29.85	28.77	27.93	27.03	25.57	24.32	23.27	22.36	21.55	20.86	20.23	19.70	19.23	18.77	18.42	18.03	17.73
7.3	19.85	34.22	32.96	31.60	30.57	29.47	28.61	27.69	26.19	24.92	23.84	22.91	22.09	21.37	20.73	20.19	19.71	19.24	18.88	18.48	18.18
7.4	20.13	35.03	33.75	32.35	31.30	30.17	29.30	28.35	26.82	25.52	24.42	23.47	22.62	21.90	21.24	20.68	20.20	19.71	19.35	18.93	18.63
7.5	20.40	35.85	34.54	33.11	32.04	30.88	29.99	29.03	27.46	26.13	25.01	24.03	23.17	22.42	21.75	21.18	20.69	20.19	19.82	19.39	19.08
7.6	20.67	36.68	35.34	33.88	32.79	31.60	30.69	29.71	28.11	26.75	25.60	24.60	23.72	22.96	22.27	21.69	21.18	20.67	20.29	19.86	19.54
7.7	20.94	37.51	36.14	34.65	33.54	32.33	31.40	30.39	28.76	27.37	26.20	25.18	24.28	23.50	22.79	22.20	21.68	21.16	20.77	20.33	20.00
7.8	21.21	38.36	36.96	35.44	34.30	33.07	32.11	31.08	29.42	28.00	26.80	25.76	24.84	24.04	23.32	22.72	22.19	21.65	21.26	20.80	20.47
7.9	21.49	39.21	37.78	36.23	35.07	33.81	32.83	31.79	30.08	28.63	27.41	26.35	25.40	24.59	23.86	23.24	22.70	22.15	21.75	21.28	20.94
8.0	21.76	40.07	38.61	37.03	35.84	34.56	33.56	32.49	30.75	29.27	28.02	26.94	25.98	25.15	24.40	23.76	23.21	22.65	22.24	21.77	21.42

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1¼" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	4.08	2.71	2.58	2.44	2.34	2.23	2.14	2.05	1.90	1.78	1.68	1.59	1.52	1.45	1.40	1.35	1.30	1.26	1.22	1.19	1.16
1.6	4.35	3.01	2.87	2.72	2.60	2.48	2.38	2.28	2.12	1.99	1.88	1.78	1.70	1.62	1.56	1.50	1.46	1.41	1.37	1.34	1.30
1.7	4.62	3.33	3.17	3.00	2.88	2.74	2.64	2.53	2.35	2.20	2.08	1.97	1.88	1.80	1.73	1.67	1.62	1.57	1.52	1.48	1.45
1.8	4.90	3.66	3.49	3.30	3.17	3.02	2.90	2.78	2.59	2.43	2.29	2.18	2.08	1.99	1.91	1.84	1.79	1.73	1.68	1.64	1.60
1.9	5.17	4.00	3.81	3.61	3.46	3.30	3.18	3.05	2.84	2.66	2.52	2.39	2.28	2.18	2.10	2.03	1.96	1.90	1.85	1.80	1.76
2.0	5.44	4.35	4.15	3.94	3.77	3.60	3.47	3.33	3.10	2.91	2.75	2.61	2.49	2.39	2.29	2.22	2.15	2.08	2.02	1.97	1.93
2.1	5.71	4.72	4.50	4.27	4.10	3.91	3.77	3.61	3.37	3.16	2.99	2.84	2.71	2.60	2.50	2.41	2.34	2.27	2.20	2.15	2.10
2.2	5.98	5.10	4.87	4.61	4.43	4.23	4.07	3.91	3.64	3.42	3.23	3.07	2.93	2.81	2.71	2.61	2.53	2.46	2.39	2.33	2.28
2.3	6.26	5.49	5.24	4.97	4.77	4.56	4.39	4.21	3.93	3.69	3.49	3.32	3.17	3.04	2.93	2.83	2.74	2.66	2.58	2.52	2.46
2.4	6.53	5.89	5.62	5.34	5.12	4.89	4.72	4.53	4.23	3.97	3.75	3.57	3.41	3.27	3.15	3.04	2.95	2.86	2.78	2.72	2.65
2.5	6.80	6.30	6.02	5.72	5.49	5.24	5.06	4.85	4.53	4.26	4.03	3.83	3.66	3.51	3.38	3.27	3.17	3.07	2.99	2.92	2.85
2.6	7.07	6.73	6.43	6.11	5.86	5.60	5.40	5.19	4.84	4.55	4.31	4.10	3.92	3.76	3.62	3.50	3.39	3.29	3.20	3.13	3.05
2.7	7.34	7.17	6.85	6.50	6.25	5.97	5.76	5.53	5.17	4.86	4.60	4.38	4.18	4.02	3.87	3.74	3.62	3.52	3.42	3.34	3.26
2.8	7.62	7.62	7.28	6.92	6.64	6.35	6.13	5.88	5.50	5.17	4.90	4.66	4.46	4.28	4.12	3.98	3.86	3.75	3.65	3.56	3.48
2.9	7.89	8.07	7.72	7.34	7.05	6.74	6.50	6.25	5.84	5.49	5.20	4.95	4.74	4.55	4.38	4.23	4.11	3.99	3.88	3.79	3.70
3.0	8.16	8.55	8.17	7.77	7.46	7.14	6.89	6.62	6.19	5.82	5.52	5.25	5.02	4.82	4.65	4.49	4.36	4.23	4.12	4.02	3.93
3.1	8.43	9.03	8.63	8.21	7.89	7.55	7.28	7.00	6.55	6.16	5.84	5.56	5.32	5.11	4.92	4.76	4.62	4.48	4.36	4.26	4.16
3.2	8.70	9.52	9.11	8.66	8.33	7.96	7.69	7.39	6.91	6.51	6.17	5.87	5.62	5.40	5.20	5.03	4.88	4.74	4.61	4.51	4.40
3.3	8.98	10.02	9.59	9.12	8.77	8.39	8.10	7.79	7.29	6.86	6.50	6.20	5.93	5.70	5.49	5.31	5.15	5.00	4.87	4.76	4.65
3.4	9.25	10.54	10.08	9.59	9.23	8.83	8.52	8.20	7.67	7.22	6.85	6.53	6.25	6.00	5.78	5.60	5.43	5.27	5.13	5.02	4.90
3.5	9.52	11.07	10.59	10.08	9.69	9.28	8.96	8.61	8.06	7.60	7.20	6.86	6.57	6.31	6.09	5.89	5.71	5.55	5.40	5.28	5.16
3.6	9.79	11.60	11.10	10.57	10.16	9.73	9.40	9.04	8.46	7.97	7.56	7.21	6.90	6.63	6.39	6.19	6.00	5.83	5.68	5.55	5.42
3.7	10.06	12.15	11.63	11.07	10.65	10.20	9.85	9.47	8.87	8.36	7.93	7.56	7.24	6.96	6.71	6.49	6.30	6.12	5.96	5.82	5.69
3.8	10.34	12.71	12.17	11.58	11.14	10.67	10.31	9.91	9.29	8.75	8.30	7.92	7.58	7.29	7.03	6.80	6.60	6.41	6.25	6.11	5.97
3.9	10.61	13.27	12.71	12.10	11.65	11.15	10.77	10.37	9.71	9.16	8.69	8.28	7.93	7.63	7.36	7.12	6.91	6.71	6.54	6.39	6.25
4.0	10.88	13.85	13.27	12.63	12.16	11.65	11.25	10.83	10.14	9.57	9.08	8.66	8.29	7.97	7.69	7.44	7.23	7.02	6.84	6.68	6.54
4.1	11.15	14.44	13.83	13.17	12.68	12.15	11.74	11.29	10.59	9.98	9.48	9.04	8.66	8.33	8.03	7.77	7.55	7.33	7.14	6.98	6.83
4.2	11.42	15.04	14.41	13.72	13.21	12.66	12.23	11.77	11.04	10.41	9.88	9.43	9.03	8.68	8.38	8.11	7.87	7.65	7.45	7.29	7.13
4.3	11.70	15.65	14.99	14.28	13.75	13.18	12.73	12.26	11.49	10.84	10.29	9.82	9.41	9.05	8.73	8.45	8.21	7.98	7.77	7.60	7.43
4.4	11.97	16.27	15.59	14.85	14.30	13.70	13.25	12.75	11.96	11.28	10.71	10.22	9.79	9.42	9.09	8.80	8.55	8.31	8.09	7.91	7.74
4.5	12.24	16.90	16.19	15.43	14.86	14.24	13.77	13.25	12.43	11.73	11.14	10.63	10.19	9.80	9.46	9.16	8.89	8.64	8.42	8.24	8.05
4.6	12.51	17.54	16.81	16.02	15.43	14.79	14.29	13.76	12.91	12.19	11.57	11.05	10.59	10.19	9.83	9.52	9.24	8.99	8.76	8.56	8.37
4.7	12.78	18.19	17.43	16.62	16.00	15.34	14.83	14.28	13.40	12.65	12.02	11.47	10.99	10.58	10.21	9.89	9.60	9.34	9.10	8.90	8.70
4.8	13.06	18.85	18.07	17.22	16.59	15.91	15.38	14.81	13.90	13.12	12.46	11.90	11.41	10.98	10.59	10.26	9.97	9.69	9.44	9.23	9.03
4.9	13.33	19.52	18.71	17.84	17.18	16.48	15.93	15.35	14.40	13.60	12.92	12.34	11.83	11.38	10.99	10.64	10.34	10.05	9.79	9.58	9.37

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1¼" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	13.60	20.19	19.36	18.46	17.79	17.06	16.50	15.89	14.91	14.09	13.38	12.78	12.25	11.79	11.38	11.03	10.71	10.42	10.15	9.93	9.71
5.1	13.87	20.88	20.03	19.10	18.40	17.65	17.07	16.44	15.43	14.58	13.85	13.23	12.68	12.21	11.79	11.42	11.09	10.79	10.51	10.28	10.06
5.2	14.14	21.58	20.70	19.74	19.02	18.25	17.65	17.00	15.96	15.08	14.33	13.69	13.12	12.63	12.20	11.82	11.48	11.16	10.88	10.64	10.41
5.3	14.42	22.29	21.38	20.39	19.65	18.85	18.23	17.57	16.50	15.59	14.81	14.15	13.57	13.06	12.61	12.22	11.87	11.55	11.26	11.01	10.77
5.4	14.69	23.01	22.07	21.06	20.29	19.47	18.83	18.14	17.04	16.10	15.30	14.62	14.02	13.50	13.04	12.63	12.27	11.94	11.64	11.38	11.14
5.5	14.96	23.74	22.77	21.73	20.94	20.09	19.43	18.73	17.59	16.62	15.80	15.10	14.48	13.94	13.47	13.05	12.68	12.33	12.02	11.76	11.51
5.6	15.23	24.47	23.48	22.41	21.60	20.72	20.05	19.32	18.15	17.15	16.31	15.58	14.95	14.39	13.90	13.47	13.09	12.73	12.41	12.14	11.88
5.7	15.50	25.22	24.20	23.09	22.26	21.36	20.67	19.92	18.72	17.69	16.82	16.07	15.42	14.85	14.34	13.90	13.51	13.14	12.81	12.53	12.26
5.8	15.78	25.98	24.93	23.79	22.94	22.01	21.30	20.53	19.29	18.23	17.34	16.57	15.90	15.31	14.79	14.33	13.93	13.55	13.21	12.92	12.65
5.9	16.05	26.74	25.67	24.50	23.62	22.67	21.93	21.14	19.87	18.79	17.86	17.07	16.38	15.78	15.24	14.77	14.36	13.97	13.62	13.32	13.04
6.0	16.32	27.52	26.41	25.21	24.31	23.33	22.58	21.77	20.46	19.34	18.40	17.58	16.87	16.25	15.70	15.22	14.79	14.39	14.03	13.73	13.43
6.1	16.59	28.30	27.17	25.94	25.01	24.01	23.23	22.40	21.05	19.91	18.94	18.10	17.37	16.73	16.17	15.67	15.23	14.82	14.45	14.14	13.84
6.2	16.86	29.10	27.93	26.67	25.72	24.69	23.89	23.04	21.66	20.48	19.48	18.62	17.87	17.22	16.64	16.13	15.68	15.25	14.87	14.55	14.24
6.3	17.13	29.90	28.71	27.41	26.43	25.38	24.56	23.68	22.27	21.06	20.04	19.15	18.38	17.71	17.11	16.59	16.13	15.69	15.30	14.97	14.66
6.4	17.41	30.72	29.49	28.16	27.16	26.08	25.24	24.34	22.89	21.65	20.60	19.69	18.90	18.21	17.60	17.06	16.58	16.14	15.74	15.40	15.07
6.5	17.68	31.54	30.28	28.92	27.89	26.78	25.92	25.00	23.51	22.24	21.16	20.23	19.42	18.71	18.09	17.53	17.05	16.59	16.18	15.83	15.50
6.6	17.95	32.37	31.08	29.68	28.63	27.50	26.62	25.67	24.14	22.84	21.74	20.78	19.95	19.23	18.58	18.01	17.51	17.04	16.62	16.27	15.92
6.7	18.22	33.21	31.89	30.46	29.38	28.22	27.32	26.35	24.78	23.45	22.32	21.34	20.49	19.74	19.08	18.50	17.99	17.51	17.07	16.71	16.36
6.8	18.49	34.06	32.71	31.24	30.14	28.95	28.03	27.03	25.43	24.06	22.90	21.90	21.03	20.27	19.59	18.99	18.47	17.97	17.53	17.16	16.79
6.9	18.77	34.92	33.54	32.04	30.91	29.69	28.74	27.73	26.08	24.68	23.50	22.47	21.58	20.79	20.10	19.49	18.95	18.44	17.99	17.61	17.24
7.0	19.04	35.79	34.37	32.84	31.68	30.43	29.47	28.43	26.75	25.31	24.10	23.05	22.13	21.33	20.62	19.99	19.44	18.92	18.46	18.07	17.69
7.1	19.31	36.66	35.22	33.65	32.47	31.19	30.20	29.13	27.42	25.95	24.70	23.63	22.69	21.87	21.14	20.50	19.94	19.41	18.93	18.53	18.14
7.2	19.58	37.55	36.07	34.47	33.26	31.95	30.94	29.85	28.09	26.59	25.32	24.22	23.26	22.42	21.67	21.02	20.44	19.90	19.41	19.00	18.60
7.3	19.85	38.44	36.93	35.29	34.06	32.72	31.69	30.57	28.77	27.24	25.94	24.81	23.83	22.97	22.21	21.54	20.95	20.39	19.89	19.47	19.06
7.4	20.13	39.35	37.81	36.13	34.87	33.50	32.44	31.30	29.46	27.90	26.56	25.41	24.41	23.53	22.75	22.06	21.46	20.89	20.38	19.95	19.53
7.5	20.40	40.26	38.69	36.97	35.68	34.29	33.21	32.04	30.16	28.56	27.20	26.02	24.99	24.09	23.30	22.59	21.98	21.39	20.87	20.43	20.01
7.6	20.67	41.18	39.57	37.82	36.51	35.08	33.98	32.79	30.87	29.23	27.83	26.63	25.58	24.67	23.85	23.13	22.50	21.91	21.37	20.92	20.49
7.7	20.94	42.12	40.47	38.68	37.34	35.88	34.75	33.54	31.58	29.90	28.48	27.25	26.18	25.24	24.41	23.68	23.03	22.42	21.88	21.42	20.97
7.8	21.21	43.06	41.38	39.55	38.18	36.69	35.54	34.30	32.30	30.59	29.13	27.88	26.78	25.82	24.97	24.22	23.56	22.94	22.39	21.92	21.46
7.9	21.49	44.00	42.29	40.43	39.03	37.51	36.33	35.07	33.02	31.28	29.79	28.51	27.39	26.41	25.54	24.78	24.10	23.47	22.90	22.42	21.95
8.0	21.76	44.96	43.21	41.31	39.88	38.34	37.13	35.84	33.76	31.97	30.46	29.15	28.01	27.01	26.12	25.34	24.65	24.00	23.42	22.93	22.45

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1½" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	5.68	1.13	1.08	1.01	1.00	0.98	0.96	0.94	0.91	0.89	0.86	0.84	0.82	0.81	0.79	0.78	0.76	0.75	0.74	0.73	0.72
1.6	6.06	1.26	1.20	1.14	1.11	1.09	1.07	1.05	1.02	0.99	0.97	0.94	0.92	0.90	0.89	0.87	0.86	0.84	0.83	0.82	0.81
1.7	6.44	1.40	1.34	1.26	1.24	1.21	1.19	1.17	1.14	1.10	1.08	1.05	1.03	1.01	0.99	0.97	0.95	0.94	0.92	0.91	0.90
1.8	6.82	1.55	1.48	1.39	1.37	1.34	1.32	1.30	1.26	1.22	1.19	1.16	1.14	1.11	1.09	1.07	1.05	1.04	1.02	1.01	1.00
1.9	7.20	1.70	1.62	1.53	1.50	1.47	1.45	1.42	1.38	1.34	1.31	1.28	1.25	1.22	1.20	1.18	1.16	1.14	1.13	1.11	1.10
2.0	7.58	1.86	1.77	1.68	1.64	1.61	1.59	1.56	1.51	1.47	1.43	1.40	1.37	1.34	1.32	1.29	1.27	1.25	1.23	1.22	1.20
2.1	7.96	2.02	1.93	1.82	1.79	1.76	1.73	1.70	1.65	1.60	1.56	1.52	1.49	1.46	1.43	1.41	1.39	1.36	1.35	1.33	1.31
2.2	8.34	2.19	2.09	1.98	1.94	1.91	1.88	1.84	1.79	1.74	1.69	1.66	1.62	1.59	1.56	1.53	1.51	1.48	1.46	1.44	1.42
2.3	8.71	2.37	2.26	2.14	2.10	2.06	2.03	1.99	1.93	1.88	1.83	1.79	1.75	1.72	1.69	1.66	1.63	1.60	1.58	1.56	1.54
2.4	9.09	2.55	2.44	2.31	2.26	2.22	2.18	2.15	2.08	2.03	1.98	1.93	1.89	1.85	1.82	1.79	1.76	1.73	1.71	1.68	1.66
2.5	9.47	2.74	2.62	2.48	2.43	2.39	2.35	2.31	2.24	2.18	2.12	2.08	2.03	1.99	1.96	1.92	1.89	1.86	1.84	1.81	1.79
2.6	9.85	2.93	2.80	2.65	2.61	2.56	2.52	2.47	2.40	2.33	2.28	2.23	2.18	2.14	2.10	2.06	2.03	2.00	1.97	1.94	1.92
2.7	10.23	3.13	2.99	2.83	2.78	2.73	2.69	2.64	2.57	2.50	2.43	2.38	2.33	2.28	2.24	2.20	2.17	2.14	2.11	2.08	2.05
2.8	10.61	3.34	3.19	3.02	2.97	2.91	2.87	2.82	2.74	2.66	2.60	2.54	2.48	2.44	2.39	2.35	2.32	2.28	2.25	2.22	2.19
2.9	10.99	3.55	3.39	3.21	3.16	3.10	3.05	3.00	2.91	2.83	2.76	2.70	2.64	2.59	2.55	2.50	2.46	2.43	2.39	2.36	2.33
3.0	11.37	3.76	3.60	3.41	3.35	3.29	3.24	3.18	3.09	3.01	2.93	2.87	2.81	2.76	2.71	2.66	2.62	2.58	2.54	2.51	2.48
3.1	11.75	3.98	3.81	3.61	3.55	3.48	3.43	3.37	3.27	3.19	3.11	3.04	2.98	2.92	2.87	2.82	2.78	2.74	2.70	2.66	2.63
3.2	12.12	4.21	4.03	3.82	3.75	3.68	3.63	3.57	3.46	3.37	3.29	3.22	3.15	3.09	3.04	2.99	2.94	2.90	2.86	2.82	2.79
3.3	12.50	4.45	4.25	4.03	3.96	3.89	3.83	3.77	3.66	3.56	3.48	3.40	3.33	3.27	3.21	3.15	3.11	3.06	3.02	2.98	2.94
3.4	12.88	4.68	4.48	4.25	4.18	4.10	4.04	3.97	3.86	3.76	3.67	3.58	3.51	3.44	3.38	3.33	3.28	3.23	3.18	3.14	3.11
3.5	13.26	4.93	4.72	4.47	4.40	4.32	4.25	4.18	4.06	3.95	3.86	3.77	3.70	3.63	3.56	3.50	3.45	3.40	3.35	3.31	3.27
3.6	13.64	5.18	4.95	4.70	4.62	4.54	4.47	4.39	4.27	4.16	4.06	3.97	3.89	3.81	3.75	3.69	3.63	3.58	3.53	3.48	3.44
3.7	14.02	5.43	5.20	4.93	4.85	4.76	4.69	4.61	4.48	4.36	4.26	4.17	4.08	4.01	3.94	3.87	3.81	3.76	3.71	3.66	3.62
3.8	14.40	5.69	5.45	5.17	5.08	4.99	4.92	4.84	4.70	4.58	4.47	4.37	4.28	4.20	4.13	4.06	4.00	3.94	3.89	3.84	3.79
3.9	14.78	5.96	5.70	5.41	5.32	5.23	5.15	5.06	4.92	4.79	4.68	4.58	4.48	4.40	4.32	4.25	4.19	4.13	4.07	4.02	3.97
4.0	15.16	6.23	5.96	5.66	5.57	5.47	5.38	5.30	5.15	5.01	4.90	4.79	4.69	4.60	4.52	4.45	4.38	4.32	4.26	4.21	4.16
4.1	15.53	6.50	6.23	5.91	5.82	5.71	5.62	5.53	5.38	5.24	5.12	5.00	4.90	4.81	4.73	4.65	4.58	4.52	4.46	4.40	4.35
4.2	15.91	6.79	6.50	6.17	6.07	5.96	5.87	5.78	5.61	5.47	5.34	5.22	5.12	5.02	4.94	4.86	4.78	4.72	4.65	4.60	4.54
4.3	16.29	7.07	6.77	6.43	6.33	6.21	6.12	6.02	5.85	5.70	5.57	5.45	5.34	5.24	5.15	5.07	4.99	4.92	4.86	4.79	4.74
4.4	16.67	7.36	7.05	6.70	6.59	6.47	6.37	6.27	6.10	5.94	5.80	5.68	5.56	5.46	5.37	5.28	5.20	5.13	5.06	5.00	4.94
4.5	17.05	7.66	7.34	6.97	6.86	6.73	6.63	6.53	6.35	6.18	6.04	5.91	5.79	5.69	5.59	5.50	5.42	5.34	5.27	5.20	5.14
4.6	17.43	7.96	7.63	7.25	7.13	7.00	6.90	6.79	6.60	6.43	6.28	6.15	6.02	5.91	5.81	5.72	5.63	5.55	5.48	5.41	5.35
4.7	17.81	8.27	7.92	7.53	7.41	7.27	7.17	7.05	6.86	6.68	6.53	6.39	6.26	6.15	6.04	5.94	5.86	5.77	5.70	5.63	5.56
4.8	18.19	8.58	8.22	7.82	7.69	7.55	7.44	7.32	7.12	6.94	6.78	6.63	6.50	6.38	6.27	6.17	6.08	6.00	5.92	5.85	5.78
4.9	18.57	8.90	8.53	8.11	7.97	7.83	7.72	7.59	7.38	7.20	7.03	6.88	6.75	6.62	6.51	6.41	6.31	6.22	6.14	6.07	6.00

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1½" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	18.94	9.22	8.84	8.40	8.26	8.12	8.00	7.87	7.66	7.46	7.29	7.14	6.99	6.87	6.75	6.64	6.55	6.45	6.37	6.29	6.22
5.1	19.32	9.55	9.15	8.70	8.56	8.41	8.28	8.15	7.93	7.73	7.55	7.39	7.25	7.12	7.00	6.88	6.78	6.69	6.60	6.52	6.45
5.2	19.70	9.88	9.47	9.01	8.86	8.70	8.58	8.44	8.21	8.00	7.82	7.65	7.50	7.37	7.24	7.13	7.02	6.93	6.84	6.75	6.68
5.3	20.08	10.22	9.80	9.32	9.16	9.00	8.87	8.73	8.49	8.28	8.09	7.92	7.77	7.62	7.50	7.38	7.27	7.17	7.08	6.99	6.91
5.4	20.46	10.56	10.13	9.63	9.47	9.31	9.17	9.03	8.78	8.56	8.37	8.19	8.03	7.88	7.75	7.63	7.52	7.41	7.32	7.23	7.15
5.5	20.84	10.91	10.46	9.95	9.79	9.62	9.48	9.33	9.07	8.85	8.64	8.46	8.30	8.15	8.01	7.89	7.77	7.66	7.56	7.47	7.39
5.6	21.22	11.26	10.80	10.27	10.11	9.93	9.78	9.63	9.37	9.14	8.93	8.74	8.57	8.42	8.28	8.15	8.03	7.92	7.81	7.72	7.63
5.7	21.60	11.62	11.14	10.60	10.43	10.25	10.10	9.94	9.67	9.43	9.22	9.02	8.85	8.69	8.54	8.41	8.29	8.17	8.07	7.97	7.88
5.8	21.98	11.98	11.49	10.93	10.76	10.57	10.42	10.25	9.98	9.73	9.51	9.31	9.13	8.96	8.82	8.68	8.55	8.43	8.33	8.23	8.13
5.9	22.35	12.35	11.84	11.27	11.09	10.90	10.74	10.57	10.28	10.03	9.80	9.60	9.41	9.24	9.09	8.95	8.82	8.70	8.59	8.48	8.39
6.0	22.73	12.72	12.20	11.61	11.42	11.23	11.06	10.89	10.60	10.34	10.10	9.89	9.70	9.53	9.37	9.22	9.09	8.96	8.85	8.75	8.65
6.1	23.11	13.10	12.56	11.96	11.77	11.56	11.39	11.22	10.92	10.65	10.41	10.19	9.99	9.82	9.65	9.50	9.37	9.24	9.12	9.01	8.91
6.2	23.49	13.48	12.93	12.31	12.11	11.90	11.73	11.55	11.24	10.96	10.71	10.49	10.29	10.11	9.94	9.79	9.64	9.51	9.39	9.28	9.18
6.3	23.87	13.86	13.30	12.66	12.46	12.25	12.07	11.88	11.56	11.28	11.03	10.80	10.59	10.40	10.23	10.07	9.93	9.79	9.67	9.55	9.44
6.4	24.25	14.26	13.68	13.02	12.81	12.59	12.41	12.22	11.89	11.60	11.34	11.11	10.89	10.70	10.52	10.36	10.21	10.07	9.95	9.83	9.72
6.5	24.63	14.65	14.06	13.39	13.17	12.95	12.76	12.56	12.23	11.93	11.66	11.42	11.20	11.00	10.82	10.66	10.50	10.36	10.23	10.11	9.99
6.6	25.01	15.05	14.45	13.76	13.54	13.30	13.11	12.91	12.57	12.26	11.98	11.74	11.51	11.31	11.12	10.95	10.80	10.65	10.52	10.39	10.27
6.7	25.38	15.46	14.84	14.13	13.90	13.67	13.47	13.26	12.91	12.59	12.31	12.06	11.83	11.62	11.43	11.25	11.09	10.94	10.81	10.68	10.56
6.8	25.76	15.87	15.23	14.51	14.27	14.03	13.83	13.62	13.26	12.93	12.64	12.38	12.15	11.93	11.74	11.56	11.39	11.24	11.10	10.97	10.85
6.9	26.14	16.28	15.63	14.89	14.65	14.40	14.19	13.98	13.61	13.28	12.98	12.71	12.47	12.25	12.05	11.87	11.70	11.54	11.40	11.26	11.14
7.0	26.52	16.70	16.04	15.27	15.03	14.78	14.56	14.34	13.96	13.62	13.32	13.05	12.80	12.57	12.37	12.18	12.01	11.84	11.70	11.56	11.43
7.1	26.90	17.13	16.45	15.66	15.42	15.15	14.94	14.71	14.32	13.97	13.66	13.38	13.13	12.90	12.69	12.50	12.32	12.15	12.00	11.86	11.73
7.2	27.28	17.56	16.86	16.06	15.81	15.54	15.32	15.08	14.68	14.33	14.01	13.72	13.46	13.23	13.01	12.82	12.63	12.46	12.31	12.16	12.03
7.3	27.66	17.99	17.28	16.46	16.20	15.92	15.70	15.46	15.05	14.69	14.36	14.07	13.80	13.56	13.34	13.14	12.95	12.78	12.62	12.47	12.33
7.4	28.04	18.43	17.70	16.86	16.60	16.32	16.08	15.84	15.42	15.05	14.72	14.42	14.15	13.90	13.67	13.47	13.28	13.10	12.93	12.78	12.64
7.5	28.42	18.88	18.13	17.27	17.00	16.71	16.47	16.23	15.80	15.42	15.08	14.77	14.49	14.24	14.01	13.80	13.60	13.42	13.25	13.10	12.95
7.6	28.79	19.32	18.56	17.68	17.40	17.11	16.87	16.61	16.18	15.79	15.44	15.13	14.84	14.58	14.35	14.13	13.93	13.74	13.57	13.42	13.27
7.7	29.17	19.78	18.99	18.10	17.82	17.52	17.27	17.01	16.56	16.16	15.81	15.49	15.20	14.93	14.69	14.47	14.27	14.07	13.90	13.74	13.59
7.8	29.55	20.24	19.43	18.52	18.23	17.92	17.67	17.40	16.95	16.54	16.18	15.85	15.55	15.28	15.04	14.81	14.60	14.41	14.23	14.06	13.91
7.9	29.93	20.70	19.88	18.95	18.65	18.34	18.08	17.81	17.34	16.92	16.55	16.22	15.91	15.64	15.39	15.15	14.94	14.74	14.56	14.39	14.24
8.0	30.31	21.16	20.33	19.38	19.07	18.75	18.49	18.21	17.73	17.31	16.93	16.59	16.28	16.00	15.74	15.50	15.29	15.08	14.90	14.73	14.56

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1½" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	5.68	1.59	1.53	1.47	1.43	1.38	1.34	1.30	1.23	1.17	1.12	1.07	1.04	1.00	0.97	0.95	0.92	0.90	0.88	0.86	0.85
1.6	6.06	1.77	1.71	1.64	1.59	1.54	1.49	1.45	1.37	1.31	1.25	1.20	1.16	1.12	1.09	1.06	1.03	1.01	0.99	0.97	0.95
1.7	6.44	1.96	1.89	1.82	1.77	1.71	1.66	1.61	1.52	1.45	1.39	1.33	1.29	1.25	1.21	1.18	1.15	1.12	1.10	1.08	1.06
1.8	6.82	2.16	2.09	2.01	1.95	1.88	1.83	1.77	1.68	1.60	1.53	1.47	1.42	1.38	1.34	1.30	1.27	1.24	1.21	1.19	1.17
1.9	7.20	2.37	2.29	2.20	2.14	2.06	2.01	1.94	1.84	1.76	1.68	1.62	1.56	1.51	1.47	1.43	1.40	1.36	1.34	1.31	1.29
2.0	7.58	2.59	2.50	2.40	2.33	2.25	2.19	2.12	2.02	1.92	1.84	1.77	1.71	1.66	1.61	1.57	1.53	1.49	1.46	1.43	1.41
2.1	7.96	2.81	2.71	2.61	2.53	2.45	2.38	2.31	2.19	2.09	2.00	1.93	1.86	1.80	1.75	1.71	1.67	1.63	1.59	1.56	1.54
2.2	8.34	3.04	2.94	2.83	2.75	2.65	2.58	2.50	2.38	2.27	2.17	2.09	2.02	1.96	1.90	1.85	1.81	1.77	1.73	1.70	1.67
2.3	8.71	3.28	3.17	3.05	2.96	2.87	2.79	2.70	2.57	2.45	2.35	2.26	2.18	2.12	2.05	2.00	1.96	1.91	1.87	1.83	1.81
2.4	9.09	3.53	3.41	3.28	3.19	3.08	3.00	2.91	2.76	2.64	2.53	2.43	2.35	2.28	2.21	2.16	2.11	2.06	2.02	1.98	1.95
2.5	9.47	3.78	3.66	3.52	3.42	3.31	3.22	3.12	2.97	2.83	2.72	2.61	2.53	2.45	2.38	2.32	2.27	2.21	2.17	2.13	2.09
2.6	9.85	4.04	3.91	3.77	3.66	3.54	3.44	3.34	3.18	3.03	2.91	2.80	2.71	2.62	2.55	2.49	2.43	2.37	2.33	2.28	2.25
2.7	10.23	4.31	4.17	4.02	3.90	3.78	3.68	3.57	3.39	3.24	3.11	2.99	2.89	2.80	2.72	2.66	2.60	2.54	2.49	2.44	2.40
2.8	10.61	4.59	4.44	4.28	4.16	4.02	3.92	3.80	3.61	3.45	3.31	3.19	3.08	2.99	2.90	2.84	2.77	2.70	2.65	2.60	2.56
2.9	10.99	4.87	4.72	4.55	4.41	4.27	4.16	4.04	3.84	3.67	3.52	3.39	3.28	3.18	3.09	3.02	2.94	2.88	2.82	2.77	2.73
3.0	11.37	5.17	5.00	4.82	4.68	4.53	4.41	4.28	4.07	3.89	3.74	3.60	3.48	3.38	3.28	3.20	3.13	3.06	3.00	2.94	2.90
3.1	11.75	5.46	5.29	5.10	4.95	4.80	4.67	4.53	4.31	4.12	3.96	3.81	3.69	3.58	3.48	3.39	3.31	3.24	3.18	3.12	3.07
3.2	12.12	5.77	5.59	5.39	5.23	5.07	4.93	4.79	4.56	4.36	4.18	4.03	3.90	3.78	3.68	3.59	3.51	3.43	3.36	3.30	3.25
3.3	12.50	6.08	5.89	5.68	5.52	5.35	5.21	5.06	4.81	4.60	4.42	4.26	4.12	3.99	3.88	3.79	3.70	3.62	3.55	3.48	3.43
3.4	12.88	6.40	6.20	5.98	5.81	5.63	5.48	5.32	5.07	4.85	4.65	4.49	4.34	4.21	4.09	4.00	3.90	3.82	3.74	3.67	3.62
3.5	13.26	6.73	6.52	6.29	6.11	5.92	5.76	5.60	5.33	5.10	4.90	4.72	4.57	4.43	4.31	4.21	4.11	4.02	3.94	3.87	3.81
3.6	13.64	7.06	6.84	6.60	6.42	6.22	6.05	5.88	5.60	5.36	5.15	4.96	4.80	4.66	4.53	4.42	4.32	4.22	4.14	4.07	4.01
3.7	14.02	7.41	7.17	6.92	6.73	6.52	6.35	6.17	5.87	5.62	5.40	5.21	5.04	4.89	4.75	4.64	4.54	4.44	4.35	4.27	4.21
3.8	14.40	7.75	7.51	7.25	7.05	6.83	6.65	6.46	6.15	5.89	5.66	5.46	5.28	5.13	4.98	4.87	4.76	4.65	4.56	4.48	4.41
3.9	14.78	8.11	7.85	7.58	7.37	7.14	6.96	6.76	6.44	6.16	5.92	5.71	5.53	5.37	5.22	5.10	4.98	4.87	4.78	4.69	4.62
4.0	15.16	8.47	8.21	7.92	7.70	7.46	7.27	7.07	6.73	6.44	6.19	5.97	5.78	5.61	5.46	5.33	5.21	5.10	5.00	4.91	4.83
4.1	15.53	8.84	8.56	8.27	8.04	7.79	7.59	7.38	7.03	6.73	6.47	6.24	6.04	5.86	5.70	5.57	5.44	5.32	5.23	5.13	5.05
4.2	15.91	9.21	8.93	8.62	8.38	8.13	7.92	7.70	7.33	7.02	6.75	6.51	6.30	6.12	5.95	5.81	5.68	5.56	5.45	5.35	5.27
4.3	16.29	9.60	9.30	8.98	8.73	8.47	8.25	8.02	7.64	7.32	7.03	6.78	6.57	6.38	6.20	6.06	5.92	5.80	5.69	5.58	5.50
4.4	16.67	9.98	9.68	9.34	9.09	8.81	8.59	8.35	7.96	7.62	7.32	7.07	6.84	6.64	6.46	6.32	6.17	6.04	5.93	5.82	5.73
4.5	17.05	10.38	10.06	9.72	9.45	9.16	8.93	8.68	8.28	7.92	7.62	7.35	7.12	6.91	6.72	6.57	6.42	6.29	6.17	6.05	5.97
4.6	17.43	10.78	10.45	10.09	9.82	9.52	9.28	9.02	8.60	8.24	7.92	7.64	7.40	7.19	6.99	6.84	6.68	6.54	6.42	6.30	6.21
4.7	17.81	11.19	10.85	10.48	10.19	9.88	9.63	9.37	8.93	8.55	8.23	7.94	7.69	7.47	7.27	7.10	6.94	6.79	6.67	6.54	6.45
4.8	18.19	11.61	11.25	10.87	10.57	10.25	10.00	9.72	9.27	8.88	8.54	8.24	7.98	7.75	7.54	7.37	7.21	7.05	6.92	6.79	6.70
4.9	18.57	12.03	11.66	11.26	10.96	10.63	10.36	10.08	9.61	9.20	8.85	8.55	8.28	8.04	7.82	7.65	7.48	7.32	7.18	7.05	6.95

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1½" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	18.94	12.45	12.08	11.67	11.35	11.01	10.73	10.44	9.96	9.54	9.18	8.86	8.58	8.34	8.11	7.93	7.75	7.58	7.45	7.31	7.21
5.1	19.32	12.89	12.50	12.08	11.75	11.40	11.11	10.81	10.31	9.88	9.50	9.17	8.89	8.63	8.40	8.21	8.03	7.86	7.72	7.57	7.47
5.2	19.70	13.33	12.93	12.49	12.15	11.79	11.50	11.18	10.67	10.22	9.83	9.49	9.20	8.94	8.70	8.50	8.31	8.14	7.99	7.84	7.73
5.3	20.08	13.78	13.36	12.91	12.56	12.19	11.89	11.56	11.03	10.57	10.17	9.82	9.52	9.24	9.00	8.80	8.60	8.42	8.26	8.11	8.00
5.4	20.46	14.23	13.80	13.34	12.98	12.59	12.28	11.95	11.40	10.92	10.51	10.15	9.84	9.56	9.30	9.09	8.89	8.70	8.55	8.39	8.27
5.5	20.84	14.69	14.25	13.77	13.40	13.01	12.68	12.34	11.77	11.28	10.86	10.48	10.16	9.87	9.61	9.40	9.19	8.99	8.83	8.67	8.55
5.6	21.22	15.16	14.70	14.21	13.83	13.42	13.09	12.73	12.15	11.65	11.21	10.82	10.49	10.19	9.92	9.70	9.49	9.29	9.12	8.95	8.83
5.7	21.60	15.63	15.16	14.66	14.26	13.84	13.50	13.13	12.54	12.02	11.57	11.17	10.83	10.52	10.24	10.01	9.79	9.59	9.41	9.24	9.11
5.8	21.98	16.11	15.63	15.11	14.70	14.27	13.92	13.54	12.92	12.39	11.93	11.52	11.17	10.85	10.56	10.33	10.10	9.89	9.71	9.53	9.40
5.9	22.35	16.59	16.10	15.56	15.15	14.70	14.34	13.95	13.32	12.77	12.29	11.87	11.51	11.19	10.89	10.65	10.41	10.20	10.01	9.83	9.69
6.0	22.73	17.09	16.58	16.03	15.60	15.14	14.77	14.37	13.72	13.15	12.66	12.23	11.86	11.53	11.22	10.97	10.73	10.51	10.32	10.13	9.99
6.1	23.11	17.58	17.06	16.50	16.06	15.59	15.20	14.80	14.13	13.54	13.04	12.60	12.21	11.87	11.56	11.30	11.05	10.82	10.63	10.44	10.29
6.2	23.49	18.09	17.55	16.97	16.52	16.04	15.64	15.22	14.54	13.94	13.42	12.96	12.57	12.22	11.90	11.64	11.38	11.14	10.94	10.75	10.60
6.3	23.87	18.60	18.05	17.45	16.99	16.49	16.09	15.66	14.95	14.34	13.81	13.34	12.93	12.57	12.24	11.97	11.71	11.47	11.26	11.06	10.91
6.4	24.25	19.11	18.55	17.94	17.46	16.96	16.54	16.10	15.37	14.74	14.20	13.72	13.30	12.93	12.59	12.31	12.05	11.79	11.59	11.38	11.22
6.5	24.63	19.64	19.06	18.43	17.94	17.42	17.00	16.54	15.80	15.15	14.59	14.10	13.67	13.29	12.94	12.66	12.38	12.13	11.91	11.70	11.54
6.6	25.01	20.17	19.57	18.93	18.43	17.89	17.46	16.99	16.23	15.57	14.99	14.49	14.05	13.66	13.30	13.01	12.73	12.46	12.24	12.02	11.86
6.7	25.38	20.70	20.09	19.43	18.92	18.37	17.93	17.45	16.67	15.99	15.40	14.88	14.43	14.03	13.66	13.37	13.07	12.80	12.58	12.35	12.18
6.8	25.76	21.24	20.61	19.94	19.42	18.86	18.40	17.91	17.11	16.41	15.81	15.28	14.82	14.40	14.03	13.72	13.43	13.15	12.92	12.68	12.51
6.9	26.14	21.79	21.15	20.46	19.92	19.35	18.88	18.38	17.55	16.84	16.22	15.68	15.21	14.78	14.40	14.09	13.78	13.50	13.26	13.02	12.84
7.0	26.52	22.34	21.68	20.98	20.43	19.84	19.36	18.85	18.00	17.27	16.64	16.08	15.60	15.17	14.77	14.45	14.14	13.85	13.61	13.36	13.18
7.1	26.90	22.90	22.23	21.51	20.94	20.34	19.85	19.32	18.46	17.71	17.07	16.49	16.00	15.56	15.15	14.83	14.50	14.21	13.96	13.71	13.52
7.2	27.28	23.46	22.78	22.04	21.46	20.85	20.34	19.80	18.92	18.16	17.49	16.91	16.40	15.95	15.54	15.20	14.87	14.57	14.31	14.06	13.87
7.3	27.66	24.03	23.33	22.58	21.99	21.36	20.84	20.29	19.39	18.61	17.93	17.33	16.81	16.35	15.92	15.58	15.25	14.93	14.67	14.41	14.21
7.4	28.04	24.61	23.89	23.12	22.52	21.87	21.35	20.78	19.86	19.06	18.37	17.75	17.22	16.75	16.31	15.97	15.62	15.30	15.03	14.77	14.57
7.5	28.42	25.19	24.46	23.67	23.05	22.40	21.86	21.28	20.34	19.52	18.81	18.18	17.64	17.16	16.71	16.35	16.00	15.67	15.40	15.13	14.92
7.6	28.79	25.78	25.03	24.23	23.60	22.92	22.37	21.78	20.82	19.98	19.26	18.62	18.06	17.57	17.11	16.75	16.39	16.05	15.77	15.49	15.28
7.7	29.17	26.38	25.61	24.79	24.14	23.46	22.89	22.29	21.31	20.45	19.71	19.05	18.49	17.98	17.52	17.14	16.77	16.43	16.15	15.86	15.65
7.8	29.55	26.98	26.20	25.35	24.70	23.99	23.42	22.80	21.80	20.92	20.17	19.50	18.92	18.40	17.93	17.54	17.17	16.82	16.53	16.23	16.01
7.9	29.93	27.58	26.79	25.92	25.25	24.54	23.95	23.32	22.29	21.40	20.63	19.94	19.35	18.82	18.34	17.95	17.56	17.21	16.91	16.61	16.39
8.0	30.31	28.20	27.38	26.50	25.82	25.09	24.49	23.85	22.80	21.88	21.09	20.39	19.79	19.25	18.76	18.36	17.97	17.60	17.29	16.99	16.76

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1½" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	5.68	1.88	1.80	1.71	1.65	1.58	1.52	1.47	1.37	1.29	1.23	1.17	1.12	1.08	1.04	1.01	0.98	0.96	0.94	0.91	0.89
1.6	6.06	2.10	2.01	1.91	1.84	1.76	1.70	1.64	1.53	1.45	1.37	1.31	1.26	1.21	1.17	1.13	1.10	1.07	1.05	1.02	1.00
1.7	6.44	2.32	2.22	2.12	2.04	1.95	1.88	1.81	1.70	1.60	1.52	1.46	1.40	1.34	1.30	1.26	1.22	1.19	1.16	1.14	1.12
1.8	6.82	2.56	2.45	2.33	2.24	2.15	2.08	2.00	1.87	1.77	1.68	1.61	1.54	1.48	1.43	1.39	1.35	1.32	1.29	1.26	1.23
1.9	7.20	2.80	2.68	2.55	2.46	2.35	2.28	2.19	2.06	1.94	1.85	1.76	1.69	1.63	1.57	1.53	1.49	1.45	1.42	1.38	1.36
2.0	7.58	3.05	2.92	2.78	2.68	2.57	2.48	2.39	2.25	2.12	2.02	1.93	1.85	1.78	1.72	1.67	1.63	1.58	1.55	1.51	1.48
2.1	7.96	3.31	3.17	3.02	2.91	2.79	2.70	2.60	2.44	2.31	2.20	2.10	2.01	1.94	1.88	1.82	1.77	1.72	1.69	1.65	1.62
2.2	8.34	3.58	3.43	3.27	3.15	3.02	2.92	2.82	2.65	2.50	2.38	2.28	2.18	2.11	2.03	1.97	1.92	1.87	1.83	1.79	1.76
2.3	8.71	3.86	3.70	3.53	3.40	3.26	3.15	3.04	2.86	2.70	2.57	2.46	2.36	2.28	2.20	2.14	2.08	2.02	1.98	1.94	1.90
2.4	9.09	4.14	3.97	3.79	3.65	3.50	3.39	3.27	3.07	2.91	2.77	2.65	2.54	2.45	2.37	2.30	2.24	2.18	2.14	2.09	2.05
2.5	9.47	4.44	4.26	4.06	3.91	3.76	3.64	3.51	3.30	3.12	2.97	2.84	2.73	2.63	2.55	2.47	2.41	2.34	2.30	2.24	2.20
2.6	9.85	4.74	4.55	4.34	4.19	4.02	3.89	3.75	3.53	3.34	3.18	3.04	2.92	2.82	2.73	2.65	2.58	2.51	2.46	2.40	2.36
2.7	10.23	5.06	4.85	4.63	4.46	4.29	4.15	4.00	3.76	3.56	3.40	3.25	3.12	3.01	2.91	2.83	2.76	2.68	2.63	2.57	2.52
2.8	10.61	5.38	5.16	4.93	4.75	4.56	4.42	4.26	4.01	3.80	3.62	3.46	3.33	3.21	3.11	3.02	2.94	2.86	2.81	2.74	2.69
2.9	10.99	5.71	5.48	5.23	5.04	4.84	4.69	4.53	4.26	4.03	3.85	3.68	3.54	3.41	3.30	3.21	3.13	3.05	2.98	2.92	2.86
3.0	11.37	6.04	5.80	5.54	5.34	5.13	4.97	4.80	4.52	4.28	4.08	3.91	3.75	3.62	3.51	3.41	3.32	3.23	3.17	3.10	3.04
3.1	11.75	6.39	6.13	5.86	5.65	5.43	5.26	5.08	4.78	4.53	4.32	4.14	3.98	3.84	3.71	3.61	3.52	3.43	3.36	3.28	3.22
3.2	12.12	6.74	6.48	6.19	5.97	5.74	5.56	5.36	5.05	4.79	4.57	4.37	4.20	4.06	3.93	3.82	3.72	3.62	3.55	3.47	3.41
3.3	12.50	7.11	6.82	6.52	6.29	6.05	5.86	5.66	5.33	5.05	4.82	4.62	4.44	4.28	4.15	4.03	3.93	3.83	3.75	3.67	3.60
3.4	12.88	7.47	7.18	6.86	6.62	6.37	6.17	5.95	5.61	5.32	5.07	4.86	4.68	4.52	4.37	4.25	4.14	4.03	3.96	3.87	3.80
3.5	13.26	7.85	7.54	7.21	6.96	6.69	6.48	6.26	5.90	5.60	5.34	5.12	4.92	4.75	4.60	4.47	4.36	4.25	4.16	4.07	4.00
3.6	13.64	8.24	7.92	7.57	7.31	7.02	6.81	6.57	6.20	5.88	5.61	5.38	5.17	4.99	4.83	4.70	4.58	4.46	4.38	4.28	4.20
3.7	14.02	8.63	8.29	7.93	7.66	7.36	7.14	6.89	6.50	6.16	5.88	5.64	5.42	5.24	5.07	4.93	4.81	4.69	4.60	4.49	4.41
3.8	14.40	9.03	8.68	8.30	8.02	7.71	7.47	7.22	6.81	6.46	6.16	5.91	5.69	5.49	5.32	5.17	5.04	4.91	4.82	4.71	4.63
3.9	14.78	9.44	9.08	8.68	8.38	8.06	7.82	7.55	7.12	6.76	6.45	6.19	5.95	5.75	5.57	5.41	5.28	5.15	5.05	4.93	4.85
4.0	15.16	9.86	9.48	9.06	8.76	8.42	8.16	7.89	7.44	7.06	6.74	6.47	6.22	6.01	5.82	5.66	5.52	5.38	5.28	5.16	5.07
4.1	15.53	10.28	9.89	9.46	9.14	8.79	8.52	8.23	7.77	7.37	7.04	6.75	6.50	6.28	6.08	5.91	5.77	5.62	5.51	5.39	5.30
4.2	15.91	10.72	10.30	9.86	9.52	9.16	8.88	8.58	8.10	7.69	7.34	7.04	6.78	6.55	6.35	6.17	6.02	5.87	5.76	5.63	5.53
4.3	16.29	11.16	10.73	10.26	9.92	9.54	9.25	8.94	8.44	8.01	7.65	7.34	7.07	6.83	6.62	6.43	6.28	6.12	6.00	5.87	5.77
4.4	16.67	11.60	11.16	10.68	10.32	9.93	9.63	9.31	8.78	8.34	7.97	7.64	7.36	7.11	6.89	6.70	6.54	6.37	6.25	6.11	6.01
4.5	17.05	12.06	11.60	11.10	10.72	10.32	10.01	9.68	9.13	8.68	8.29	7.95	7.66	7.40	7.17	6.97	6.81	6.63	6.51	6.36	6.26
4.6	17.43	12.52	12.04	11.53	11.14	10.72	10.40	10.05	9.49	9.02	8.61	8.27	7.96	7.69	7.45	7.25	7.08	6.90	6.77	6.62	6.51
4.7	17.81	12.99	12.50	11.96	11.56	11.13	10.79	10.44	9.85	9.36	8.95	8.59	8.27	7.99	7.74	7.53	7.35	7.17	7.03	6.88	6.76
4.8	18.19	13.47	12.96	12.40	11.99	11.54	11.20	10.82	10.22	9.71	9.28	8.91	8.58	8.29	8.04	7.82	7.63	7.44	7.30	7.14	7.02
4.9	18.57	13.95	13.42	12.85	12.42	11.96	11.60	11.22	10.60	10.07	9.62	9.24	8.90	8.60	8.34	8.11	7.92	7.72	7.57	7.41	7.28

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1½" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	18.94	14.44	13.90	13.31	12.86	12.39	12.02	11.62	10.98	10.43	9.97	9.57	9.22	8.91	8.64	8.41	8.21	8.00	7.85	7.68	7.55
5.1	19.32	14.94	14.38	13.77	13.31	12.82	12.44	12.03	11.36	10.80	10.32	9.91	9.55	9.23	8.95	8.71	8.50	8.29	8.13	7.96	7.82
5.2	19.70	15.45	14.87	14.24	13.77	13.26	12.86	12.44	11.76	11.17	10.68	10.26	9.88	9.56	9.26	9.01	8.80	8.58	8.42	8.24	8.10
5.3	20.08	15.96	15.36	14.71	14.23	13.70	13.30	12.86	12.15	11.55	11.05	10.61	10.22	9.88	9.58	9.32	9.10	8.88	8.71	8.52	8.38
5.4	20.46	16.48	15.86	15.20	14.70	14.16	13.74	13.29	12.56	11.94	11.42	10.96	10.56	10.22	9.90	9.64	9.41	9.18	9.01	8.81	8.66
5.5	20.84	17.01	16.37	15.68	15.17	14.61	14.18	13.72	12.97	12.33	11.79	11.32	10.91	10.55	10.23	9.96	9.72	9.48	9.31	9.10	8.95
5.6	21.22	17.54	16.89	16.18	15.65	15.08	14.63	14.16	13.38	12.73	12.17	11.69	11.26	10.90	10.56	10.28	10.04	9.79	9.61	9.40	9.25
5.7	21.60	18.08	17.41	16.68	16.14	15.55	15.09	14.60	13.80	13.13	12.56	12.06	11.62	11.24	10.90	10.61	10.36	10.11	9.92	9.70	9.54
5.8	21.98	18.63	17.94	17.19	16.63	16.02	15.56	15.05	14.23	13.53	12.95	12.44	11.98	11.59	11.24	10.94	10.69	10.42	10.23	10.01	9.85
5.9	22.35	19.19	18.48	17.71	17.13	16.51	16.02	15.51	14.66	13.95	13.34	12.82	12.35	11.95	11.59	11.28	11.02	10.75	10.55	10.32	10.15
6.0	22.73	19.75	19.02	18.23	17.64	17.00	16.50	15.97	15.10	14.36	13.74	13.20	12.72	12.31	11.94	11.63	11.35	11.07	10.87	10.64	10.46
6.1	23.11	20.32	19.57	18.76	18.15	17.49	16.98	16.43	15.54	14.79	14.15	13.59	13.10	12.68	12.30	11.97	11.69	11.41	11.20	10.96	10.78
6.2	23.49	20.90	20.13	19.30	18.67	17.99	17.47	16.91	15.99	15.22	14.56	13.99	13.49	13.05	12.66	12.32	12.03	11.74	11.53	11.28	11.09
6.3	23.87	21.48	20.69	19.84	19.20	18.50	17.96	17.39	16.45	15.65	14.98	14.39	13.87	13.43	13.02	12.68	12.38	12.08	11.86	11.61	11.42
6.4	24.25	22.07	21.26	20.39	19.73	19.02	18.46	17.87	16.91	16.09	15.40	14.80	14.27	13.81	13.39	13.04	12.74	12.43	12.20	11.94	11.74
6.5	24.63	22.67	21.84	20.94	20.27	19.54	18.97	18.36	17.37	16.53	15.82	15.21	14.66	14.19	13.77	13.41	13.09	12.78	12.54	12.27	12.07
6.6	25.01	23.27	22.43	21.50	20.81	20.06	19.48	18.86	17.85	16.98	16.26	15.63	15.06	14.58	14.15	13.78	13.45	13.13	12.89	12.61	12.41
6.7	25.38	23.89	23.02	22.07	21.36	20.59	20.00	19.36	18.32	17.44	16.69	16.05	15.47	14.98	14.53	14.15	13.82	13.49	13.24	12.96	12.75
6.8	25.76	24.50	23.61	22.64	21.92	21.13	20.52	19.87	18.81	17.90	17.14	16.47	15.88	15.38	14.92	14.53	14.19	13.85	13.60	13.31	13.09
6.9	26.14	25.13	24.22	23.22	22.48	21.68	21.05	20.38	19.29	18.37	17.58	16.90	16.30	15.78	15.31	14.91	14.56	14.22	13.96	13.66	13.44
7.0	26.52	25.76	24.83	23.81	23.05	22.23	21.59	20.90	19.79	18.84	18.04	17.34	16.72	16.19	15.71	15.30	14.94	14.59	14.32	14.02	13.79
7.1	26.90	26.40	25.44	24.41	23.63	22.78	22.13	21.43	20.29	19.31	18.49	17.78	17.15	16.60	16.11	15.69	15.33	14.96	14.69	14.38	14.15
7.2	27.28	27.04	26.07	25.00	24.21	23.35	22.68	21.96	20.79	19.80	18.96	18.23	17.58	17.02	16.51	16.09	15.71	15.34	15.06	14.74	14.51
7.3	27.66	27.70	26.70	25.61	24.80	23.91	23.23	22.50	21.30	20.28	19.42	18.68	18.01	17.44	16.93	16.49	16.11	15.72	15.44	15.11	14.87
7.4	28.04	28.36	27.33	26.22	25.39	24.49	23.79	23.04	21.82	20.78	19.90	19.13	18.45	17.87	17.34	16.89	16.50	16.11	15.82	15.48	15.24
7.5	28.42	29.02	27.98	26.84	25.99	25.07	24.35	23.59	22.34	21.27	20.37	19.59	18.90	18.30	17.76	17.30	16.90	16.50	16.20	15.86	15.61
7.6	28.79	29.69	28.63	27.47	26.60	25.66	24.93	24.14	22.86	21.78	20.86	20.06	19.35	18.74	18.18	17.72	17.31	16.90	16.59	16.24	15.98
7.7	29.17	30.37	29.28	28.10	27.21	26.25	25.50	24.70	23.39	22.28	21.34	20.53	19.80	19.18	18.61	18.13	17.72	17.30	16.99	16.63	16.36
7.8	29.55	31.06	29.94	28.73	27.83	26.85	26.08	25.26	23.93	22.80	21.84	21.00	20.26	19.62	19.05	18.56	18.13	17.70	17.38	17.02	16.75
7.9	29.93	31.75	30.61	29.38	28.45	27.45	26.67	25.83	24.47	23.31	22.33	21.48	20.73	20.07	19.48	18.98	18.55	18.11	17.78	17.41	17.14
8.0	30.31	32.45	31.29	30.03	29.08	28.06	27.26	26.41	25.02	23.84	22.84	21.97	21.19	20.53	19.93	19.42	18.97	18.52	18.19	17.81	17.53

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1½" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	5.68	2.17	2.06	1.95	1.87	1.79	1.72	1.65	1.53	1.44	1.36	1.29	1.23	1.18	1.13	1.09	1.06	1.02	0.99	0.97	0.95
1.6	6.06	2.41	2.30	2.18	2.09	1.99	1.91	1.84	1.71	1.60	1.51	1.44	1.37	1.31	1.26	1.22	1.18	1.14	1.11	1.09	1.06
1.7	6.44	2.66	2.54	2.41	2.31	2.20	2.12	2.03	1.89	1.78	1.68	1.60	1.52	1.46	1.40	1.35	1.31	1.27	1.24	1.21	1.18
1.8	6.82	2.93	2.79	2.65	2.54	2.42	2.34	2.24	2.09	1.96	1.85	1.76	1.68	1.61	1.55	1.50	1.45	1.41	1.37	1.33	1.30
1.9	7.20	3.20	3.05	2.90	2.78	2.65	2.56	2.45	2.29	2.15	2.03	1.93	1.84	1.77	1.70	1.64	1.59	1.54	1.50	1.47	1.43
2.0	7.58	3.49	3.33	3.16	3.03	2.89	2.79	2.68	2.50	2.35	2.22	2.11	2.02	1.93	1.86	1.80	1.74	1.69	1.64	1.60	1.57
2.1	7.96	3.78	3.61	3.43	3.29	3.14	3.03	2.91	2.72	2.55	2.41	2.30	2.19	2.10	2.03	1.96	1.90	1.84	1.79	1.75	1.71
2.2	8.34	4.08	3.90	3.71	3.56	3.40	3.28	3.15	2.94	2.76	2.61	2.49	2.38	2.28	2.20	2.12	2.06	2.00	1.94	1.90	1.85
2.3	8.71	4.40	4.20	3.99	3.83	3.67	3.53	3.40	3.17	2.98	2.82	2.69	2.57	2.46	2.37	2.29	2.22	2.16	2.10	2.05	2.00
2.4	9.09	4.72	4.51	4.29	4.12	3.94	3.80	3.65	3.41	3.21	3.04	2.89	2.76	2.65	2.56	2.47	2.40	2.33	2.26	2.21	2.16
2.5	9.47	5.06	4.83	4.59	4.41	4.22	4.07	3.91	3.66	3.44	3.26	3.10	2.97	2.85	2.75	2.65	2.57	2.50	2.43	2.38	2.32
2.6	9.85	5.40	5.16	4.91	4.72	4.51	4.35	4.18	3.91	3.68	3.49	3.32	3.18	3.05	2.94	2.84	2.76	2.68	2.61	2.55	2.49
2.7	10.23	5.75	5.50	5.23	5.03	4.81	4.64	4.46	4.17	3.93	3.72	3.55	3.39	3.26	3.14	3.04	2.95	2.86	2.78	2.72	2.66
2.8	10.61	6.11	5.85	5.56	5.35	5.12	4.94	4.75	4.44	4.18	3.96	3.78	3.61	3.47	3.35	3.24	3.14	3.05	2.97	2.90	2.83
2.9	10.99	6.48	6.20	5.90	5.67	5.43	5.24	5.04	4.72	4.44	4.21	4.01	3.84	3.69	3.56	3.44	3.34	3.24	3.16	3.09	3.02
3.0	11.37	6.86	6.57	6.25	6.01	5.75	5.56	5.34	5.00	4.71	4.47	4.26	4.08	3.92	3.78	3.65	3.55	3.44	3.35	3.28	3.20
3.1	11.75	7.25	6.94	6.61	6.35	6.08	5.88	5.65	5.29	4.99	4.73	4.51	4.32	4.15	4.00	3.87	3.76	3.65	3.55	3.47	3.39
3.2	12.12	7.65	7.32	6.97	6.71	6.42	6.20	5.97	5.59	5.27	5.00	4.76	4.56	4.38	4.23	4.09	3.97	3.86	3.76	3.67	3.59
3.3	12.50	8.05	7.71	7.34	7.07	6.77	6.54	6.29	5.89	5.56	5.27	5.03	4.81	4.63	4.46	4.32	4.19	4.07	3.97	3.88	3.79
3.4	12.88	8.47	8.11	7.73	7.43	7.12	6.88	6.62	6.20	5.85	5.55	5.29	5.07	4.88	4.70	4.55	4.42	4.29	4.18	4.09	4.00
3.5	13.26	8.89	8.52	8.11	7.81	7.48	7.23	6.96	6.52	6.15	5.84	5.57	5.33	5.13	4.95	4.79	4.65	4.52	4.40	4.30	4.21
3.6	13.64	9.33	8.94	8.51	8.19	7.85	7.59	7.30	6.85	6.46	6.13	5.85	5.60	5.39	5.20	5.03	4.89	4.75	4.63	4.52	4.42
3.7	14.02	9.77	9.36	8.92	8.59	8.23	7.95	7.65	7.18	6.77	6.43	6.13	5.88	5.65	5.46	5.28	5.13	4.98	4.86	4.75	4.64
3.8	14.40	10.22	9.79	9.33	8.99	8.61	8.32	8.01	7.52	7.09	6.73	6.43	6.16	5.92	5.72	5.54	5.38	5.23	5.09	4.98	4.87
3.9	14.78	10.68	10.23	9.75	9.39	9.00	8.70	8.38	7.86	7.42	7.05	6.73	6.45	6.20	5.98	5.79	5.63	5.47	5.33	5.21	5.10
4.0	15.16	11.14	10.68	10.18	9.81	9.40	9.09	8.75	8.21	7.75	7.36	7.03	6.74	6.48	6.26	6.06	5.88	5.72	5.57	5.45	5.33
4.1	15.53	11.62	11.14	10.62	10.23	9.81	9.48	9.13	8.57	8.09	7.69	7.34	7.03	6.77	6.53	6.33	6.15	5.98	5.82	5.70	5.57
4.2	15.91	12.10	11.61	11.07	10.66	10.22	9.88	9.52	8.94	8.44	8.02	7.65	7.34	7.06	6.82	6.60	6.41	6.24	6.08	5.94	5.81
4.3	16.29	12.60	12.08	11.52	11.10	10.64	10.29	9.91	9.31	8.79	8.35	7.98	7.65	7.36	7.11	6.88	6.69	6.50	6.34	6.20	6.06
4.4	16.67	13.10	12.56	11.98	11.54	11.07	10.71	10.32	9.69	9.15	8.69	8.30	7.96	7.66	7.40	7.17	6.96	6.77	6.60	6.46	6.32
4.5	17.05	13.61	13.05	12.45	12.00	11.51	11.13	10.72	10.07	9.51	9.04	8.64	8.28	7.97	7.70	7.46	7.25	7.05	6.87	6.72	6.57
4.6	17.43	14.12	13.55	12.92	12.46	11.95	11.56	11.14	10.46	9.88	9.40	8.97	8.61	8.29	8.00	7.75	7.53	7.33	7.14	6.99	6.84
4.7	17.81	14.65	14.05	13.41	12.92	12.40	11.99	11.56	10.86	10.26	9.75	9.32	8.94	8.61	8.31	8.05	7.83	7.61	7.42	7.26	7.10
4.8	18.19	15.18	14.57	13.90	13.40	12.86	12.44	11.99	11.26	10.64	10.12	9.67	9.28	8.93	8.63	8.36	8.12	7.90	7.70	7.54	7.37
4.9	18.57	15.72	15.09	14.40	13.88	13.32	12.89	12.42	11.67	11.03	10.49	10.02	9.62	9.26	8.95	8.67	8.42	8.20	7.99	7.82	7.65

Continued on next page

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1½" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	18.94	16.27	15.62	14.90	14.37	13.79	13.34	12.86	12.09	11.43	10.87	10.39	9.96	9.60	9.27	8.98	8.73	8.49	8.28	8.10	7.93
5.1	19.32	16.83	16.15	15.42	14.87	14.27	13.81	13.31	12.51	11.83	11.25	10.75	10.32	9.94	9.60	9.30	9.04	8.80	8.58	8.39	8.21
5.2	19.70	17.39	16.70	15.94	15.37	14.75	14.28	13.77	12.94	12.24	11.64	11.13	10.68	10.28	9.94	9.63	9.36	9.11	8.88	8.69	8.50
5.3	20.08	17.97	17.25	16.47	15.88	15.25	14.75	14.23	13.38	12.65	12.03	11.50	11.04	10.63	10.28	9.96	9.68	9.42	9.19	8.99	8.80
5.4	20.46	18.55	17.81	17.00	16.40	15.74	15.24	14.69	13.82	13.07	12.43	11.89	11.41	10.99	10.62	10.29	10.01	9.74	9.50	9.29	9.09
5.5	20.84	19.14	18.37	17.55	16.92	16.25	15.73	15.17	14.26	13.49	12.84	12.28	11.78	11.35	10.97	10.63	10.34	10.06	9.81	9.60	9.40
5.6	21.22	19.73	18.95	18.10	17.46	16.76	16.23	15.65	14.72	13.92	13.25	12.67	12.16	11.72	11.33	10.98	10.67	10.39	10.13	9.91	9.70
5.7	21.60	20.34	19.53	18.66	18.00	17.28	16.73	16.14	15.18	14.36	13.67	13.07	12.55	12.09	11.69	11.33	11.02	10.72	10.45	10.23	10.02
5.8	21.98	20.95	20.12	19.22	18.54	17.81	17.24	16.63	15.65	14.80	14.09	13.48	12.94	12.47	12.05	11.68	11.36	11.06	10.78	10.55	10.33
5.9	22.35	21.57	20.72	19.79	19.10	18.34	17.76	17.13	16.12	15.25	14.52	13.89	13.33	12.85	12.42	12.04	11.71	11.40	11.12	10.88	10.65
6.0	22.73	22.20	21.32	20.37	19.66	18.88	18.28	17.64	16.60	15.71	14.95	14.30	13.73	13.24	12.80	12.41	12.07	11.74	11.45	11.21	10.98
6.1	23.11	22.83	21.94	20.96	20.22	19.43	18.81	18.15	17.08	16.17	15.39	14.72	14.14	13.63	13.17	12.78	12.42	12.09	11.80	11.55	11.30
6.2	23.49	23.48	22.56	21.55	20.80	19.98	19.35	18.67	17.57	16.63	15.84	15.15	14.55	14.03	13.56	13.15	12.79	12.45	12.14	11.89	11.64
6.3	23.87	24.13	23.18	22.15	21.38	20.54	19.89	19.20	18.07	17.11	16.29	15.58	14.97	14.43	13.95	13.53	13.16	12.81	12.49	12.23	11.97
6.4	24.25	24.79	23.82	22.76	21.97	21.11	20.44	19.73	18.57	17.58	16.74	16.02	15.39	14.84	14.34	13.91	13.53	13.17	12.85	12.58	12.32
6.5	24.63	25.45	24.46	23.38	22.56	21.68	21.00	20.27	19.08	18.07	17.21	16.46	15.82	15.25	14.74	14.30	13.91	13.54	13.21	12.93	12.66
6.6	25.01	26.13	25.11	24.00	23.17	22.26	21.56	20.81	19.59	18.56	17.67	16.91	16.25	15.66	15.15	14.69	14.29	13.91	13.58	13.29	13.01
6.7	25.38	26.81	25.76	24.63	23.77	22.85	22.13	21.36	20.12	19.05	18.15	17.37	16.68	16.09	15.56	15.09	14.68	14.29	13.94	13.65	13.37
6.8	25.76	27.50	26.43	25.27	24.39	23.44	22.71	21.92	20.64	19.55	18.62	17.83	17.13	16.51	15.97	15.49	15.07	14.67	14.32	14.02	13.73
6.9	26.14	28.19	27.10	25.91	25.01	24.04	23.29	22.48	21.18	20.06	19.11	18.29	17.57	16.95	16.39	15.90	15.47	15.06	14.70	14.39	14.09
7.0	26.52	28.89	27.78	26.56	25.64	24.65	23.88	23.05	21.71	20.57	19.60	18.76	18.03	17.38	16.81	16.31	15.87	15.45	15.08	14.76	14.46
7.1	26.90	29.60	28.46	27.22	26.28	25.26	24.48	23.63	22.26	21.09	20.09	19.23	18.48	17.83	17.24	16.73	16.27	15.85	15.46	15.14	14.83
7.2	27.28	30.32	29.15	27.88	26.92	25.88	25.08	24.21	22.81	21.61	20.59	19.71	18.94	18.27	17.67	17.15	16.68	16.25	15.86	15.53	15.20
7.3	27.66	31.05	29.85	28.55	27.57	26.51	25.68	24.80	23.36	22.14	21.10	20.20	19.41	18.72	18.11	17.57	17.10	16.65	16.25	15.91	15.58
7.4	28.04	31.78	30.56	29.23	28.23	27.14	26.30	25.39	23.93	22.67	21.61	20.69	19.88	19.18	18.55	18.00	17.52	17.06	16.65	16.30	15.97
7.5	28.42	32.52	31.27	29.91	28.89	27.78	26.92	25.99	24.49	23.21	22.13	21.19	20.36	19.64	19.00	18.44	17.94	17.47	17.05	16.70	16.36
7.6	28.79	33.27	31.99	30.60	29.56	28.42	27.55	26.60	25.07	23.76	22.65	21.69	20.84	20.11	19.45	18.88	18.37	17.89	17.46	17.10	16.75
7.7	29.17	34.02	32.72	31.30	30.23	29.08	28.18	27.21	25.65	24.31	23.17	22.19	21.33	20.58	19.91	19.32	18.80	18.31	17.88	17.51	17.15
7.8	29.55	34.79	33.45	32.01	30.92	29.73	28.82	27.83	26.23	24.87	23.71	22.70	21.82	21.06	20.37	19.77	19.24	18.74	18.29	17.91	17.55
7.9	29.93	35.55	34.20	32.72	31.61	30.40	29.46	28.45	26.82	25.43	24.24	23.22	22.32	21.54	20.84	20.22	19.68	19.17	18.71	18.33	17.95
8.0	30.31	36.33	34.95	33.44	32.30	31.07	30.11	29.08	27.42	26.00	24.79	23.74	22.82	22.02	21.31	20.68	20.13	19.61	19.14	18.75	18.36

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	9.75	0.80	0.76	0.72	0.71	0.70	0.68	0.67	0.65	0.63	0.62	0.60	0.59	0.58	0.57	0.56	0.55	0.54	0.53	0.52	0.52
1.6	10.39	0.90	0.86	0.81	0.79	0.78	0.77	0.75	0.73	0.71	0.69	0.68	0.66	0.65	0.64	0.62	0.61	0.60	0.60	0.59	0.58
1.7	11.04	1.00	0.95	0.90	0.88	0.87	0.85	0.84	0.81	0.79	0.77	0.75	0.74	0.72	0.71	0.70	0.68	0.67	0.66	0.66	0.65
1.8	11.69	1.10	1.05	0.99	0.98	0.96	0.94	0.93	0.90	0.87	0.85	0.83	0.81	0.80	0.78	0.77	0.76	0.75	0.74	0.73	0.72
1.9	12.34	1.21	1.15	1.09	1.07	1.05	1.04	1.02	0.99	0.96	0.94	0.92	0.90	0.88	0.86	0.85	0.83	0.82	0.81	0.80	0.79
2.0	12.99	1.32	1.26	1.20	1.17	1.15	1.13	1.11	1.08	1.05	1.03	1.00	0.98	0.96	0.95	0.93	0.91	0.90	0.89	0.88	0.87
2.1	13.64	1.44	1.38	1.30	1.28	1.26	1.24	1.22	1.18	1.15	1.12	1.09	1.07	1.05	1.03	1.01	1.00	0.98	0.97	0.96	0.94
2.2	14.29	1.56	1.49	1.41	1.39	1.36	1.34	1.32	1.28	1.25	1.22	1.19	1.16	1.14	1.12	1.10	1.08	1.07	1.05	1.04	1.03
2.3	14.94	1.69	1.61	1.53	1.50	1.47	1.45	1.43	1.39	1.35	1.32	1.29	1.26	1.23	1.21	1.19	1.17	1.16	1.14	1.13	1.11
2.4	15.59	1.82	1.74	1.65	1.62	1.59	1.56	1.54	1.49	1.45	1.42	1.39	1.36	1.33	1.31	1.29	1.27	1.25	1.23	1.21	1.20
2.5	16.24	1.95	1.87	1.77	1.74	1.71	1.68	1.65	1.61	1.56	1.53	1.49	1.46	1.43	1.41	1.38	1.36	1.34	1.32	1.31	1.29
2.6	16.89	2.09	2.00	1.90	1.86	1.83	1.80	1.77	1.72	1.68	1.64	1.60	1.57	1.54	1.51	1.48	1.46	1.44	1.42	1.40	1.38
2.7	17.54	2.23	2.14	2.03	1.99	1.96	1.93	1.89	1.84	1.79	1.75	1.71	1.68	1.64	1.61	1.59	1.56	1.54	1.52	1.50	1.48
2.8	18.19	2.38	2.28	2.16	2.12	2.09	2.05	2.02	1.96	1.91	1.87	1.82	1.79	1.75	1.72	1.69	1.67	1.64	1.62	1.60	1.58
2.9	18.84	2.53	2.42	2.30	2.26	2.22	2.19	2.15	2.09	2.03	1.99	1.94	1.90	1.87	1.83	1.80	1.78	1.75	1.73	1.71	1.68
3.0	19.49	2.69	2.57	2.44	2.40	2.36	2.32	2.28	2.22	2.16	2.11	2.06	2.02	1.98	1.95	1.92	1.89	1.86	1.84	1.81	1.79
3.1	20.14	2.85	2.72	2.59	2.54	2.50	2.46	2.42	2.35	2.29	2.24	2.19	2.14	2.10	2.07	2.03	2.00	1.97	1.95	1.92	1.90
3.2	20.79	3.01	2.88	2.74	2.69	2.64	2.60	2.56	2.49	2.42	2.37	2.32	2.27	2.23	2.19	2.15	2.12	2.09	2.06	2.04	2.01
3.3	21.44	3.18	3.04	2.89	2.84	2.79	2.75	2.70	2.63	2.56	2.50	2.45	2.40	2.35	2.31	2.27	2.24	2.21	2.18	2.15	2.13
3.4	22.09	3.35	3.21	3.05	2.99	2.94	2.90	2.85	2.77	2.70	2.64	2.58	2.53	2.48	2.44	2.40	2.36	2.33	2.30	2.27	2.24
3.5	22.74	3.52	3.37	3.21	3.15	3.10	3.05	3.00	2.92	2.84	2.78	2.72	2.66	2.61	2.57	2.53	2.49	2.45	2.42	2.39	2.36
3.6	23.39	3.70	3.55	3.37	3.31	3.25	3.21	3.16	3.07	2.99	2.92	2.86	2.80	2.75	2.70	2.66	2.62	2.58	2.55	2.52	2.49
3.7	24.04	3.88	3.72	3.54	3.48	3.42	3.37	3.31	3.22	3.14	3.07	3.00	2.94	2.89	2.84	2.79	2.75	2.71	2.68	2.64	2.61
3.8	24.69	4.07	3.90	3.71	3.65	3.58	3.53	3.47	3.38	3.29	3.22	3.15	3.09	3.03	2.98	2.93	2.89	2.85	2.81	2.77	2.74
3.9	25.34	4.26	4.08	3.88	3.82	3.75	3.70	3.64	3.54	3.45	3.37	3.30	3.23	3.17	3.12	3.07	3.02	2.98	2.94	2.91	2.87
4.0	25.99	4.46	4.27	4.06	3.99	3.92	3.87	3.81	3.70	3.61	3.52	3.45	3.38	3.32	3.26	3.21	3.17	3.12	3.08	3.04	3.01
4.1	26.64	4.65	4.46	4.24	4.17	4.10	4.04	3.98	3.87	3.77	3.68	3.61	3.54	3.47	3.41	3.36	3.31	3.26	3.22	3.18	3.14
4.2	27.29	4.86	4.66	4.43	4.36	4.28	4.22	4.15	4.04	3.94	3.85	3.77	3.69	3.62	3.56	3.51	3.46	3.41	3.36	3.32	3.28
4.3	27.94	5.06	4.85	4.62	4.54	4.46	4.40	4.33	4.21	4.11	4.01	3.93	3.85	3.78	3.72	3.66	3.61	3.55	3.51	3.47	3.43
4.4	28.59	5.27	5.06	4.81	4.73	4.65	4.58	4.51	4.39	4.28	4.18	4.09	4.01	3.94	3.87	3.81	3.76	3.70	3.66	3.61	3.57
4.5	29.24	5.48	5.26	5.01	4.92	4.84	4.77	4.69	4.57	4.45	4.35	4.26	4.18	4.10	4.03	3.97	3.91	3.86	3.81	3.76	3.72
4.6	29.89	5.70	5.47	5.20	5.12	5.03	4.96	4.88	4.75	4.63	4.53	4.43	4.35	4.27	4.20	4.13	4.07	4.01	3.96	3.92	3.87
4.7	30.54	5.92	5.68	5.41	5.32	5.23	5.15	5.07	4.93	4.81	4.70	4.61	4.52	4.44	4.36	4.29	4.23	4.17	4.12	4.07	4.02
4.8	31.18	6.15	5.90	5.61	5.52	5.43	5.35	5.27	5.12	5.00	4.88	4.78	4.69	4.61	4.53	4.46	4.40	4.33	4.28	4.23	4.18
4.9	31.83	6.37	6.12	5.82	5.73	5.63	5.55	5.46	5.32	5.19	5.07	4.96	4.87	4.78	4.70	4.63	4.56	4.50	4.44	4.39	4.34

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	32.48	6.61	6.34	6.04	5.94	5.84	5.75	5.66	5.51	5.38	5.26	5.15	5.05	4.96	4.88	4.80	4.73	4.67	4.61	4.55	4.50
5.1	33.13	6.84	6.57	6.25	6.15	6.05	5.96	5.87	5.71	5.57	5.45	5.33	5.23	5.14	5.05	4.97	4.90	4.84	4.78	4.72	4.67
5.2	33.78	7.08	6.80	6.47	6.37	6.26	6.17	6.07	5.91	5.77	5.64	5.52	5.42	5.32	5.23	5.15	5.08	5.01	4.95	4.89	4.83
5.3	34.43	7.32	7.03	6.69	6.59	6.48	6.38	6.28	6.12	5.97	5.83	5.71	5.61	5.51	5.42	5.33	5.26	5.18	5.12	5.06	5.00
5.4	35.08	7.57	7.27	6.92	6.81	6.69	6.60	6.50	6.32	6.17	6.03	5.91	5.80	5.69	5.60	5.52	5.44	5.36	5.29	5.23	5.17
5.5	35.73	7.82	7.51	7.15	7.04	6.92	6.82	6.71	6.54	6.38	6.24	6.11	5.99	5.89	5.79	5.70	5.62	5.54	5.47	5.41	5.35
5.6	36.38	8.07	7.75	7.38	7.27	7.14	7.04	6.93	6.75	6.59	6.44	6.31	6.19	6.08	5.98	5.89	5.81	5.73	5.65	5.59	5.53
5.7	37.03	8.33	8.00	7.62	7.50	7.37	7.27	7.16	6.97	6.80	6.65	6.51	6.39	6.28	6.17	6.08	5.99	5.91	5.84	5.77	5.71
5.8	37.68	8.59	8.25	7.86	7.74	7.60	7.50	7.38	7.19	7.01	6.86	6.72	6.59	6.48	6.37	6.27	6.19	6.10	6.03	5.96	5.89
5.9	38.33	8.86	8.50	8.10	7.98	7.84	7.73	7.61	7.41	7.23	7.07	6.93	6.80	6.68	6.57	6.47	6.38	6.29	6.22	6.14	6.07
6.0	38.98	9.12	8.76	8.35	8.22	8.08	7.97	7.85	7.64	7.45	7.29	7.14	7.01	6.88	6.77	6.67	6.58	6.49	6.41	6.33	6.26
6.1	39.63	9.39	9.02	8.60	8.46	8.32	8.20	8.08	7.87	7.68	7.51	7.36	7.22	7.09	6.98	6.87	6.78	6.68	6.60	6.52	6.45
6.2	40.28	9.67	9.29	8.85	8.71	8.57	8.45	8.32	8.10	7.91	7.73	7.58	7.43	7.30	7.19	7.08	6.98	6.88	6.80	6.72	6.65
6.3	40.93	9.95	9.56	9.11	8.97	8.82	8.69	8.56	8.34	8.14	7.96	7.80	7.65	7.52	7.40	7.29	7.18	7.09	7.00	6.92	6.84
6.4	41.58	10.23	9.83	9.37	9.22	9.07	8.94	8.81	8.57	8.37	8.19	8.02	7.87	7.73	7.61	7.50	7.39	7.29	7.20	7.12	7.04
6.5	42.23	10.51	10.10	9.63	9.48	9.32	9.19	9.05	8.82	8.61	8.42	8.25	8.09	7.95	7.83	7.71	7.60	7.50	7.41	7.32	7.24
6.6	42.88	10.80	10.38	9.90	9.74	9.58	9.45	9.30	9.06	8.85	8.65	8.48	8.32	8.18	8.05	7.92	7.81	7.71	7.61	7.53	7.44
6.7	43.53	11.10	10.66	10.17	10.01	9.84	9.70	9.56	9.31	9.09	8.89	8.71	8.55	8.40	8.27	8.14	8.03	7.92	7.83	7.74	7.65
6.8	44.18	11.39	10.95	10.44	10.28	10.10	9.96	9.82	9.56	9.33	9.13	8.95	8.78	8.63	8.49	8.36	8.25	8.14	8.04	7.95	7.86
6.9	44.83	11.69	11.23	10.71	10.55	10.37	10.23	10.08	9.81	9.58	9.37	9.19	9.01	8.86	8.72	8.59	8.47	8.36	8.25	8.16	8.07
7.0	45.48	11.99	11.53	10.99	10.82	10.64	10.49	10.34	10.07	9.83	9.62	9.43	9.25	9.09	8.95	8.81	8.69	8.58	8.47	8.38	8.28
7.1	46.13	12.30	11.82	11.27	11.10	10.92	10.76	10.60	10.33	10.09	9.87	9.67	9.49	9.33	9.18	9.04	8.92	8.80	8.69	8.59	8.50
7.2	46.78	12.61	12.12	11.56	11.38	11.19	11.04	10.87	10.59	10.34	10.12	9.92	9.73	9.57	9.42	9.28	9.15	9.03	8.92	8.81	8.72
7.3	47.43	12.92	12.42	11.85	11.67	11.47	11.31	11.15	10.86	10.60	10.37	10.17	9.98	9.81	9.65	9.51	9.38	9.25	9.14	9.04	8.94
7.4	48.08	13.24	12.73	12.14	11.95	11.76	11.59	11.42	11.13	10.87	10.63	10.42	10.23	10.05	9.89	9.75	9.61	9.49	9.37	9.26	9.16
7.5	48.73	13.56	13.03	12.43	12.24	12.04	11.87	11.70	11.40	11.13	10.89	10.68	10.48	10.30	10.14	9.99	9.85	9.72	9.60	9.49	9.39
7.6	49.38	13.88	13.35	12.73	12.54	12.33	12.16	11.98	11.67	11.40	11.15	10.93	10.73	10.55	10.38	10.23	10.09	9.96	9.84	9.72	9.62
7.7	50.03	14.21	13.66	13.03	12.83	12.62	12.45	12.27	11.95	11.67	11.42	11.19	10.99	10.80	10.63	10.47	10.33	10.20	10.07	9.96	9.85
7.8	50.68	14.54	13.98	13.34	13.13	12.92	12.74	12.55	12.23	11.95	11.69	11.46	11.25	11.06	10.88	10.72	10.58	10.44	10.31	10.19	10.09
7.9	51.33	14.87	14.30	13.64	13.44	13.22	13.03	12.84	12.51	12.22	11.96	11.72	11.51	11.32	11.14	10.97	10.82	10.68	10.55	10.43	10.32
8.0	51.97	15.21	14.62	13.95	13.74	13.52	13.33	13.14	12.80	12.50	12.23	11.99	11.77	11.58	11.39	11.23	11.07	10.93	10.80	10.68	10.56

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	9.75	1.12	1.08	1.04	1.01	0.97	0.95	0.92	0.87	0.83	0.79	0.76	0.74	0.71	0.69	0.68	0.66	0.64	0.63	0.62	0.61
1.6	10.39	1.25	1.20	1.16	1.12	1.09	1.06	1.02	0.97	0.93	0.89	0.85	0.83	0.80	0.78	0.76	0.74	0.72	0.71	0.69	0.68
1.7	11.04	1.38	1.34	1.29	1.25	1.21	1.17	1.14	1.08	1.03	0.99	0.95	0.92	0.89	0.86	0.84	0.82	0.80	0.79	0.77	0.76
1.8	11.69	1.52	1.47	1.42	1.38	1.33	1.29	1.26	1.19	1.14	1.09	1.05	1.01	0.98	0.95	0.93	0.91	0.89	0.87	0.85	0.84
1.9	12.34	1.67	1.61	1.56	1.51	1.46	1.42	1.38	1.31	1.25	1.20	1.15	1.12	1.08	1.05	1.02	1.00	0.98	0.96	0.94	0.92
2.0	12.99	1.82	1.76	1.70	1.65	1.60	1.55	1.51	1.43	1.37	1.31	1.26	1.22	1.18	1.15	1.12	1.09	1.07	1.05	1.03	1.01
2.1	13.64	1.98	1.92	1.85	1.79	1.74	1.69	1.64	1.56	1.49	1.43	1.38	1.33	1.29	1.25	1.22	1.19	1.17	1.14	1.12	1.10
2.2	14.29	2.15	2.08	2.00	1.94	1.88	1.83	1.78	1.69	1.61	1.55	1.49	1.44	1.40	1.36	1.33	1.30	1.27	1.24	1.22	1.20
2.3	14.94	2.32	2.24	2.16	2.10	2.03	1.98	1.92	1.83	1.75	1.68	1.61	1.56	1.51	1.47	1.44	1.40	1.37	1.34	1.32	1.30
2.4	15.59	2.49	2.41	2.33	2.26	2.19	2.13	2.07	1.97	1.88	1.80	1.74	1.68	1.63	1.58	1.55	1.51	1.48	1.45	1.42	1.40
2.5	16.24	2.67	2.59	2.49	2.42	2.35	2.29	2.22	2.11	2.02	1.94	1.87	1.81	1.75	1.70	1.66	1.62	1.59	1.56	1.53	1.51
2.6	16.89	2.86	2.77	2.67	2.59	2.51	2.45	2.38	2.26	2.16	2.08	2.00	1.94	1.88	1.83	1.78	1.74	1.70	1.67	1.64	1.61
2.7	17.54	3.05	2.95	2.85	2.77	2.68	2.61	2.54	2.42	2.31	2.22	2.14	2.07	2.01	1.95	1.91	1.86	1.82	1.79	1.75	1.73
2.8	18.19	3.25	3.14	3.03	2.95	2.86	2.78	2.70	2.57	2.46	2.37	2.28	2.21	2.14	2.08	2.03	1.99	1.94	1.91	1.87	1.84
2.9	18.84	3.45	3.34	3.22	3.13	3.04	2.96	2.87	2.74	2.62	2.52	2.43	2.35	2.28	2.22	2.16	2.11	2.07	2.03	1.99	1.96
3.0	19.49	3.66	3.54	3.42	3.32	3.22	3.14	3.05	2.90	2.78	2.67	2.58	2.49	2.42	2.35	2.30	2.25	2.20	2.15	2.11	2.08
3.1	20.14	3.87	3.75	3.62	3.52	3.41	3.32	3.23	3.08	2.94	2.83	2.73	2.64	2.56	2.49	2.44	2.38	2.33	2.28	2.24	2.21
3.2	20.79	4.09	3.96	3.82	3.72	3.60	3.51	3.41	3.25	3.11	2.99	2.89	2.79	2.71	2.64	2.58	2.52	2.46	2.42	2.37	2.34
3.3	21.44	4.31	4.18	4.03	3.92	3.80	3.70	3.60	3.43	3.29	3.16	3.05	2.95	2.86	2.79	2.72	2.66	2.60	2.55	2.51	2.47
3.4	22.09	4.54	4.40	4.25	4.13	4.00	3.90	3.79	3.62	3.46	3.33	3.21	3.11	3.02	2.94	2.87	2.81	2.74	2.69	2.64	2.60
3.5	22.74	4.77	4.62	4.47	4.34	4.21	4.11	3.99	3.80	3.64	3.50	3.38	3.27	3.18	3.09	3.02	2.95	2.89	2.84	2.78	2.74
3.6	23.39	5.01	4.85	4.69	4.56	4.42	4.31	4.19	4.00	3.83	3.68	3.55	3.44	3.34	3.25	3.18	3.11	3.04	2.98	2.93	2.89
3.7	24.04	5.25	5.09	4.92	4.78	4.64	4.52	4.40	4.19	4.02	3.86	3.73	3.61	3.51	3.41	3.34	3.26	3.19	3.13	3.07	3.03
3.8	24.69	5.50	5.33	5.15	5.01	4.86	4.74	4.61	4.40	4.21	4.05	3.91	3.79	3.68	3.58	3.50	3.42	3.35	3.29	3.22	3.18
3.9	25.34	5.75	5.58	5.39	5.24	5.09	4.96	4.82	4.60	4.41	4.24	4.09	3.97	3.85	3.75	3.66	3.58	3.50	3.44	3.38	3.33
4.0	25.99	6.01	5.83	5.63	5.48	5.32	5.18	5.04	4.81	4.61	4.43	4.28	4.15	4.03	3.92	3.83	3.75	3.67	3.60	3.53	3.48
4.1	26.64	6.27	6.08	5.88	5.72	5.55	5.41	5.26	5.02	4.81	4.63	4.47	4.33	4.21	4.10	4.01	3.92	3.83	3.76	3.69	3.64
4.2	27.29	6.54	6.34	6.13	5.97	5.79	5.65	5.49	5.24	5.02	4.83	4.67	4.52	4.39	4.28	4.18	4.09	4.00	3.93	3.86	3.80
4.3	27.94	6.81	6.61	6.39	6.22	6.03	5.88	5.72	5.46	5.23	5.04	4.86	4.72	4.58	4.46	4.36	4.26	4.17	4.10	4.02	3.97
4.4	28.59	7.09	6.88	6.65	6.47	6.28	6.12	5.96	5.69	5.45	5.25	5.07	4.91	4.77	4.65	4.54	4.44	4.35	4.27	4.19	4.13
4.5	29.24	7.37	7.15	6.91	6.73	6.53	6.37	6.20	5.92	5.67	5.46	5.27	5.11	4.97	4.83	4.73	4.62	4.53	4.45	4.36	4.30
4.6	29.89	7.66	7.43	7.18	6.99	6.79	6.62	6.44	6.15	5.90	5.68	5.48	5.32	5.17	5.03	4.92	4.81	4.71	4.62	4.54	4.48
4.7	30.54	7.95	7.71	7.46	7.26	7.05	6.88	6.69	6.39	6.12	5.90	5.70	5.52	5.37	5.22	5.11	5.00	4.89	4.81	4.72	4.65
4.8	31.18	8.25	8.00	7.74	7.53	7.31	7.13	6.94	6.63	6.36	6.12	5.91	5.73	5.57	5.42	5.31	5.19	5.08	4.99	4.90	4.83
4.9	31.83	8.55	8.30	8.02	7.81	7.58	7.40	7.20	6.87	6.59	6.35	6.13	5.95	5.78	5.63	5.50	5.38	5.27	5.18	5.08	5.01

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	32.48	8.85	8.59	8.31	8.09	7.86	7.66	7.46	7.12	6.83	6.58	6.36	6.16	5.99	5.83	5.71	5.58	5.47	5.37	5.27	5.20
5.1	33.13	9.16	8.89	8.60	8.38	8.13	7.94	7.72	7.38	7.08	6.81	6.58	6.39	6.21	6.04	5.91	5.78	5.66	5.56	5.46	5.39
5.2	33.78	9.48	9.20	8.90	8.67	8.42	8.21	7.99	7.63	7.32	7.05	6.81	6.61	6.43	6.26	6.12	5.99	5.86	5.76	5.66	5.58
5.3	34.43	9.80	9.51	9.20	8.96	8.70	8.49	8.26	7.89	7.57	7.29	7.05	6.84	6.65	6.47	6.33	6.20	6.07	5.96	5.85	5.77
5.4	35.08	10.12	9.83	9.51	9.26	8.99	8.77	8.54	8.16	7.83	7.54	7.29	7.07	6.87	6.69	6.55	6.41	6.27	6.16	6.05	5.97
5.5	35.73	10.45	10.15	9.82	9.56	9.29	9.06	8.82	8.43	8.09	7.79	7.53	7.30	7.10	6.92	6.77	6.62	6.48	6.37	6.26	6.17
5.6	36.38	10.79	10.47	10.13	9.87	9.58	9.35	9.11	8.70	8.35	8.04	7.77	7.54	7.33	7.14	6.99	6.84	6.70	6.58	6.46	6.37
5.7	37.03	11.12	10.80	10.45	10.18	9.89	9.65	9.39	8.98	8.61	8.30	8.02	7.78	7.57	7.37	7.21	7.06	6.91	6.79	6.67	6.58
5.8	37.68	11.47	11.13	10.77	10.49	10.19	9.95	9.69	9.26	8.88	8.56	8.27	8.03	7.81	7.60	7.44	7.28	7.13	7.01	6.88	6.79
5.9	38.33	11.81	11.47	11.10	10.81	10.50	10.25	9.98	9.54	9.16	8.82	8.53	8.28	8.05	7.84	7.67	7.51	7.35	7.23	7.10	7.00
6.0	38.98	12.16	11.81	11.43	11.14	10.82	10.56	10.28	9.83	9.43	9.09	8.79	8.53	8.29	8.08	7.91	7.74	7.58	7.45	7.31	7.22
6.1	39.63	12.52	12.16	11.77	11.46	11.14	10.87	10.59	10.12	9.71	9.36	9.05	8.78	8.54	8.32	8.14	7.97	7.81	7.67	7.54	7.43
6.2	40.28	12.88	12.51	12.11	11.80	11.46	11.19	10.89	10.42	10.00	9.64	9.32	9.04	8.79	8.57	8.39	8.21	8.04	7.90	7.76	7.65
6.3	40.93	13.25	12.86	12.45	12.13	11.79	11.51	11.21	10.71	10.29	9.91	9.59	9.30	9.05	8.82	8.63	8.44	8.27	8.13	7.99	7.88
6.4	41.58	13.62	13.22	12.80	12.47	12.12	11.83	11.52	11.02	10.58	10.20	9.86	9.57	9.31	9.07	8.88	8.69	8.51	8.36	8.22	8.10
6.5	42.23	13.99	13.59	13.15	12.82	12.45	12.16	11.84	11.32	10.87	10.48	10.14	9.84	9.57	9.32	9.13	8.93	8.75	8.60	8.45	8.33
6.6	42.88	14.37	13.96	13.51	13.16	12.79	12.49	12.17	11.63	11.17	10.77	10.42	10.11	9.83	9.58	9.38	9.18	8.99	8.84	8.68	8.57
6.7	43.53	14.75	14.33	13.87	13.52	13.14	12.83	12.49	11.95	11.47	11.06	10.70	10.38	10.10	9.84	9.64	9.43	9.24	9.08	8.92	8.80
6.8	44.18	15.14	14.70	14.24	13.87	13.48	13.16	12.82	12.26	11.78	11.36	10.98	10.66	10.37	10.11	9.90	9.69	9.49	9.33	9.16	9.04
6.9	44.83	15.53	15.08	14.61	14.23	13.83	13.51	13.16	12.59	12.09	11.66	11.27	10.94	10.65	10.38	10.16	9.94	9.74	9.57	9.41	9.28
7.0	45.48	15.92	15.47	14.98	14.60	14.19	13.86	13.50	12.91	12.40	11.96	11.57	11.23	10.93	10.65	10.42	10.20	10.00	9.83	9.65	9.52
7.1	46.13	16.32	15.86	15.36	14.97	14.55	14.21	13.84	13.24	12.72	12.26	11.86	11.52	11.21	10.92	10.69	10.47	10.26	10.08	9.90	9.77
7.2	46.78	16.73	16.25	15.74	15.34	14.91	14.56	14.19	13.57	13.04	12.57	12.16	11.81	11.49	11.20	10.96	10.73	10.52	10.34	10.16	10.02
7.3	47.43	17.14	16.65	16.13	15.72	15.28	14.92	14.54	13.91	13.36	12.89	12.47	12.10	11.78	11.48	11.24	11.00	10.78	10.60	10.41	10.27
7.4	48.08	17.55	17.05	16.52	16.10	15.65	15.28	14.89	14.25	13.69	13.20	12.77	12.40	12.07	11.76	11.52	11.27	11.05	10.86	10.67	10.53
7.5	48.73	17.97	17.46	16.91	16.48	16.02	15.65	15.25	14.59	14.02	13.52	13.08	12.70	12.36	12.05	11.80	11.55	11.32	11.13	10.93	10.79
7.6	49.38	18.39	17.87	17.31	16.87	16.40	16.02	15.61	14.94	14.35	13.84	13.39	13.01	12.66	12.34	12.08	11.83	11.59	11.39	11.20	11.05
7.7	50.03	18.82	18.28	17.71	17.27	16.79	16.39	15.98	15.29	14.69	14.17	13.71	13.31	12.96	12.63	12.37	12.11	11.87	11.67	11.46	11.31
7.8	50.68	19.25	18.70	18.12	17.66	17.17	16.77	16.34	15.64	15.03	14.50	14.03	13.63	13.26	12.93	12.66	12.39	12.15	11.94	11.73	11.58
7.9	51.33	19.68	19.13	18.53	18.06	17.56	17.15	16.72	16.00	15.38	14.83	14.35	13.94	13.57	13.23	12.95	12.68	12.43	12.22	12.01	11.85
8.0	51.97	20.12	19.55	18.94	18.47	17.96	17.54	17.09	16.36	15.72	15.17	14.68	14.26	13.88	13.53	13.25	12.97	12.71	12.50	12.28	12.12

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
1.5	9.75	1.32	1.26	1.20	1.16	1.11	1.07	1.03	0.97	0.92	0.87	0.83	0.80	0.77	0.74	0.72	0.70	0.68	0.67	0.65	0.64
1.6	10.39	1.47	1.41	1.34	1.29	1.24	1.20	1.15	1.08	1.02	0.97	0.93	0.89	0.86	0.83	0.81	0.79	0.76	0.75	0.73	0.72
1.7	11.04	1.63	1.56	1.49	1.43	1.37	1.33	1.28	1.20	1.14	1.08	1.03	0.99	0.96	0.92	0.90	0.87	0.85	0.83	0.81	0.80
1.8	11.69	1.79	1.72	1.64	1.58	1.51	1.46	1.41	1.33	1.25	1.19	1.14	1.10	1.06	1.02	0.99	0.97	0.94	0.92	0.90	0.88
1.9	12.34	1.96	1.88	1.79	1.73	1.66	1.61	1.55	1.46	1.38	1.31	1.26	1.21	1.16	1.12	1.09	1.06	1.03	1.01	0.99	0.97
2.0	12.99	2.14	2.05	1.96	1.89	1.81	1.75	1.69	1.59	1.51	1.43	1.37	1.32	1.27	1.23	1.19	1.16	1.13	1.11	1.08	1.06
2.1	13.64	2.32	2.23	2.13	2.05	1.97	1.91	1.84	1.73	1.64	1.56	1.49	1.44	1.38	1.34	1.30	1.27	1.23	1.21	1.18	1.16
2.2	14.29	2.51	2.41	2.30	2.22	2.13	2.07	1.99	1.88	1.78	1.69	1.62	1.56	1.50	1.45	1.41	1.38	1.34	1.31	1.28	1.26
2.3	14.94	2.71	2.60	2.48	2.40	2.30	2.23	2.15	2.03	1.92	1.83	1.75	1.68	1.62	1.57	1.53	1.49	1.45	1.42	1.39	1.36
2.4	15.59	2.91	2.80	2.67	2.58	2.48	2.40	2.31	2.18	2.07	1.97	1.89	1.81	1.75	1.69	1.65	1.60	1.56	1.53	1.50	1.47
2.5	16.24	3.12	3.00	2.86	2.76	2.66	2.57	2.48	2.34	2.22	2.12	2.03	1.95	1.88	1.82	1.77	1.72	1.68	1.65	1.61	1.58
2.6	16.89	3.34	3.20	3.06	2.96	2.84	2.75	2.66	2.50	2.37	2.26	2.17	2.09	2.01	1.95	1.90	1.85	1.80	1.76	1.72	1.69
2.7	17.54	3.56	3.42	3.27	3.15	3.03	2.94	2.84	2.67	2.54	2.42	2.32	2.23	2.15	2.08	2.03	1.98	1.92	1.89	1.84	1.81
2.8	18.19	3.78	3.64	3.48	3.36	3.23	3.13	3.02	2.85	2.70	2.58	2.47	2.38	2.30	2.22	2.16	2.11	2.05	2.01	1.97	1.93
2.9	18.84	4.02	3.86	3.69	3.57	3.43	3.32	3.21	3.03	2.87	2.74	2.63	2.53	2.44	2.36	2.30	2.24	2.18	2.14	2.09	2.06
3.0	19.49	4.26	4.09	3.91	3.78	3.64	3.52	3.40	3.21	3.05	2.91	2.79	2.68	2.59	2.51	2.44	2.38	2.32	2.27	2.22	2.19
3.1	20.14	4.50	4.33	4.14	4.00	3.85	3.73	3.60	3.40	3.23	3.08	2.95	2.84	2.75	2.66	2.59	2.52	2.46	2.41	2.36	2.32
3.2	20.79	4.75	4.57	4.37	4.22	4.06	3.94	3.81	3.59	3.41	3.26	3.12	3.01	2.90	2.81	2.74	2.67	2.60	2.55	2.49	2.45
3.3	21.44	5.01	4.82	4.61	4.45	4.29	4.16	4.02	3.79	3.60	3.44	3.30	3.17	3.07	2.97	2.89	2.82	2.75	2.69	2.63	2.59
3.4	22.09	5.27	5.07	4.85	4.69	4.51	4.38	4.23	3.99	3.79	3.62	3.47	3.34	3.23	3.13	3.05	2.97	2.90	2.84	2.78	2.73
3.5	22.74	5.54	5.33	5.10	4.93	4.74	4.60	4.45	4.20	3.99	3.81	3.66	3.52	3.40	3.30	3.21	3.13	3.05	2.99	2.93	2.88
3.6	23.39	5.81	5.59	5.35	5.17	4.98	4.83	4.67	4.41	4.19	4.00	3.84	3.70	3.58	3.47	3.37	3.29	3.21	3.15	3.08	3.02
3.7	24.04	6.09	5.86	5.61	5.42	5.22	5.07	4.90	4.63	4.40	4.20	4.03	3.88	3.75	3.64	3.54	3.45	3.37	3.30	3.23	3.18
3.8	24.69	6.38	6.14	5.88	5.68	5.47	5.31	5.13	4.85	4.61	4.40	4.23	4.07	3.93	3.81	3.71	3.62	3.53	3.46	3.39	3.33
3.9	25.34	6.67	6.42	6.15	5.94	5.72	5.55	5.37	5.07	4.82	4.61	4.42	4.26	4.12	3.99	3.89	3.79	3.70	3.63	3.55	3.49
4.0	25.99	6.96	6.70	6.42	6.21	5.98	5.80	5.61	5.30	5.04	4.82	4.63	4.45	4.31	4.18	4.06	3.97	3.87	3.80	3.71	3.65
4.1	26.64	7.27	6.99	6.70	6.48	6.24	6.06	5.86	5.53	5.26	5.03	4.83	4.65	4.50	4.36	4.25	4.14	4.04	3.97	3.88	3.82
4.2	27.29	7.57	7.29	6.98	6.75	6.51	6.31	6.11	5.77	5.49	5.25	5.04	4.86	4.70	4.55	4.43	4.33	4.22	4.14	4.05	3.98
4.3	27.94	7.88	7.59	7.27	7.04	6.78	6.58	6.36	6.02	5.72	5.47	5.25	5.06	4.90	4.75	4.62	4.51	4.40	4.32	4.22	4.15
4.4	28.59	8.20	7.90	7.57	7.32	7.05	6.85	6.62	6.26	5.96	5.70	5.47	5.27	5.10	4.95	4.81	4.70	4.58	4.50	4.40	4.33
4.5	29.24	8.53	8.21	7.87	7.61	7.33	7.12	6.89	6.51	6.20	5.93	5.69	5.49	5.31	5.15	5.01	4.89	4.77	4.68	4.58	4.51
4.6	29.89	8.85	8.53	8.17	7.91	7.62	7.40	7.16	6.77	6.44	6.16	5.92	5.70	5.52	5.35	5.21	5.09	4.96	4.87	4.77	4.69
4.7	30.54	9.19	8.85	8.48	8.21	7.91	7.68	7.43	7.03	6.69	6.40	6.15	5.92	5.73	5.56	5.41	5.29	5.16	5.06	4.95	4.87
4.8	31.18	9.53	9.18	8.80	8.51	8.20	7.97	7.71	7.29	6.94	6.64	6.38	6.15	5.95	5.77	5.62	5.49	5.35	5.26	5.14	5.06
4.9	31.83	9.87	9.51	9.12	8.82	8.50	8.26	7.99	7.56	7.20	6.89	6.62	6.38	6.17	5.99	5.83	5.69	5.56	5.45	5.34	5.25

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
5.0	32.48	10.22	9.85	9.44	9.14	8.81	8.55	8.28	7.83	7.46	7.14	6.86	6.61	6.40	6.21	6.04	5.90	5.76	5.65	5.53	5.44
5.1	33.13	10.58	10.19	9.77	9.46	9.12	8.85	8.57	8.11	7.72	7.39	7.10	6.85	6.63	6.43	6.26	6.11	5.97	5.86	5.73	5.64
5.2	33.78	10.94	10.54	10.11	9.78	9.43	9.16	8.87	8.39	7.99	7.65	7.35	7.09	6.86	6.65	6.48	6.33	6.18	6.06	5.93	5.84
5.3	34.43	11.30	10.89	10.45	10.11	9.75	9.47	9.17	8.68	8.26	7.91	7.60	7.33	7.10	6.88	6.70	6.55	6.39	6.27	6.14	6.04
5.4	35.08	11.67	11.25	10.79	10.45	10.07	9.78	9.47	8.97	8.54	8.17	7.86	7.58	7.34	7.12	6.93	6.77	6.61	6.49	6.35	6.25
5.5	35.73	12.05	11.61	11.14	10.78	10.40	10.10	9.78	9.26	8.82	8.44	8.12	7.83	7.58	7.35	7.16	7.00	6.83	6.70	6.56	6.46
5.6	36.38	12.43	11.98	11.49	11.13	10.73	10.43	10.10	9.56	9.10	8.72	8.38	8.08	7.82	7.59	7.40	7.22	7.05	6.92	6.78	6.67
5.7	37.03	12.82	12.35	11.85	11.48	11.07	10.75	10.41	9.86	9.39	8.99	8.65	8.34	8.08	7.84	7.63	7.46	7.28	7.15	7.00	6.88
5.8	37.68	13.21	12.73	12.22	11.83	11.41	11.08	10.73	10.17	9.68	9.27	8.92	8.60	8.33	8.08	7.87	7.69	7.51	7.37	7.22	7.10
5.9	38.33	13.60	13.11	12.58	12.19	11.75	11.42	11.06	10.48	9.98	9.56	9.19	8.87	8.59	8.33	8.12	7.93	7.74	7.60	7.44	7.32
6.0	38.98	14.00	13.50	12.96	12.55	12.10	11.76	11.39	10.79	10.28	9.85	9.47	9.14	8.85	8.59	8.37	8.17	7.98	7.83	7.67	7.55
6.1	39.63	14.41	13.89	13.33	12.91	12.46	12.11	11.73	11.11	10.58	10.14	9.75	9.41	9.11	8.84	8.62	8.42	8.22	8.07	7.90	7.77
6.2	40.28	14.82	14.29	13.72	13.29	12.82	12.46	12.07	11.43	10.89	10.43	10.04	9.68	9.38	9.10	8.87	8.67	8.46	8.31	8.13	8.01
6.3	40.93	15.24	14.69	14.10	13.66	13.18	12.81	12.41	11.76	11.20	10.73	10.32	9.96	9.65	9.37	9.13	8.92	8.71	8.55	8.37	8.24
6.4	41.58	15.66	15.10	14.50	14.04	13.55	13.17	12.76	12.09	11.52	11.04	10.62	10.25	9.92	9.63	9.39	9.17	8.96	8.80	8.61	8.47
6.5	42.23	16.08	15.51	14.89	14.43	13.92	13.53	13.11	12.42	11.84	11.34	10.91	10.53	10.20	9.90	9.65	9.43	9.21	9.04	8.85	8.71
6.6	42.88	16.52	15.93	15.29	14.82	14.30	13.90	13.46	12.76	12.16	11.65	11.21	10.82	10.48	10.18	9.92	9.69	9.46	9.29	9.10	8.96
6.7	43.53	16.95	16.35	15.70	15.21	14.68	14.27	13.82	13.10	12.49	11.97	11.52	11.11	10.77	10.45	10.19	9.96	9.72	9.55	9.35	9.20
6.8	44.18	17.39	16.78	16.11	15.61	15.06	14.64	14.19	13.45	12.82	12.29	11.82	11.41	11.06	10.73	10.46	10.22	9.98	9.81	9.60	9.45
6.9	44.83	17.84	17.21	16.52	16.01	15.45	15.02	14.56	13.80	13.15	12.61	12.13	11.71	11.35	11.02	10.74	10.49	10.25	10.07	9.86	9.70
7.0	45.48	18.29	17.65	16.94	16.42	15.85	15.41	14.93	14.15	13.49	12.93	12.45	12.02	11.64	11.30	11.02	10.77	10.52	10.33	10.12	9.96
7.1	46.13	18.74	18.09	17.37	16.83	16.25	15.79	15.31	14.51	13.84	13.26	12.77	12.32	11.94	11.59	11.30	11.05	10.79	10.60	10.38	10.21
7.2	46.78	19.20	18.53	17.80	17.25	16.65	16.19	15.69	14.88	14.18	13.60	13.09	12.63	12.24	11.89	11.59	11.33	11.06	10.87	10.64	10.47
7.3	47.43	19.67	18.98	18.23	17.67	17.06	16.58	16.07	15.24	14.53	13.93	13.41	12.95	12.55	12.18	11.88	11.61	11.34	11.14	10.91	10.74
7.4	48.08	20.14	19.44	18.67	18.09	17.47	16.98	16.46	15.61	14.89	14.27	13.74	13.26	12.85	12.48	12.17	11.90	11.62	11.41	11.18	11.00
7.5	48.73	20.61	19.90	19.11	18.52	17.88	17.39	16.86	15.99	15.24	14.62	14.07	13.59	13.17	12.79	12.47	12.19	11.90	11.69	11.45	11.27
7.6	49.38	21.09	20.36	19.56	18.96	18.30	17.80	17.25	16.36	15.61	14.96	14.41	13.91	13.48	13.09	12.76	12.48	12.19	11.97	11.73	11.55
7.7	50.03	21.58	20.83	20.01	19.39	18.73	18.21	17.65	16.75	15.97	15.32	14.75	14.24	13.80	13.40	13.07	12.77	12.48	12.26	12.01	11.82
7.8	50.68	22.07	21.30	20.46	19.84	19.16	18.63	18.06	17.13	16.34	15.67	15.09	14.57	14.12	13.72	13.37	13.07	12.77	12.55	12.29	12.10
7.9	51.33	22.56	21.78	20.93	20.28	19.59	19.05	18.47	17.52	16.71	16.03	15.43	14.90	14.45	14.03	13.68	13.38	13.07	12.84	12.57	12.38
8.0	51.97	23.06	22.26	21.39	20.74	20.03	19.48	18.88	17.91	17.09	16.39	15.78	15.24	14.77	14.35	13.99	13.68	13.36	13.13	12.86	12.66

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
1.5	9.75	1.51	1.44	1.36	1.31	1.25	1.20	1.16	1.08	1.01	0.96	0.91	0.87	0.83	0.80	0.78	0.75	0.73	0.71	0.69	0.68
1.6	10.39	1.68	1.60	1.52	1.46	1.39	1.34	1.29	1.20	1.13	1.07	1.02	0.97	0.93	0.90	0.87	0.84	0.82	0.79	0.77	0.76
1.7	11.04	1.85	1.77	1.68	1.62	1.54	1.49	1.43	1.34	1.26	1.19	1.13	1.08	1.04	1.00	0.96	0.94	0.91	0.88	0.86	0.84
1.8	11.69	2.04	1.95	1.85	1.78	1.70	1.64	1.58	1.47	1.39	1.31	1.25	1.19	1.15	1.10	1.07	1.03	1.00	0.98	0.95	0.93
1.9	12.34	2.23	2.14	2.03	1.95	1.86	1.80	1.73	1.62	1.52	1.44	1.37	1.31	1.26	1.21	1.17	1.14	1.10	1.07	1.05	1.02
2.0	12.99	2.43	2.33	2.21	2.13	2.03	1.96	1.89	1.76	1.66	1.57	1.50	1.43	1.38	1.33	1.28	1.24	1.21	1.17	1.15	1.12
2.1	13.64	2.64	2.53	2.40	2.31	2.21	2.13	2.05	1.92	1.81	1.71	1.63	1.56	1.50	1.44	1.40	1.35	1.32	1.28	1.25	1.22
2.2	14.29	2.85	2.73	2.60	2.50	2.39	2.31	2.22	2.08	1.96	1.85	1.77	1.69	1.62	1.57	1.51	1.47	1.43	1.39	1.36	1.33
2.3	14.94	3.08	2.94	2.80	2.69	2.58	2.49	2.40	2.24	2.11	2.00	1.91	1.83	1.76	1.69	1.64	1.59	1.54	1.50	1.47	1.44
2.4	15.59	3.30	3.16	3.01	2.90	2.77	2.68	2.58	2.41	2.27	2.16	2.06	1.97	1.89	1.82	1.76	1.71	1.66	1.62	1.58	1.55
2.5	16.24	3.54	3.39	3.23	3.10	2.97	2.87	2.76	2.59	2.44	2.31	2.21	2.11	2.03	1.96	1.90	1.84	1.79	1.74	1.70	1.66
2.6	16.89	3.78	3.62	3.45	3.32	3.18	3.07	2.95	2.77	2.61	2.48	2.36	2.26	2.18	2.10	2.03	1.97	1.92	1.87	1.82	1.78
2.7	17.54	4.03	3.86	3.68	3.54	3.39	3.28	3.15	2.96	2.79	2.65	2.52	2.42	2.32	2.24	2.17	2.11	2.05	1.99	1.95	1.91
2.8	18.19	4.28	4.10	3.91	3.76	3.61	3.49	3.36	3.15	2.97	2.82	2.69	2.58	2.48	2.39	2.31	2.25	2.18	2.13	2.08	2.03
2.9	18.84	4.55	4.36	4.15	4.00	3.83	3.70	3.56	3.34	3.15	3.00	2.86	2.74	2.63	2.54	2.46	2.39	2.32	2.26	2.21	2.16
3.0	19.49	4.81	4.61	4.40	4.23	4.06	3.92	3.78	3.54	3.35	3.18	3.03	2.91	2.80	2.70	2.61	2.54	2.47	2.40	2.35	2.30
3.1	20.14	5.09	4.88	4.65	4.48	4.29	4.15	4.00	3.75	3.54	3.36	3.21	3.08	2.96	2.86	2.77	2.69	2.61	2.55	2.49	2.44
3.2	20.79	5.37	5.15	4.91	4.73	4.53	4.38	4.22	3.96	3.74	3.56	3.39	3.25	3.13	3.02	2.93	2.84	2.76	2.69	2.63	2.58
3.3	21.44	5.66	5.42	5.17	4.98	4.78	4.62	4.45	4.18	3.95	3.75	3.58	3.43	3.31	3.19	3.09	3.00	2.92	2.85	2.78	2.72
3.4	22.09	5.95	5.71	5.44	5.24	5.03	4.87	4.69	4.40	4.16	3.95	3.77	3.62	3.48	3.36	3.26	3.17	3.08	3.00	2.93	2.87
3.5	22.74	6.25	6.00	5.72	5.51	5.29	5.11	4.93	4.63	4.37	4.16	3.97	3.81	3.67	3.54	3.43	3.33	3.24	3.16	3.09	3.02
3.6	23.39	6.56	6.29	6.00	5.78	5.55	5.37	5.17	4.86	4.59	4.37	4.17	4.00	3.85	3.72	3.60	3.50	3.41	3.32	3.25	3.18
3.7	24.04	6.87	6.59	6.29	6.06	5.82	5.63	5.42	5.10	4.82	4.58	4.38	4.20	4.04	3.90	3.78	3.68	3.58	3.49	3.41	3.34
3.8	24.69	7.19	6.90	6.58	6.35	6.09	5.89	5.68	5.34	5.05	4.80	4.59	4.40	4.24	4.09	3.97	3.85	3.75	3.65	3.58	3.50
3.9	25.34	7.51	7.21	6.88	6.64	6.37	6.16	5.94	5.58	5.28	5.02	4.80	4.60	4.43	4.28	4.15	4.04	3.93	3.83	3.74	3.66
4.0	25.99	7.84	7.53	7.19	6.93	6.65	6.44	6.21	5.83	5.52	5.25	5.02	4.81	4.64	4.48	4.34	4.22	4.11	4.00	3.92	3.83
4.1	26.64	8.18	7.85	7.50	7.23	6.94	6.72	6.48	6.09	5.76	5.48	5.24	5.03	4.84	4.68	4.54	4.41	4.29	4.18	4.09	4.01
4.2	27.29	8.52	8.18	7.81	7.54	7.24	7.00	6.75	6.35	6.01	5.72	5.46	5.25	5.05	4.88	4.73	4.60	4.48	4.37	4.27	4.18
4.3	27.94	8.87	8.52	8.13	7.85	7.54	7.29	7.03	6.62	6.26	5.96	5.70	5.47	5.27	5.09	4.93	4.80	4.67	4.55	4.46	4.36
4.4	28.59	9.22	8.86	8.46	8.16	7.84	7.59	7.32	6.89	6.52	6.20	5.93	5.69	5.49	5.30	5.14	5.00	4.86	4.74	4.64	4.54
4.5	29.24	9.59	9.21	8.79	8.49	8.15	7.89	7.61	7.16	6.78	6.45	6.17	5.92	5.71	5.52	5.35	5.20	5.06	4.94	4.83	4.73
4.6	29.89	9.95	9.56	9.13	8.81	8.47	8.20	7.91	7.44	7.04	6.70	6.41	6.16	5.93	5.74	5.56	5.41	5.26	5.13	5.02	4.92
4.7	30.54	10.32	9.92	9.48	9.14	8.79	8.51	8.21	7.72	7.31	6.96	6.66	6.39	6.16	5.96	5.78	5.62	5.47	5.33	5.22	5.11
4.8	31.18	10.70	10.28	9.83	9.48	9.11	8.82	8.51	8.01	7.59	7.22	6.91	6.64	6.40	6.18	6.00	5.83	5.68	5.54	5.42	5.31
4.9	31.83	11.09	10.65	10.18	9.83	9.44	9.14	8.82	8.31	7.86	7.49	7.16	6.88	6.63	6.41	6.22	6.05	5.89	5.74	5.62	5.51

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
5.0	32.48	11.48	11.03	10.54	10.17	9.78	9.47	9.14	8.60	8.15	7.76	7.42	7.13	6.87	6.65	6.45	6.27	6.10	5.96	5.83	5.71
5.1	33.13	11.87	11.41	10.91	10.53	10.12	9.80	9.46	8.91	8.43	8.03	7.69	7.38	7.12	6.88	6.68	6.50	6.32	6.17	6.04	5.91
5.2	33.78	12.27	11.80	11.28	10.89	10.46	10.14	9.78	9.21	8.73	8.31	7.95	7.64	7.37	7.13	6.91	6.72	6.55	6.39	6.25	6.12
5.3	34.43	12.68	12.19	11.65	11.25	10.81	10.48	10.11	9.52	9.02	8.59	8.23	7.90	7.62	7.37	7.15	6.96	6.77	6.61	6.47	6.33
5.4	35.08	13.09	12.58	12.03	11.62	11.17	10.82	10.45	9.84	9.32	8.88	8.50	8.17	7.88	7.62	7.39	7.19	7.00	6.83	6.69	6.55
5.5	35.73	13.51	12.99	12.42	11.99	11.53	11.17	10.78	10.16	9.63	9.17	8.78	8.44	8.14	7.87	7.64	7.43	7.23	7.06	6.91	6.77
5.6	36.38	13.93	13.40	12.81	12.37	11.90	11.53	11.13	10.49	9.94	9.47	9.06	8.71	8.40	8.13	7.88	7.67	7.47	7.29	7.14	6.99
5.7	37.03	14.36	13.81	13.21	12.76	12.27	11.89	11.48	10.81	10.25	9.77	9.35	8.99	8.67	8.39	8.14	7.92	7.71	7.52	7.37	7.21
5.8	37.68	14.80	14.23	13.61	13.15	12.64	12.25	11.83	11.15	10.57	10.07	9.64	9.27	8.94	8.65	8.39	8.17	7.95	7.76	7.60	7.44
5.9	38.33	15.24	14.65	14.02	13.54	13.02	12.62	12.19	11.49	10.89	10.38	9.94	9.55	9.21	8.91	8.65	8.42	8.20	8.00	7.84	7.67
6.0	38.98	15.68	15.08	14.43	13.94	13.41	12.99	12.55	11.83	11.21	10.69	10.24	9.84	9.49	9.18	8.91	8.67	8.45	8.25	8.07	7.91
6.1	39.63	16.14	15.52	14.85	14.34	13.80	13.37	12.92	12.18	11.54	11.00	10.54	10.13	9.78	9.46	9.18	8.93	8.70	8.49	8.32	8.15
6.2	40.28	16.59	15.96	15.27	14.75	14.19	13.76	13.29	12.53	11.88	11.32	10.85	10.43	10.06	9.74	9.45	9.20	8.96	8.74	8.56	8.39
6.3	40.93	17.05	16.41	15.70	15.17	14.59	14.15	13.66	12.88	12.22	11.65	11.16	10.73	10.35	10.02	9.72	9.46	9.22	9.00	8.81	8.63
6.4	41.58	17.52	16.86	16.13	15.59	15.00	14.54	14.04	13.24	12.56	11.98	11.47	11.03	10.64	10.30	10.00	9.73	9.48	9.25	9.06	8.88
6.5	42.23	18.00	17.31	16.57	16.01	15.41	14.94	14.43	13.61	12.91	12.31	11.79	11.34	10.94	10.59	10.28	10.00	9.75	9.51	9.32	9.13
6.6	42.88	18.47	17.78	17.02	16.44	15.82	15.34	14.82	13.98	13.26	12.64	12.11	11.65	11.24	10.88	10.56	10.28	10.02	9.78	9.58	9.38
6.7	43.53	18.96	18.24	17.46	16.88	16.24	15.75	15.21	14.35	13.61	12.98	12.44	11.96	11.55	11.17	10.85	10.56	10.29	10.04	9.84	9.64
6.8	44.18	19.45	18.72	17.92	17.32	16.66	16.16	15.61	14.73	13.97	13.33	12.77	12.28	11.85	11.47	11.14	10.84	10.56	10.31	10.10	9.90
6.9	44.83	19.94	19.19	18.38	17.76	17.09	16.57	16.01	15.11	14.33	13.67	13.10	12.60	12.16	11.77	11.43	11.13	10.84	10.59	10.37	10.16
7.0	45.48	20.44	19.68	18.84	18.21	17.52	16.99	16.42	15.49	14.70	14.02	13.44	12.93	12.48	12.08	11.73	11.42	11.13	10.86	10.64	10.43
7.1	46.13	20.95	20.16	19.31	18.66	17.96	17.42	16.83	15.88	15.07	14.38	13.78	13.26	12.80	12.39	12.03	11.71	11.41	11.14	10.92	10.69
7.2	46.78	21.46	20.66	19.78	19.12	18.41	17.85	17.25	16.28	15.45	14.74	14.13	13.59	13.12	12.70	12.33	12.01	11.70	11.42	11.19	10.97
7.3	47.43	21.98	21.15	20.26	19.58	18.85	18.28	17.67	16.68	15.83	15.10	14.48	13.93	13.45	13.02	12.64	12.31	11.99	11.71	11.47	11.24
7.4	48.08	22.50	21.66	20.74	20.05	19.30	18.72	18.10	17.08	16.21	15.47	14.83	14.27	13.77	13.34	12.95	12.61	12.29	12.00	11.76	11.52
7.5	48.73	23.02	22.17	21.23	20.53	19.76	19.17	18.53	17.49	16.60	15.84	15.19	14.61	14.11	13.66	13.26	12.92	12.59	12.29	12.04	11.80
7.6	49.38	23.56	22.68	21.72	21.00	20.22	19.61	18.96	17.90	16.99	16.22	15.55	14.96	14.44	13.98	13.58	13.22	12.89	12.59	12.33	12.08
7.7	50.03	24.09	23.20	22.22	21.49	20.69	20.07	19.40	18.31	17.39	16.59	15.91	15.31	14.78	14.31	13.90	13.54	13.19	12.89	12.63	12.37
7.8	50.68	24.64	23.72	22.73	21.97	21.16	20.52	19.84	18.73	17.79	16.98	16.28	15.66	15.13	14.65	14.23	13.85	13.50	13.19	12.92	12.66
7.9	51.33	25.18	24.25	23.23	22.47	21.63	20.99	20.29	19.16	18.19	17.36	16.65	16.02	15.47	14.98	14.55	14.17	13.81	13.49	13.22	12.96
8.0	51.97	25.74	24.78	23.75	22.96	22.11	21.45	20.74	19.59	18.60	17.75	17.02	16.38	15.82	15.32	14.88	14.49	14.13	13.80	13.52	13.25

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2½" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
1.5	14.85	0.61	0.59	0.56	0.55	0.53	0.53	0.52	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.42	0.42	0.41	0.41	0.40
1.6	15.84	0.69	0.66	0.62	0.61	0.60	0.59	0.58	0.56	0.55	0.53	0.52	0.51	0.50	0.49	0.48	0.48	0.47	0.46	0.46	0.45
1.7	16.83	0.76	0.73	0.69	0.68	0.67	0.66	0.64	0.63	0.61	0.59	0.58	0.57	0.56	0.55	0.54	0.53	0.52	0.51	0.51	0.50
1.8	17.82	0.84	0.81	0.76	0.75	0.74	0.73	0.71	0.69	0.67	0.66	0.64	0.63	0.62	0.61	0.60	0.59	0.58	0.57	0.56	0.55
1.9	18.81	0.93	0.89	0.84	0.83	0.81	0.80	0.78	0.76	0.74	0.72	0.71	0.69	0.68	0.67	0.66	0.65	0.64	0.63	0.62	0.61
2.0	19.80	1.01	0.97	0.92	0.90	0.89	0.87	0.86	0.83	0.81	0.79	0.77	0.76	0.74	0.73	0.72	0.71	0.70	0.69	0.68	0.67
2.1	20.79	1.11	1.06	1.00	0.99	0.97	0.95	0.94	0.91	0.89	0.86	0.85	0.83	0.81	0.80	0.78	0.77	0.76	0.75	0.74	0.73
2.2	21.78	1.20	1.15	1.09	1.07	1.05	1.03	1.02	0.99	0.96	0.94	0.92	0.90	0.88	0.87	0.85	0.84	0.83	0.82	0.81	0.80
2.3	22.77	1.30	1.24	1.18	1.16	1.14	1.12	1.10	1.07	1.04	1.02	0.99	0.97	0.96	0.94	0.92	0.91	0.90	0.88	0.87	0.86
2.4	23.76	1.40	1.34	1.27	1.25	1.22	1.21	1.19	1.15	1.12	1.10	1.07	1.05	1.03	1.01	1.00	0.98	0.97	0.95	0.94	0.93
2.5	24.75	1.50	1.44	1.36	1.34	1.32	1.30	1.28	1.24	1.21	1.18	1.15	1.13	1.11	1.09	1.07	1.06	1.04	1.03	1.01	1.00
2.6	25.74	1.61	1.54	1.46	1.44	1.41	1.39	1.37	1.33	1.29	1.26	1.24	1.21	1.19	1.17	1.15	1.13	1.12	1.10	1.09	1.07
2.7	26.73	1.72	1.65	1.56	1.54	1.51	1.49	1.46	1.42	1.38	1.35	1.32	1.30	1.27	1.25	1.23	1.21	1.19	1.18	1.16	1.15
2.8	27.72	1.83	1.75	1.67	1.64	1.61	1.59	1.56	1.52	1.48	1.44	1.41	1.38	1.36	1.33	1.31	1.29	1.27	1.26	1.24	1.23
2.9	28.71	1.95	1.87	1.77	1.74	1.71	1.69	1.66	1.61	1.57	1.54	1.50	1.47	1.45	1.42	1.40	1.38	1.36	1.34	1.32	1.31
3.0	29.70	2.07	1.98	1.88	1.85	1.82	1.79	1.76	1.71	1.67	1.63	1.60	1.57	1.54	1.51	1.49	1.46	1.44	1.42	1.41	1.39
3.1	30.69	2.19	2.10	2.00	1.96	1.93	1.90	1.87	1.82	1.77	1.73	1.69	1.66	1.63	1.60	1.58	1.55	1.53	1.51	1.49	1.47
3.2	31.68	2.32	2.22	2.11	2.08	2.04	2.01	1.98	1.92	1.87	1.83	1.79	1.76	1.72	1.70	1.67	1.64	1.62	1.60	1.58	1.56
3.3	32.67	2.45	2.34	2.23	2.19	2.15	2.12	2.09	2.03	1.98	1.93	1.89	1.86	1.82	1.79	1.76	1.74	1.71	1.69	1.67	1.65
3.4	33.66	2.58	2.47	2.35	2.31	2.27	2.24	2.20	2.14	2.09	2.04	2.00	1.96	1.92	1.89	1.86	1.83	1.81	1.78	1.76	1.74
3.5	34.65	2.71	2.60	2.47	2.43	2.39	2.36	2.32	2.26	2.20	2.15	2.10	2.06	2.03	1.99	1.96	1.93	1.90	1.88	1.86	1.84
3.6	35.64	2.85	2.73	2.60	2.56	2.51	2.48	2.44	2.37	2.31	2.26	2.21	2.17	2.13	2.09	2.06	2.03	2.00	1.98	1.95	1.93
3.7	36.63	2.99	2.87	2.73	2.69	2.64	2.60	2.56	2.49	2.43	2.37	2.32	2.28	2.24	2.20	2.17	2.13	2.10	2.08	2.05	2.03
3.8	37.62	3.14	3.01	2.86	2.82	2.77	2.73	2.69	2.61	2.55	2.49	2.44	2.39	2.35	2.31	2.27	2.24	2.21	2.18	2.15	2.13
3.9	38.61	3.28	3.15	3.00	2.95	2.90	2.86	2.81	2.74	2.67	2.61	2.55	2.50	2.46	2.42	2.38	2.35	2.31	2.28	2.26	2.23
4.0	39.60	3.43	3.29	3.14	3.09	3.03	2.99	2.94	2.86	2.79	2.73	2.67	2.62	2.57	2.53	2.49	2.46	2.42	2.39	2.36	2.34
4.1	40.59	3.59	3.44	3.28	3.22	3.17	3.12	3.08	2.99	2.92	2.85	2.79	2.74	2.69	2.65	2.61	2.57	2.53	2.50	2.47	2.44
4.2	41.58	3.74	3.59	3.42	3.37	3.31	3.26	3.21	3.12	3.05	2.98	2.92	2.86	2.81	2.76	2.72	2.68	2.65	2.61	2.58	2.55
4.3	42.57	3.90	3.75	3.57	3.51	3.45	3.40	3.35	3.26	3.18	3.11	3.04	2.99	2.93	2.88	2.84	2.80	2.76	2.73	2.69	2.66
4.4	43.57	4.06	3.90	3.72	3.66	3.59	3.54	3.49	3.40	3.31	3.24	3.17	3.11	3.06	3.01	2.96	2.92	2.88	2.84	2.81	2.78
4.5	44.56	4.23	4.06	3.87	3.81	3.74	3.69	3.63	3.53	3.45	3.37	3.30	3.24	3.18	3.13	3.08	3.04	3.00	2.96	2.92	2.89
4.6	45.55	4.40	4.22	4.02	3.96	3.89	3.84	3.78	3.68	3.59	3.51	3.44	3.37	3.31	3.26	3.21	3.16	3.12	3.08	3.04	3.01
4.7	46.54	4.57	4.39	4.18	4.11	4.04	3.99	3.92	3.82	3.73	3.65	3.57	3.50	3.44	3.39	3.33	3.29	3.24	3.20	3.16	3.13
4.8	47.53	4.74	4.55	4.34	4.27	4.20	4.14	4.08	3.97	3.87	3.79	3.71	3.64	3.57	3.52	3.46	3.41	3.37	3.33	3.29	3.25
4.9	48.52	4.92	4.72	4.50	4.43	4.35	4.29	4.23	4.12	4.02	3.93	3.85	3.78	3.71	3.65	3.59	3.54	3.49	3.45	3.41	3.37

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2½" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
5.0	49.51	5.10	4.90	4.67	4.59	4.51	4.45	4.38	4.27	4.17	4.07	3.99	3.92	3.85	3.79	3.73	3.67	3.63	3.58	3.54	3.50
5.1	50.50	5.28	5.07	4.83	4.76	4.68	4.61	4.54	4.42	4.32	4.22	4.14	4.06	3.99	3.92	3.86	3.81	3.76	3.71	3.67	3.63
5.2	51.49	5.46	5.25	5.00	4.93	4.84	4.77	4.70	4.58	4.47	4.37	4.28	4.20	4.13	4.06	4.00	3.94	3.89	3.84	3.80	3.76
5.3	52.48	5.65	5.43	5.18	5.10	5.01	4.94	4.87	4.74	4.63	4.52	4.43	4.35	4.27	4.21	4.14	4.08	4.03	3.98	3.93	3.89
5.4	53.47	5.84	5.61	5.35	5.27	5.18	5.11	5.03	4.90	4.78	4.68	4.58	4.50	4.42	4.35	4.28	4.22	4.17	4.12	4.07	4.02
5.5	54.46	6.04	5.80	5.53	5.44	5.35	5.28	5.20	5.06	4.94	4.84	4.74	4.65	4.57	4.50	4.43	4.37	4.31	4.25	4.21	4.16
5.6	55.45	6.23	5.99	5.71	5.62	5.53	5.45	5.37	5.23	5.11	4.99	4.89	4.80	4.72	4.64	4.57	4.51	4.45	4.40	4.35	4.30
5.7	56.44	6.43	6.18	5.89	5.80	5.71	5.63	5.54	5.40	5.27	5.16	5.05	4.96	4.87	4.80	4.72	4.66	4.60	4.54	4.49	4.44
5.8	57.43	6.63	6.38	6.08	5.99	5.89	5.80	5.72	5.57	5.44	5.32	5.21	5.12	5.03	4.95	4.87	4.81	4.74	4.68	4.63	4.58
5.9	58.42	6.84	6.57	6.27	6.17	6.07	5.99	5.90	5.74	5.61	5.49	5.38	5.28	5.19	5.10	5.03	4.96	4.89	4.83	4.78	4.72
6.0	59.41	7.05	6.77	6.46	6.36	6.25	6.17	6.08	5.92	5.78	5.65	5.54	5.44	5.35	5.26	5.18	5.11	5.04	4.98	4.92	4.87
6.1	60.40	7.26	6.97	6.65	6.55	6.44	6.35	6.26	6.10	5.95	5.83	5.71	5.60	5.51	5.42	5.34	5.27	5.20	5.13	5.07	5.02
6.2	61.39	7.47	7.18	6.85	6.74	6.63	6.54	6.45	6.28	6.13	6.00	5.88	5.77	5.67	5.58	5.50	5.42	5.35	5.29	5.23	5.17
6.3	62.38	7.68	7.39	7.05	6.94	6.83	6.73	6.63	6.46	6.31	6.17	6.05	5.94	5.84	5.75	5.66	5.58	5.51	5.44	5.38	5.32
6.4	63.37	7.90	7.60	7.25	7.14	7.02	6.92	6.82	6.65	6.49	6.35	6.23	6.11	6.01	5.91	5.83	5.75	5.67	5.60	5.54	5.48
6.5	64.36	8.12	7.81	7.45	7.34	7.22	7.12	7.02	6.84	6.68	6.53	6.40	6.29	6.18	6.08	5.99	5.91	5.83	5.76	5.70	5.63
6.6	65.35	8.35	8.03	7.66	7.54	7.42	7.32	7.21	7.03	6.86	6.71	6.58	6.46	6.35	6.25	6.16	6.07	6.00	5.92	5.86	5.79
6.7	66.34	8.57	8.24	7.87	7.75	7.62	7.52	7.41	7.22	7.05	6.90	6.76	6.64	6.53	6.42	6.33	6.24	6.16	6.09	6.02	5.95
6.8	67.33	8.80	8.47	8.08	7.96	7.83	7.72	7.61	7.41	7.24	7.09	6.95	6.82	6.70	6.60	6.50	6.41	6.33	6.25	6.18	6.12
6.9	68.32	9.03	8.69	8.29	8.17	8.03	7.92	7.81	7.61	7.43	7.27	7.13	7.00	6.88	6.78	6.68	6.59	6.50	6.42	6.35	6.28
7.0	69.31	9.27	8.92	8.51	8.38	8.24	8.13	8.01	7.81	7.63	7.47	7.32	7.19	7.07	6.95	6.85	6.76	6.67	6.59	6.52	6.45
7.1	70.30	9.51	9.14	8.73	8.60	8.46	8.34	8.22	8.01	7.83	7.66	7.51	7.37	7.25	7.14	7.03	6.94	6.85	6.76	6.69	6.62
7.2	71.29	9.75	9.37	8.95	8.81	8.67	8.55	8.43	8.22	8.03	7.85	7.70	7.56	7.43	7.32	7.21	7.11	7.02	6.94	6.86	6.79
7.3	72.28	9.99	9.61	9.17	9.04	8.89	8.77	8.64	8.42	8.23	8.05	7.90	7.75	7.62	7.50	7.39	7.29	7.20	7.11	7.03	6.96
7.4	73.27	10.23	9.85	9.40	9.26	9.11	8.99	8.86	8.63	8.43	8.25	8.09	7.95	7.81	7.69	7.58	7.48	7.38	7.29	7.21	7.13
7.5	74.26	10.48	10.08	9.63	9.48	9.33	9.20	9.07	8.84	8.64	8.46	8.29	8.14	8.01	7.88	7.77	7.66	7.56	7.47	7.39	7.31
7.6	75.25	10.73	10.33	9.86	9.71	9.56	9.43	9.29	9.06	8.85	8.66	8.49	8.34	8.20	8.07	7.96	7.85	7.75	7.65	7.57	7.49
7.7	76.24	10.98	10.57	10.09	9.94	9.78	9.65	9.51	9.27	9.06	8.87	8.70	8.54	8.40	8.27	8.15	8.04	7.93	7.84	7.75	7.67
7.8	77.23	11.24	10.82	10.33	10.17	10.01	9.88	9.73	9.49	9.27	9.08	8.90	8.74	8.59	8.46	8.34	8.23	8.12	8.03	7.94	7.85
7.9	78.22	11.50	11.07	10.57	10.41	10.24	10.10	9.96	9.71	9.49	9.29	9.11	8.94	8.80	8.66	8.53	8.42	8.31	8.21	8.12	8.04
8.0	79.21	11.76	11.32	10.81	10.65	10.48	10.34	10.19	9.93	9.70	9.50	9.32	9.15	9.00	8.86	8.73	8.61	8.50	8.40	8.31	8.22

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2½" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
1.5	14.85	0.85	0.82	0.79	0.77	0.74	0.72	0.70	0.67	0.64	0.61	0.59	0.57	0.55	0.53	0.52	0.51	0.50	0.49	0.48	0.47
1.6	15.84	0.95	0.92	0.88	0.86	0.83	0.81	0.78	0.74	0.71	0.68	0.66	0.63	0.62	0.60	0.58	0.57	0.56	0.55	0.53	0.53
1.7	16.83	1.05	1.02	0.98	0.95	0.92	0.90	0.87	0.83	0.79	0.76	0.73	0.71	0.68	0.66	0.65	0.63	0.62	0.61	0.59	0.59
1.8	17.82	1.16	1.12	1.08	1.05	1.02	0.99	0.96	0.91	0.87	0.84	0.81	0.78	0.76	0.74	0.72	0.70	0.68	0.67	0.66	0.65
1.9	18.81	1.27	1.23	1.19	1.15	1.12	1.09	1.06	1.00	0.96	0.92	0.89	0.86	0.83	0.81	0.79	0.77	0.75	0.74	0.72	0.71
2.0	19.80	1.39	1.35	1.30	1.26	1.22	1.19	1.15	1.10	1.05	1.01	0.97	0.94	0.91	0.89	0.86	0.84	0.83	0.81	0.79	0.78
2.1	20.79	1.51	1.46	1.41	1.37	1.33	1.29	1.26	1.20	1.14	1.10	1.06	1.02	0.99	0.97	0.94	0.92	0.90	0.88	0.87	0.85
2.2	21.78	1.64	1.59	1.53	1.49	1.44	1.40	1.36	1.30	1.24	1.19	1.15	1.11	1.08	1.05	1.02	1.00	0.98	0.96	0.94	0.93
2.3	22.77	1.77	1.71	1.65	1.61	1.56	1.52	1.47	1.40	1.34	1.29	1.24	1.20	1.17	1.13	1.11	1.08	1.06	1.04	1.02	1.00
2.4	23.76	1.90	1.84	1.78	1.73	1.68	1.63	1.59	1.51	1.44	1.39	1.34	1.30	1.26	1.22	1.19	1.17	1.14	1.12	1.10	1.08
2.5	24.75	2.04	1.98	1.91	1.86	1.80	1.75	1.70	1.62	1.55	1.49	1.44	1.39	1.35	1.31	1.28	1.25	1.23	1.20	1.18	1.16
2.6	25.74	2.18	2.12	2.04	1.99	1.93	1.88	1.82	1.74	1.66	1.60	1.54	1.49	1.45	1.41	1.38	1.35	1.32	1.29	1.27	1.25
2.7	26.73	2.33	2.26	2.18	2.12	2.06	2.00	1.95	1.86	1.78	1.71	1.65	1.60	1.55	1.51	1.47	1.44	1.41	1.38	1.36	1.34
2.8	27.72	2.48	2.40	2.32	2.26	2.19	2.13	2.08	1.98	1.89	1.82	1.76	1.70	1.65	1.61	1.57	1.53	1.50	1.47	1.45	1.43
2.9	28.71	2.64	2.56	2.47	2.40	2.33	2.27	2.21	2.10	2.01	1.94	1.87	1.81	1.76	1.71	1.67	1.63	1.60	1.57	1.54	1.52
3.0	29.70	2.80	2.71	2.62	2.55	2.47	2.41	2.34	2.23	2.14	2.06	1.98	1.92	1.87	1.82	1.78	1.74	1.70	1.67	1.64	1.61
3.1	30.69	2.96	2.87	2.77	2.70	2.62	2.55	2.48	2.36	2.27	2.18	2.10	2.04	1.98	1.93	1.88	1.84	1.80	1.77	1.73	1.71
3.2	31.68	3.13	3.03	2.93	2.85	2.76	2.70	2.62	2.50	2.40	2.30	2.22	2.16	2.09	2.04	1.99	1.95	1.91	1.87	1.84	1.81
3.3	32.67	3.30	3.20	3.09	3.01	2.92	2.84	2.77	2.64	2.53	2.43	2.35	2.28	2.21	2.15	2.10	2.06	2.01	1.98	1.94	1.91
3.4	33.66	3.47	3.37	3.25	3.17	3.07	3.00	2.92	2.78	2.67	2.57	2.48	2.40	2.33	2.27	2.22	2.17	2.12	2.08	2.05	2.02
3.5	34.65	3.65	3.54	3.42	3.33	3.23	3.15	3.07	2.93	2.81	2.70	2.61	2.53	2.46	2.39	2.34	2.28	2.24	2.20	2.16	2.12
3.6	35.64	3.83	3.72	3.60	3.50	3.40	3.31	3.22	3.08	2.95	2.84	2.74	2.66	2.58	2.51	2.46	2.40	2.35	2.31	2.27	2.23
3.7	36.63	4.02	3.90	3.77	3.67	3.56	3.48	3.38	3.23	3.09	2.98	2.88	2.79	2.71	2.64	2.58	2.52	2.47	2.43	2.38	2.35
3.8	37.62	4.21	4.09	3.95	3.85	3.73	3.64	3.54	3.38	3.24	3.12	3.02	2.92	2.84	2.77	2.71	2.65	2.59	2.54	2.50	2.46
3.9	38.61	4.41	4.28	4.13	4.02	3.91	3.81	3.71	3.54	3.40	3.27	3.16	3.06	2.98	2.90	2.83	2.77	2.71	2.66	2.62	2.58
4.0	39.60	4.60	4.47	4.32	4.21	4.08	3.98	3.88	3.70	3.55	3.42	3.30	3.20	3.11	3.03	2.96	2.90	2.84	2.79	2.74	2.70
4.1	40.59	4.81	4.66	4.51	4.39	4.27	4.16	4.05	3.87	3.71	3.57	3.45	3.35	3.25	3.17	3.10	3.03	2.97	2.91	2.86	2.82
4.2	41.58	5.01	4.86	4.71	4.58	4.45	4.34	4.23	4.04	3.87	3.73	3.60	3.49	3.40	3.31	3.23	3.16	3.10	3.04	2.99	2.95
4.3	42.57	5.22	5.07	4.90	4.77	4.64	4.52	4.40	4.21	4.04	3.89	3.76	3.64	3.54	3.45	3.37	3.30	3.23	3.17	3.12	3.07
4.4	43.57	5.44	5.28	5.10	4.97	4.83	4.71	4.59	4.38	4.20	4.05	3.91	3.80	3.69	3.59	3.52	3.44	3.37	3.31	3.25	3.20
4.5	44.56	5.65	5.49	5.31	5.17	5.02	4.90	4.77	4.56	4.37	4.21	4.07	3.95	3.84	3.74	3.66	3.58	3.51	3.44	3.38	3.34
4.6	45.55	5.87	5.70	5.52	5.37	5.22	5.09	4.96	4.74	4.55	4.38	4.23	4.11	3.99	3.89	3.81	3.72	3.65	3.58	3.52	3.47
4.7	46.54	6.10	5.92	5.73	5.58	5.42	5.29	5.15	4.92	4.72	4.55	4.40	4.27	4.15	4.04	3.96	3.87	3.79	3.72	3.66	3.61
4.8	47.53	6.33	6.14	5.94	5.79	5.62	5.49	5.35	5.11	4.90	4.72	4.57	4.43	4.31	4.20	4.11	4.02	3.94	3.87	3.80	3.75
4.9	48.52	6.56	6.37	6.16	6.00	5.83	5.69	5.54	5.30	5.09	4.90	4.74	4.60	4.47	4.35	4.26	4.17	4.08	4.01	3.94	3.89

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2½" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
5.0	49.51	6.79	6.60	6.38	6.22	6.04	5.90	5.74	5.49	5.27	5.08	4.91	4.77	4.64	4.52	4.42	4.32	4.24	4.16	4.09	4.03
5.1	50.50	7.03	6.83	6.61	6.44	6.26	6.11	5.95	5.69	5.46	5.26	5.09	4.94	4.80	4.68	4.58	4.48	4.39	4.31	4.24	4.18
5.2	51.49	7.27	7.06	6.84	6.66	6.47	6.32	6.16	5.89	5.65	5.45	5.27	5.11	4.97	4.84	4.74	4.64	4.54	4.47	4.39	4.33
5.3	52.48	7.52	7.30	7.07	6.89	6.70	6.54	6.37	6.09	5.84	5.63	5.45	5.29	5.14	5.01	4.90	4.80	4.70	4.62	4.54	4.48
5.4	53.47	7.77	7.55	7.31	7.12	6.92	6.75	6.58	6.29	6.04	5.82	5.63	5.47	5.32	5.18	5.07	4.96	4.86	4.78	4.69	4.63
5.5	54.46	8.02	7.79	7.55	7.35	7.15	6.98	6.80	6.50	6.24	6.02	5.82	5.65	5.50	5.35	5.24	5.13	5.03	4.94	4.85	4.79
5.6	55.45	8.28	8.04	7.79	7.59	7.38	7.20	7.02	6.71	6.44	6.21	6.01	5.83	5.68	5.53	5.41	5.30	5.19	5.10	5.01	4.95
5.7	56.44	8.54	8.30	8.03	7.83	7.61	7.43	7.24	6.92	6.65	6.41	6.20	6.02	5.86	5.71	5.59	5.47	5.36	5.27	5.17	5.11
5.8	57.43	8.80	8.55	8.28	8.07	7.85	7.66	7.46	7.14	6.86	6.61	6.40	6.21	6.04	5.89	5.77	5.64	5.53	5.43	5.34	5.27
5.9	58.42	9.07	8.81	8.54	8.32	8.09	7.90	7.69	7.36	7.07	6.82	6.60	6.40	6.23	6.07	5.94	5.82	5.70	5.60	5.51	5.43
6.0	59.41	9.34	9.08	8.79	8.57	8.33	8.13	7.93	7.58	7.28	7.03	6.80	6.60	6.42	6.26	6.13	6.00	5.88	5.78	5.68	5.60
6.1	60.40	9.62	9.34	9.05	8.82	8.58	8.38	8.16	7.81	7.50	7.24	7.00	6.80	6.61	6.45	6.31	6.18	6.05	5.95	5.85	5.77
6.2	61.39	9.89	9.61	9.31	9.08	8.83	8.62	8.40	8.04	7.72	7.45	7.21	7.00	6.81	6.64	6.50	6.36	6.23	6.13	6.02	5.94
6.3	62.38	10.18	9.89	9.58	9.34	9.08	8.87	8.64	8.27	7.94	7.66	7.41	7.20	7.01	6.83	6.69	6.55	6.42	6.31	6.20	6.12
6.4	63.37	10.46	10.17	9.85	9.60	9.33	9.12	8.88	8.50	8.17	7.88	7.63	7.41	7.21	7.03	6.88	6.74	6.60	6.49	6.38	6.29
6.5	64.36	10.75	10.45	10.12	9.87	9.59	9.37	9.13	8.74	8.40	8.10	7.84	7.61	7.41	7.22	7.07	6.93	6.79	6.67	6.56	6.47
6.6	65.35	11.04	10.73	10.40	10.14	9.86	9.63	9.38	8.98	8.63	8.33	8.06	7.83	7.62	7.42	7.27	7.12	6.98	6.86	6.74	6.65
6.7	66.34	11.34	11.02	10.67	10.41	10.12	9.89	9.63	9.22	8.86	8.55	8.28	8.04	7.82	7.63	7.47	7.31	7.17	7.05	6.93	6.83
6.8	67.33	11.63	11.31	10.96	10.68	10.39	10.15	9.89	9.47	9.10	8.78	8.50	8.25	8.04	7.83	7.67	7.51	7.36	7.24	7.11	7.02
6.9	68.32	11.94	11.60	11.24	10.96	10.66	10.41	10.15	9.72	9.34	9.01	8.72	8.47	8.25	8.04	7.88	7.71	7.56	7.43	7.30	7.21
7.0	69.31	12.24	11.90	11.53	11.24	10.93	10.68	10.41	9.97	9.58	9.25	8.95	8.69	8.46	8.25	8.08	7.91	7.76	7.63	7.50	7.40
7.1	70.30	12.55	12.20	11.82	11.53	11.21	10.95	10.68	10.22	9.83	9.48	9.18	8.92	8.68	8.46	8.29	8.12	7.96	7.82	7.69	7.59
7.2	71.29	12.86	12.50	12.12	11.82	11.49	11.23	10.95	10.48	10.08	9.72	9.41	9.14	8.90	8.68	8.50	8.33	8.16	8.02	7.89	7.78
7.3	72.28	13.18	12.81	12.42	12.11	11.78	11.51	11.22	10.74	10.33	9.97	9.65	9.37	9.13	8.90	8.72	8.53	8.37	8.23	8.09	7.98
7.4	73.27	13.50	13.12	12.72	12.40	12.06	11.79	11.49	11.00	10.58	10.21	9.89	9.60	9.35	9.12	8.93	8.75	8.57	8.43	8.29	8.18
7.5	74.26	13.82	13.43	13.02	12.70	12.35	12.07	11.77	11.27	10.84	10.46	10.13	9.84	9.58	9.34	9.15	8.96	8.78	8.64	8.49	8.38
7.6	75.25	14.14	13.75	13.33	13.00	12.65	12.36	12.05	11.54	11.09	10.71	10.37	10.07	9.81	9.57	9.37	9.18	9.00	8.85	8.70	8.58
7.7	76.24	14.47	14.07	13.64	13.30	12.94	12.65	12.33	11.81	11.36	10.96	10.61	10.31	10.04	9.79	9.59	9.40	9.21	9.06	8.90	8.79
7.8	77.23	14.80	14.39	13.95	13.61	13.24	12.94	12.61	12.08	11.62	11.22	10.86	10.55	10.28	10.02	9.82	9.62	9.43	9.27	9.11	9.00
7.9	78.22	15.14	14.72	14.27	13.92	13.54	13.23	12.90	12.36	11.89	11.48	11.11	10.80	10.52	10.26	10.05	9.84	9.65	9.49	9.33	9.21
8.0	79.21	15.48	15.05	14.59	14.23	13.85	13.53	13.19	12.64	12.16	11.74	11.37	11.04	10.76	10.49	10.28	10.07	9.87	9.71	9.54	9.42

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2½" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
1.5	14.85	1.00	0.96	0.91	0.88	0.84	0.82	0.79	0.74	0.70	0.67	0.64	0.61	0.59	0.57	0.55	0.54	0.53	0.51	0.50	0.49
1.6	15.84	1.11	1.07	1.02	0.98	0.94	0.91	0.88	0.83	0.78	0.75	0.71	0.69	0.66	0.64	0.62	0.60	0.59	0.58	0.56	0.55
1.7	16.83	1.23	1.18	1.13	1.09	1.05	1.01	0.98	0.92	0.87	0.83	0.79	0.76	0.74	0.71	0.69	0.67	0.66	0.64	0.63	0.62
1.8	17.82	1.36	1.30	1.24	1.20	1.15	1.12	1.08	1.01	0.96	0.92	0.88	0.84	0.81	0.79	0.76	0.74	0.72	0.71	0.69	0.68
1.9	18.81	1.49	1.43	1.36	1.32	1.27	1.23	1.18	1.11	1.05	1.01	0.96	0.93	0.89	0.86	0.84	0.82	0.80	0.78	0.76	0.75
2.0	19.80	1.62	1.56	1.49	1.44	1.38	1.34	1.29	1.22	1.15	1.10	1.05	1.01	0.98	0.95	0.92	0.90	0.87	0.86	0.84	0.82
2.1	20.79	1.76	1.69	1.62	1.56	1.50	1.46	1.41	1.32	1.26	1.20	1.15	1.10	1.07	1.03	1.00	0.98	0.95	0.93	0.91	0.90
2.2	21.78	1.91	1.83	1.75	1.69	1.63	1.58	1.52	1.44	1.36	1.30	1.24	1.20	1.16	1.12	1.09	1.06	1.03	1.01	0.99	0.97
2.3	22.77	2.06	1.98	1.89	1.83	1.76	1.70	1.64	1.55	1.47	1.40	1.35	1.29	1.25	1.21	1.18	1.15	1.12	1.10	1.07	1.05
2.4	23.76	2.21	2.13	2.04	1.97	1.89	1.83	1.77	1.67	1.58	1.51	1.45	1.39	1.35	1.30	1.27	1.24	1.21	1.18	1.16	1.14
2.5	24.75	2.37	2.28	2.18	2.11	2.03	1.97	1.90	1.79	1.70	1.62	1.56	1.50	1.45	1.40	1.36	1.33	1.30	1.27	1.24	1.22
2.6	25.74	2.54	2.44	2.34	2.26	2.17	2.10	2.03	1.92	1.82	1.74	1.67	1.61	1.55	1.50	1.46	1.43	1.39	1.36	1.33	1.31
2.7	26.73	2.71	2.60	2.49	2.41	2.32	2.25	2.17	2.05	1.95	1.86	1.78	1.72	1.66	1.61	1.56	1.52	1.49	1.46	1.42	1.40
2.8	27.72	2.88	2.77	2.65	2.56	2.47	2.39	2.31	2.18	2.07	1.98	1.90	1.83	1.77	1.71	1.67	1.63	1.59	1.55	1.52	1.49
2.9	28.71	3.06	2.94	2.82	2.72	2.62	2.54	2.46	2.32	2.20	2.11	2.02	1.95	1.88	1.82	1.77	1.73	1.69	1.66	1.62	1.59
3.0	29.70	3.24	3.12	2.99	2.89	2.78	2.70	2.61	2.46	2.34	2.24	2.15	2.07	2.00	1.94	1.88	1.84	1.79	1.76	1.72	1.69
3.1	30.69	3.43	3.30	3.16	3.06	2.94	2.86	2.76	2.61	2.48	2.37	2.27	2.19	2.12	2.05	2.00	1.95	1.90	1.86	1.82	1.79
3.2	31.68	3.62	3.49	3.34	3.23	3.11	3.02	2.92	2.76	2.62	2.50	2.40	2.32	2.24	2.17	2.11	2.06	2.01	1.97	1.93	1.90
3.3	32.67	3.82	3.68	3.52	3.41	3.28	3.18	3.08	2.91	2.76	2.64	2.54	2.44	2.36	2.29	2.23	2.18	2.12	2.08	2.04	2.00
3.4	33.66	4.02	3.87	3.71	3.59	3.45	3.35	3.24	3.06	2.91	2.79	2.68	2.58	2.49	2.42	2.35	2.30	2.24	2.20	2.15	2.11
3.5	34.65	4.23	4.07	3.90	3.77	3.63	3.53	3.41	3.22	3.07	2.93	2.82	2.71	2.62	2.54	2.48	2.42	2.36	2.31	2.26	2.23
3.6	35.64	4.44	4.27	4.09	3.96	3.81	3.70	3.58	3.39	3.22	3.08	2.96	2.85	2.76	2.67	2.60	2.54	2.48	2.43	2.38	2.34
3.7	36.63	4.65	4.48	4.29	4.15	4.00	3.88	3.76	3.55	3.38	3.23	3.11	2.99	2.90	2.81	2.73	2.67	2.60	2.56	2.50	2.46
3.8	37.62	4.87	4.69	4.49	4.35	4.19	4.07	3.94	3.72	3.54	3.39	3.26	3.14	3.04	2.94	2.87	2.80	2.73	2.68	2.62	2.58
3.9	38.61	5.09	4.90	4.70	4.55	4.38	4.26	4.12	3.90	3.71	3.55	3.41	3.29	3.18	3.08	3.00	2.93	2.86	2.81	2.75	2.70
4.0	39.60	5.32	5.12	4.91	4.75	4.58	4.45	4.31	4.07	3.88	3.71	3.56	3.44	3.33	3.23	3.14	3.07	2.99	2.94	2.87	2.83
4.1	40.59	5.55	5.35	5.13	4.96	4.78	4.64	4.50	4.25	4.05	3.87	3.72	3.59	3.47	3.37	3.28	3.20	3.13	3.07	3.00	2.95
4.2	41.58	5.78	5.57	5.34	5.17	4.99	4.84	4.69	4.44	4.22	4.04	3.89	3.75	3.63	3.52	3.43	3.35	3.26	3.20	3.14	3.09
4.3	42.57	6.02	5.80	5.57	5.39	5.20	5.05	4.89	4.62	4.40	4.21	4.05	3.91	3.78	3.67	3.57	3.49	3.40	3.34	3.27	3.22
4.4	43.57	6.27	6.04	5.79	5.61	5.41	5.25	5.09	4.81	4.58	4.39	4.22	4.07	3.94	3.82	3.72	3.63	3.55	3.48	3.41	3.35
4.5	44.56	6.51	6.28	6.02	5.83	5.62	5.46	5.29	5.01	4.77	4.57	4.39	4.23	4.10	3.98	3.87	3.78	3.69	3.63	3.55	3.49
4.6	45.55	6.77	6.52	6.26	6.06	5.84	5.68	5.50	5.21	4.96	4.75	4.56	4.40	4.26	4.14	4.03	3.94	3.84	3.77	3.69	3.63
4.7	46.54	7.02	6.77	6.50	6.29	6.07	5.89	5.71	5.41	5.15	4.93	4.74	4.57	4.43	4.30	4.19	4.09	3.99	3.92	3.84	3.77
4.8	47.53	7.28	7.02	6.74	6.53	6.29	6.12	5.92	5.61	5.34	5.12	4.92	4.75	4.60	4.46	4.35	4.25	4.14	4.07	3.98	3.92
4.9	48.52	7.55	7.28	6.98	6.76	6.53	6.34	6.14	5.82	5.54	5.31	5.10	4.92	4.77	4.63	4.51	4.41	4.30	4.22	4.13	4.07

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2½" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
5.0	49.51	7.82	7.54	7.23	7.01	6.76	6.57	6.36	6.03	5.74	5.50	5.29	5.10	4.94	4.80	4.67	4.57	4.46	4.38	4.29	4.22
5.1	50.50	8.09	7.80	7.49	7.25	7.00	6.80	6.59	6.24	5.95	5.70	5.48	5.29	5.12	4.97	4.84	4.73	4.62	4.54	4.44	4.37
5.2	51.49	8.37	8.07	7.74	7.50	7.24	7.03	6.82	6.46	6.15	5.90	5.67	5.47	5.30	5.15	5.01	4.90	4.78	4.70	4.60	4.53
5.3	52.48	8.65	8.34	8.01	7.76	7.48	7.27	7.05	6.68	6.36	6.10	5.87	5.66	5.48	5.32	5.19	5.07	4.95	4.86	4.76	4.68
5.4	53.47	8.93	8.61	8.27	8.01	7.73	7.52	7.28	6.90	6.58	6.30	6.06	5.85	5.67	5.50	5.36	5.24	5.12	5.03	4.92	4.84
5.5	54.46	9.22	8.89	8.54	8.27	7.98	7.76	7.52	7.13	6.79	6.51	6.27	6.05	5.86	5.69	5.54	5.42	5.29	5.19	5.09	5.01
5.6	55.45	9.51	9.18	8.81	8.54	8.24	8.01	7.76	7.36	7.01	6.72	6.47	6.24	6.05	5.87	5.72	5.59	5.46	5.36	5.25	5.17
5.7	56.44	9.81	9.46	9.09	8.81	8.50	8.26	8.01	7.59	7.24	6.94	6.68	6.44	6.24	6.06	5.91	5.77	5.64	5.54	5.42	5.34
5.8	57.43	10.11	9.75	9.37	9.08	8.76	8.52	8.26	7.83	7.46	7.15	6.88	6.65	6.44	6.25	6.09	5.96	5.82	5.71	5.60	5.51
5.9	58.42	10.41	10.05	9.65	9.35	9.03	8.78	8.51	8.07	7.69	7.37	7.10	6.85	6.64	6.45	6.28	6.14	6.00	5.89	5.77	5.68
6.0	59.41	10.72	10.35	9.94	9.63	9.30	9.04	8.76	8.31	7.92	7.60	7.31	7.06	6.84	6.64	6.48	6.33	6.18	6.07	5.95	5.85
6.1	60.40	11.03	10.65	10.23	9.91	9.57	9.31	9.02	8.56	8.16	7.82	7.53	7.27	7.05	6.84	6.67	6.52	6.37	6.25	6.13	6.03
6.2	61.39	11.35	10.95	10.52	10.20	9.85	9.58	9.28	8.80	8.40	8.05	7.75	7.48	7.25	7.04	6.87	6.71	6.56	6.44	6.31	6.21
6.3	62.38	11.67	11.26	10.82	10.49	10.13	9.85	9.55	9.06	8.64	8.28	7.97	7.70	7.46	7.25	7.07	6.91	6.75	6.63	6.49	6.39
6.4	63.37	11.99	11.58	11.12	10.78	10.41	10.13	9.82	9.31	8.88	8.52	8.20	7.92	7.68	7.46	7.27	7.11	6.94	6.82	6.68	6.57
6.5	64.36	12.32	11.89	11.43	11.08	10.70	10.40	10.09	9.57	9.13	8.76	8.43	8.14	7.89	7.67	7.47	7.31	7.14	7.01	6.87	6.76
6.6	65.35	12.65	12.21	11.74	11.38	10.99	10.69	10.36	9.83	9.38	9.00	8.66	8.37	8.11	7.88	7.68	7.51	7.34	7.21	7.06	6.95
6.7	66.34	12.99	12.54	12.05	11.68	11.28	10.97	10.64	10.10	9.63	9.24	8.90	8.59	8.33	8.09	7.89	7.71	7.54	7.40	7.25	7.14
6.8	67.33	13.33	12.87	12.37	11.99	11.58	11.26	10.92	10.36	9.89	9.49	9.14	8.82	8.55	8.31	8.10	7.92	7.74	7.60	7.45	7.33
6.9	68.32	13.67	13.20	12.68	12.30	11.88	11.56	11.21	10.64	10.15	9.74	9.38	9.06	8.78	8.53	8.32	8.13	7.94	7.81	7.65	7.53
7.0	69.31	14.02	13.53	13.01	12.61	12.19	11.85	11.49	10.91	10.41	9.99	9.62	9.29	9.01	8.75	8.53	8.34	8.15	8.01	7.85	7.73
7.1	70.30	14.37	13.87	13.33	12.93	12.49	12.15	11.78	11.19	10.68	10.24	9.87	9.53	9.24	8.98	8.75	8.56	8.36	8.22	8.05	7.93
7.2	71.29	14.72	14.22	13.67	13.25	12.80	12.45	12.08	11.47	10.94	10.50	10.11	9.77	9.47	9.20	8.98	8.78	8.58	8.43	8.26	8.13
7.3	72.28	15.08	14.56	14.00	13.58	13.12	12.76	12.38	11.75	11.21	10.76	10.37	10.01	9.71	9.43	9.20	9.00	8.79	8.64	8.46	8.33
7.4	73.27	15.44	14.91	14.34	13.90	13.43	13.07	12.68	12.04	11.49	11.02	10.62	10.26	9.95	9.67	9.43	9.22	9.01	8.85	8.67	8.54
7.5	74.26	15.81	15.27	14.68	14.24	13.76	13.38	12.98	12.33	11.77	11.29	10.88	10.51	10.19	9.90	9.66	9.45	9.23	9.07	8.89	8.75
7.6	75.25	16.17	15.62	15.02	14.57	14.08	13.70	13.29	12.62	12.04	11.56	11.14	10.76	10.44	10.14	9.89	9.67	9.45	9.29	9.10	8.96
7.7	76.24	16.55	15.98	15.37	14.91	14.41	14.02	13.60	12.91	12.33	11.83	11.40	11.01	10.68	10.38	10.13	9.90	9.68	9.51	9.32	9.18
7.8	77.23	16.92	16.35	15.72	15.25	14.74	14.34	13.91	13.21	12.61	12.11	11.66	11.27	10.93	10.62	10.36	10.14	9.90	9.73	9.54	9.39
7.9	78.22	17.30	16.72	16.08	15.59	15.07	14.67	14.23	13.51	12.90	12.38	11.93	11.53	11.18	10.87	10.60	10.37	10.13	9.96	9.76	9.61
8.0	79.21	17.69	17.09	16.43	15.94	15.41	14.99	14.55	13.82	13.19	12.66	12.20	11.79	11.44	11.12	10.84	10.61	10.37	10.19	9.98	9.83

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2½" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
1.5	14.85	1.14	1.09	1.03	0.99	0.95	0.92	0.88	0.82	0.77	0.73	0.70	0.67	0.64	0.62	0.60	0.58	0.56	0.55	0.53	0.52
1.6	15.84	1.27	1.21	1.15	1.11	1.06	1.02	0.98	0.92	0.86	0.82	0.78	0.75	0.72	0.69	0.67	0.65	0.63	0.61	0.60	0.58
1.7	16.83	1.40	1.34	1.28	1.23	1.17	1.13	1.09	1.02	0.96	0.91	0.87	0.83	0.80	0.77	0.74	0.72	0.70	0.68	0.66	0.65
1.8	17.82	1.54	1.48	1.40	1.35	1.29	1.25	1.20	1.12	1.06	1.00	0.96	0.91	0.88	0.85	0.82	0.79	0.77	0.75	0.73	0.72
1.9	18.81	1.69	1.62	1.54	1.48	1.42	1.37	1.32	1.23	1.16	1.10	1.05	1.00	0.97	0.93	0.90	0.87	0.85	0.83	0.81	0.79
2.0	19.80	1.84	1.76	1.68	1.62	1.55	1.49	1.44	1.35	1.27	1.20	1.15	1.10	1.06	1.02	0.99	0.96	0.93	0.90	0.88	0.86
2.1	20.79	2.00	1.92	1.82	1.76	1.68	1.62	1.56	1.46	1.38	1.31	1.25	1.20	1.15	1.11	1.07	1.04	1.01	0.99	0.96	0.94
2.2	21.78	2.16	2.07	1.97	1.90	1.82	1.76	1.69	1.59	1.50	1.42	1.35	1.30	1.25	1.20	1.17	1.13	1.10	1.07	1.05	1.02
2.3	22.77	2.33	2.23	2.13	2.05	1.96	1.90	1.83	1.71	1.62	1.53	1.46	1.40	1.35	1.30	1.26	1.22	1.19	1.16	1.13	1.11
2.4	23.76	2.51	2.40	2.29	2.20	2.11	2.04	1.97	1.84	1.74	1.65	1.58	1.51	1.45	1.40	1.36	1.32	1.28	1.25	1.22	1.19
2.5	24.75	2.68	2.57	2.45	2.36	2.26	2.19	2.11	1.98	1.87	1.77	1.69	1.62	1.56	1.51	1.46	1.42	1.38	1.34	1.31	1.28
2.6	25.74	2.87	2.75	2.62	2.53	2.42	2.34	2.26	2.12	2.00	1.90	1.81	1.74	1.67	1.61	1.56	1.52	1.48	1.44	1.41	1.38
2.7	26.73	3.06	2.93	2.80	2.69	2.58	2.50	2.41	2.26	2.13	2.03	1.94	1.86	1.79	1.73	1.67	1.62	1.58	1.54	1.50	1.47
2.8	27.72	3.25	3.12	2.98	2.87	2.75	2.66	2.56	2.41	2.27	2.16	2.06	1.98	1.91	1.84	1.78	1.73	1.68	1.64	1.61	1.57
2.9	28.71	3.45	3.31	3.16	3.05	2.92	2.83	2.72	2.56	2.42	2.30	2.20	2.11	2.03	1.96	1.90	1.84	1.79	1.75	1.71	1.67
3.0	29.70	3.66	3.51	3.35	3.23	3.10	3.00	2.89	2.71	2.56	2.44	2.33	2.23	2.15	2.08	2.01	1.96	1.90	1.86	1.81	1.78
3.1	30.69	3.87	3.71	3.54	3.41	3.28	3.17	3.06	2.87	2.71	2.58	2.47	2.37	2.28	2.20	2.13	2.07	2.02	1.97	1.92	1.88
3.2	31.68	4.08	3.92	3.74	3.61	3.46	3.35	3.23	3.03	2.87	2.73	2.61	2.50	2.41	2.33	2.26	2.19	2.13	2.08	2.04	1.99
3.3	32.67	4.30	4.13	3.94	3.80	3.65	3.53	3.40	3.20	3.03	2.88	2.75	2.64	2.54	2.46	2.38	2.32	2.25	2.20	2.15	2.10
3.4	33.66	4.52	4.34	4.15	4.00	3.84	3.72	3.59	3.37	3.19	3.03	2.90	2.78	2.68	2.59	2.51	2.44	2.38	2.32	2.27	2.22
3.5	34.65	4.75	4.56	4.36	4.21	4.04	3.91	3.77	3.55	3.35	3.19	3.05	2.93	2.82	2.73	2.64	2.57	2.50	2.44	2.39	2.34
3.6	35.64	4.99	4.79	4.58	4.41	4.24	4.10	3.96	3.72	3.52	3.35	3.21	3.08	2.97	2.87	2.78	2.70	2.63	2.56	2.51	2.46
3.7	36.63	5.23	5.02	4.80	4.63	4.44	4.30	4.15	3.91	3.70	3.52	3.37	3.23	3.11	3.01	2.92	2.84	2.76	2.69	2.64	2.58
3.8	37.62	5.47	5.25	5.02	4.84	4.65	4.51	4.35	4.09	3.87	3.69	3.53	3.39	3.26	3.15	3.06	2.97	2.90	2.82	2.76	2.71
3.9	38.61	5.72	5.49	5.25	5.07	4.87	4.71	4.55	4.28	4.05	3.86	3.69	3.54	3.42	3.30	3.20	3.12	3.03	2.96	2.90	2.83
4.0	39.60	5.97	5.74	5.48	5.29	5.09	4.92	4.75	4.47	4.24	4.03	3.86	3.71	3.57	3.45	3.35	3.26	3.17	3.09	3.03	2.97
4.1	40.59	6.23	5.99	5.72	5.52	5.31	5.14	4.96	4.67	4.42	4.21	4.03	3.87	3.73	3.61	3.50	3.40	3.31	3.23	3.17	3.10
4.2	41.58	6.49	6.24	5.96	5.76	5.53	5.36	5.17	4.87	4.61	4.39	4.21	4.04	3.90	3.77	3.65	3.55	3.46	3.38	3.30	3.24
4.3	42.57	6.76	6.49	6.21	6.00	5.76	5.58	5.39	5.08	4.81	4.58	4.38	4.21	4.06	3.93	3.81	3.71	3.61	3.52	3.45	3.37
4.4	43.57	7.03	6.76	6.46	6.24	6.00	5.81	5.61	5.28	5.01	4.77	4.56	4.39	4.23	4.09	3.97	3.86	3.76	3.67	3.59	3.52
4.5	44.56	7.30	7.02	6.72	6.49	6.23	6.04	5.83	5.49	5.21	4.96	4.75	4.56	4.40	4.26	4.13	4.02	3.91	3.82	3.74	3.66
4.6	45.55	7.58	7.29	6.98	6.74	6.48	6.28	6.06	5.71	5.41	5.16	4.94	4.74	4.58	4.43	4.29	4.18	4.07	3.97	3.89	3.81
4.7	46.54	7.87	7.57	7.24	6.99	6.72	6.51	6.29	5.93	5.62	5.35	5.13	4.93	4.75	4.60	4.46	4.34	4.23	4.13	4.04	3.96
4.8	47.53	8.16	7.85	7.51	7.25	6.97	6.76	6.53	6.15	5.83	5.56	5.32	5.11	4.93	4.77	4.63	4.51	4.39	4.28	4.19	4.11
4.9	48.52	8.45	8.13	7.78	7.51	7.23	7.00	6.76	6.38	6.04	5.76	5.52	5.30	5.12	4.95	4.80	4.68	4.55	4.44	4.35	4.26

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

2½" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7.2°C	50°F 10°C	55°F 12.8°C	60°F 15.6°C	65°F 18.3°C	70°F 21.1°C	80°F 26.7°C	90°F 32.2°C	100°F 37.8°C	110°F 43.3°C	120°F 48.9°C	130°F 54.4°C	140°F 60°C	150°F 65.6°C	160°F 71.1°C	170°F 76.7°C	180°F 82.2°C	190°F 87.8°C	200°F 93.3°C
5.0	49.51	8.75	8.42	8.06	7.78	7.48	7.25	7.01	6.61	6.26	5.97	5.72	5.50	5.30	5.13	4.98	4.85	4.72	4.61	4.51	4.42
5.1	50.50	9.05	8.71	8.34	8.05	7.75	7.51	7.25	6.84	6.48	6.18	5.92	5.69	5.49	5.32	5.16	5.02	4.89	4.77	4.68	4.58
5.2	51.49	9.36	9.01	8.62	8.33	8.01	7.77	7.50	7.08	6.71	6.40	6.13	5.89	5.69	5.50	5.34	5.20	5.06	4.94	4.84	4.74
5.3	52.48	9.67	9.31	8.91	8.61	8.28	8.03	7.76	7.32	6.94	6.62	6.34	6.09	5.88	5.69	5.52	5.38	5.24	5.11	5.01	4.91
5.4	53.47	9.99	9.61	9.20	8.89	8.56	8.29	8.01	7.56	7.17	6.84	6.55	6.30	6.08	5.88	5.71	5.56	5.42	5.29	5.18	5.07
5.5	54.46	10.31	9.92	9.50	9.18	8.83	8.56	8.27	7.81	7.40	7.06	6.77	6.51	6.28	6.08	5.90	5.74	5.60	5.46	5.35	5.24
5.6	55.45	10.63	10.23	9.80	9.47	9.11	8.84	8.54	8.06	7.64	7.29	6.99	6.72	6.49	6.28	6.09	5.93	5.78	5.64	5.53	5.42
5.7	56.44	10.96	10.55	10.10	9.77	9.40	9.11	8.81	8.31	7.88	7.52	7.21	6.93	6.69	6.48	6.29	6.12	5.97	5.82	5.71	5.59
5.8	57.43	11.30	10.87	10.41	10.06	9.69	9.39	9.08	8.57	8.13	7.76	7.43	7.15	6.90	6.68	6.49	6.32	6.15	6.01	5.89	5.77
5.9	58.42	11.63	11.20	10.73	10.37	9.98	9.68	9.35	8.83	8.38	7.99	7.66	7.37	7.12	6.89	6.69	6.51	6.34	6.20	6.07	5.95
6.0	59.41	11.98	11.53	11.04	10.67	10.28	9.97	9.63	9.09	8.63	8.23	7.89	7.59	7.33	7.10	6.89	6.71	6.54	6.38	6.25	6.13
6.1	60.40	12.32	11.86	11.36	10.99	10.58	10.26	9.91	9.36	8.88	8.48	8.13	7.82	7.55	7.31	7.10	6.91	6.73	6.58	6.44	6.31
6.2	61.39	12.67	12.20	11.69	11.30	10.88	10.55	10.20	9.63	9.14	8.72	8.36	8.05	7.77	7.52	7.31	7.11	6.93	6.77	6.63	6.50
6.3	62.38	13.03	12.54	12.02	11.62	11.19	10.85	10.49	9.90	9.40	8.97	8.60	8.28	7.99	7.74	7.52	7.32	7.13	6.97	6.83	6.69
6.4	63.37	13.39	12.89	12.35	11.94	11.50	11.16	10.78	10.18	9.67	9.23	8.85	8.51	8.22	7.96	7.73	7.53	7.34	7.17	7.02	6.88
6.5	64.36	13.75	13.24	12.69	12.27	11.81	11.46	11.08	10.46	9.93	9.48	9.09	8.75	8.45	8.18	7.95	7.74	7.55	7.37	7.22	7.08
6.6	65.35	14.12	13.60	13.03	12.60	12.13	11.77	11.38	10.75	10.21	9.74	9.34	8.99	8.68	8.41	8.17	7.96	7.75	7.57	7.42	7.27
6.7	66.34	14.49	13.95	13.37	12.93	12.46	12.08	11.68	11.04	10.48	10.01	9.60	9.24	8.92	8.64	8.39	8.17	7.97	7.78	7.62	7.47
6.8	67.33	14.86	14.32	13.72	13.27	12.78	12.40	11.99	11.33	10.76	10.27	9.85	9.48	9.16	8.87	8.62	8.39	8.18	7.99	7.83	7.67
6.9	68.32	15.24	14.68	14.07	13.61	13.11	12.72	12.30	11.62	11.04	10.54	10.11	9.73	9.40	9.10	8.84	8.61	8.40	8.20	8.04	7.88
7.0	69.31	15.63	15.05	14.43	13.96	13.44	13.05	12.62	11.92	11.32	10.81	10.37	9.98	9.64	9.34	9.07	8.84	8.62	8.42	8.25	8.08
7.1	70.30	16.02	15.43	14.79	14.31	13.78	13.37	12.93	12.22	11.61	11.09	10.63	10.24	9.89	9.58	9.31	9.07	8.84	8.63	8.46	8.29
7.2	71.29	16.41	15.81	15.15	14.66	14.12	13.71	13.25	12.53	11.90	11.36	10.90	10.50	10.14	9.82	9.54	9.30	9.06	8.85	8.68	8.50
7.3	72.28	16.80	16.19	15.52	15.02	14.47	14.04	13.58	12.83	12.19	11.65	11.17	10.76	10.39	10.07	9.78	9.53	9.29	9.08	8.89	8.72
7.4	73.27	17.20	16.58	15.89	15.38	14.82	14.38	13.91	13.14	12.49	11.93	11.45	11.02	10.65	10.31	10.02	9.76	9.52	9.30	9.11	8.93
7.5	74.26	17.61	16.97	16.27	15.74	15.17	14.72	14.24	13.46	12.79	12.22	11.72	11.29	10.90	10.57	10.27	10.00	9.75	9.53	9.34	9.15
7.6	75.25	18.02	17.36	16.65	16.11	15.52	15.07	14.57	13.78	13.09	12.51	12.00	11.56	11.17	10.82	10.51	10.24	9.99	9.76	9.56	9.37
7.7	76.24	18.43	17.76	17.03	16.48	15.88	15.41	14.91	14.10	13.40	12.80	12.28	11.83	11.43	11.07	10.76	10.48	10.22	9.99	9.79	9.60
7.8	77.23	18.85	18.16	17.42	16.85	16.24	15.77	15.25	14.42	13.71	13.09	12.57	12.10	11.69	11.33	11.01	10.73	10.46	10.22	10.02	9.82
7.9	78.22	19.27	18.57	17.81	17.23	16.61	16.12	15.60	14.75	14.02	13.39	12.85	12.38	11.96	11.59	11.27	10.98	10.70	10.46	10.25	10.05
8.0	79.21	19.69	18.98	18.20	17.62	16.98	16.48	15.95	15.08	14.33	13.70	13.14	12.66	12.23	11.86	11.52	11.23	10.95	10.70	10.49	10.28

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	21.12	0.49	0.47	0.45	0.44	0.43	0.42	0.42	0.40	0.39	0.38	0.37	0.37	0.36	0.35	0.35	0.34	0.34	0.33	0.33	0.32
1.6	22.53	0.55	0.53	0.50	0.49	0.48	0.47	0.47	0.45	0.44	0.43	0.42	0.41	0.40	0.40	0.39	0.38	0.38	0.37	0.37	0.36
1.7	23.93	0.61	0.59	0.56	0.55	0.54	0.53	0.52	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.43	0.42	0.42	0.41	0.40
1.8	25.34	0.68	0.65	0.61	0.60	0.59	0.58	0.57	0.56	0.54	0.53	0.52	0.51	0.50	0.49	0.48	0.47	0.47	0.46	0.45	0.45
1.9	26.75	0.74	0.71	0.68	0.66	0.65	0.64	0.63	0.61	0.60	0.58	0.57	0.56	0.55	0.54	0.53	0.52	0.51	0.51	0.50	0.49
2.0	28.16	0.81	0.78	0.74	0.73	0.71	0.70	0.69	0.67	0.65	0.64	0.63	0.61	0.60	0.59	0.58	0.57	0.56	0.56	0.55	0.54
2.1	29.57	0.89	0.85	0.81	0.79	0.78	0.77	0.75	0.73	0.71	0.70	0.68	0.67	0.66	0.64	0.63	0.62	0.61	0.61	0.60	0.59
2.2	30.97	0.96	0.92	0.88	0.86	0.85	0.83	0.82	0.80	0.78	0.76	0.74	0.73	0.71	0.70	0.69	0.68	0.67	0.66	0.65	0.64
2.3	32.38	1.04	1.00	0.95	0.93	0.91	0.90	0.89	0.86	0.84	0.82	0.80	0.79	0.77	0.76	0.75	0.73	0.72	0.71	0.71	0.70
2.4	33.79	1.12	1.07	1.02	1.00	0.99	0.97	0.96	0.93	0.91	0.88	0.87	0.85	0.83	0.82	0.80	0.79	0.78	0.77	0.76	0.75
2.5	35.20	1.21	1.16	1.10	1.08	1.06	1.04	1.03	1.00	0.97	0.95	0.93	0.91	0.90	0.88	0.87	0.85	0.84	0.83	0.82	0.81
2.6	36.60	1.29	1.24	1.18	1.16	1.14	1.12	1.10	1.07	1.04	1.02	1.00	0.98	0.96	0.94	0.93	0.92	0.90	0.89	0.88	0.87
2.7	38.01	1.38	1.32	1.26	1.24	1.22	1.20	1.18	1.15	1.12	1.09	1.07	1.05	1.03	1.01	0.99	0.98	0.97	0.95	0.94	0.93
2.8	39.42	1.47	1.41	1.34	1.32	1.30	1.28	1.26	1.22	1.19	1.16	1.14	1.12	1.10	1.08	1.06	1.05	1.03	1.02	1.00	0.99
2.9	40.83	1.57	1.50	1.43	1.40	1.38	1.36	1.34	1.30	1.27	1.24	1.21	1.19	1.17	1.15	1.13	1.11	1.10	1.08	1.07	1.06
3.0	42.24	1.66	1.59	1.52	1.49	1.47	1.44	1.42	1.38	1.35	1.32	1.29	1.26	1.24	1.22	1.20	1.18	1.17	1.15	1.14	1.13
3.1	43.64	1.76	1.69	1.61	1.58	1.55	1.53	1.51	1.47	1.43	1.40	1.37	1.34	1.32	1.29	1.27	1.26	1.24	1.22	1.21	1.19
3.2	45.05	1.86	1.79	1.70	1.67	1.64	1.62	1.60	1.55	1.51	1.48	1.45	1.42	1.39	1.37	1.35	1.33	1.31	1.29	1.28	1.26
3.3	46.46	1.97	1.89	1.80	1.77	1.74	1.71	1.69	1.64	1.60	1.56	1.53	1.50	1.47	1.45	1.43	1.41	1.39	1.37	1.35	1.34
3.4	47.87	2.07	1.99	1.89	1.86	1.83	1.80	1.78	1.73	1.69	1.65	1.61	1.58	1.55	1.53	1.51	1.48	1.46	1.44	1.43	1.41
3.5	49.28	2.18	2.09	1.99	1.96	1.93	1.90	1.87	1.82	1.78	1.74	1.70	1.67	1.64	1.61	1.59	1.56	1.54	1.52	1.50	1.49
3.6	50.68	2.29	2.20	2.10	2.06	2.03	2.00	1.97	1.92	1.87	1.83	1.79	1.75	1.72	1.69	1.67	1.64	1.62	1.60	1.58	1.56
3.7	52.09	2.41	2.31	2.20	2.17	2.13	2.10	2.07	2.01	1.96	1.92	1.88	1.84	1.81	1.78	1.75	1.73	1.70	1.68	1.66	1.64
3.8	53.50	2.52	2.42	2.31	2.27	2.23	2.20	2.17	2.11	2.06	2.01	1.97	1.93	1.90	1.87	1.84	1.81	1.79	1.77	1.74	1.72
3.9	54.91	2.64	2.54	2.42	2.38	2.34	2.31	2.27	2.21	2.16	2.11	2.07	2.03	1.99	1.96	1.93	1.90	1.87	1.85	1.83	1.81
4.0	56.31	2.76	2.65	2.53	2.49	2.45	2.41	2.38	2.31	2.26	2.21	2.16	2.12	2.08	2.05	2.02	1.99	1.96	1.94	1.91	1.89
4.1	57.72	2.89	2.77	2.64	2.60	2.56	2.52	2.48	2.42	2.36	2.31	2.26	2.22	2.18	2.14	2.11	2.08	2.05	2.03	2.00	1.98
4.2	59.13	3.01	2.90	2.76	2.72	2.67	2.63	2.59	2.52	2.46	2.41	2.36	2.31	2.27	2.24	2.20	2.17	2.14	2.12	2.09	2.07
4.3	60.54	3.14	3.02	2.88	2.83	2.78	2.74	2.70	2.63	2.57	2.51	2.46	2.42	2.37	2.33	2.30	2.27	2.24	2.21	2.18	2.16
4.4	61.95	3.27	3.14	3.00	2.95	2.90	2.86	2.82	2.74	2.68	2.62	2.57	2.52	2.47	2.43	2.40	2.36	2.33	2.30	2.27	2.25
4.5	63.35	3.41	3.27	3.12	3.07	3.02	2.98	2.93	2.86	2.79	2.73	2.67	2.62	2.58	2.53	2.50	2.46	2.43	2.40	2.37	2.34
4.6	64.76	3.54	3.40	3.24	3.19	3.14	3.10	3.05	2.97	2.90	2.84	2.78	2.73	2.68	2.64	2.60	2.56	2.53	2.49	2.47	2.44
4.7	66.17	3.68	3.54	3.37	3.32	3.26	3.22	3.17	3.09	3.01	2.95	2.89	2.83	2.79	2.74	2.70	2.66	2.63	2.59	2.56	2.54
4.8	67.58	3.82	3.67	3.50	3.45	3.39	3.34	3.29	3.21	3.13	3.06	3.00	2.94	2.89	2.85	2.80	2.77	2.73	2.69	2.66	2.63
4.9	68.99	3.96	3.81	3.63	3.58	3.52	3.47	3.42	3.33	3.25	3.18	3.11	3.06	3.00	2.96	2.91	2.87	2.83	2.80	2.76	2.73

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	70.39	4.11	3.95	3.77	3.71	3.65	3.60	3.54	3.45	3.37	3.30	3.23	3.17	3.12	3.07	3.02	2.98	2.94	2.90	2.87	2.84
5.1	71.80	4.25	4.09	3.90	3.84	3.78	3.73	3.67	3.57	3.49	3.41	3.35	3.28	3.23	3.18	3.13	3.09	3.04	3.01	2.97	2.94
5.2	73.21	4.40	4.23	4.04	3.98	3.91	3.86	3.80	3.70	3.61	3.54	3.47	3.40	3.34	3.29	3.24	3.20	3.15	3.12	3.08	3.05
5.3	74.62	4.56	4.38	4.18	4.11	4.05	3.99	3.93	3.83	3.74	3.66	3.59	3.52	3.46	3.41	3.36	3.31	3.26	3.23	3.19	3.15
5.4	76.02	4.71	4.53	4.32	4.25	4.18	4.13	4.07	3.96	3.87	3.79	3.71	3.64	3.58	3.52	3.47	3.42	3.38	3.34	3.30	3.26
5.5	77.43	4.87	4.68	4.46	4.40	4.32	4.26	4.20	4.09	4.00	3.91	3.83	3.76	3.70	3.64	3.59	3.54	3.49	3.45	3.41	3.37
5.6	78.84	5.02	4.83	4.61	4.54	4.47	4.40	4.34	4.23	4.13	4.04	3.96	3.89	3.82	3.76	3.71	3.66	3.61	3.56	3.52	3.49
5.7	80.25	5.19	4.99	4.76	4.69	4.61	4.55	4.48	4.37	4.26	4.17	4.09	4.02	3.95	3.89	3.83	3.78	3.73	3.68	3.64	3.60
5.8	81.66	5.35	5.14	4.91	4.83	4.76	4.69	4.62	4.50	4.40	4.31	4.22	4.14	4.07	4.01	3.95	3.90	3.84	3.80	3.76	3.72
5.9	83.06	5.51	5.30	5.06	4.99	4.90	4.84	4.77	4.65	4.54	4.44	4.35	4.27	4.20	4.14	4.07	4.02	3.97	3.92	3.87	3.83
6.0	84.47	5.68	5.47	5.22	5.14	5.05	4.99	4.91	4.79	4.68	4.58	4.49	4.41	4.33	4.26	4.20	4.14	4.09	4.04	3.99	3.95
6.1	85.88	5.85	5.63	5.37	5.29	5.21	5.14	5.06	4.93	4.82	4.72	4.62	4.54	4.46	4.39	4.33	4.27	4.21	4.16	4.12	4.07
6.2	87.29	6.02	5.79	5.53	5.45	5.36	5.29	5.21	5.08	4.96	4.86	4.76	4.67	4.60	4.52	4.46	4.40	4.34	4.29	4.24	4.19
6.3	88.70	6.20	5.96	5.69	5.61	5.52	5.44	5.36	5.23	5.11	5.00	4.90	4.81	4.73	4.66	4.59	4.53	4.47	4.41	4.36	4.32
6.4	90.10	6.37	6.13	5.86	5.77	5.67	5.60	5.52	5.38	5.25	5.14	5.04	4.95	4.87	4.79	4.72	4.66	4.60	4.54	4.49	4.44
6.5	91.51	6.55	6.30	6.02	5.93	5.83	5.76	5.67	5.53	5.40	5.29	5.19	5.09	5.01	4.93	4.86	4.79	4.73	4.67	4.62	4.57
6.6	92.92	6.73	6.48	6.19	6.09	6.00	5.92	5.83	5.68	5.55	5.44	5.33	5.23	5.15	5.07	4.99	4.93	4.86	4.80	4.75	4.70
6.7	94.33	6.92	6.66	6.36	6.26	6.16	6.08	5.99	5.84	5.71	5.59	5.48	5.38	5.29	5.21	5.13	5.06	5.00	4.94	4.88	4.83
6.8	95.73	7.10	6.83	6.53	6.43	6.33	6.24	6.15	6.00	5.86	5.74	5.63	5.52	5.43	5.35	5.27	5.20	5.13	5.07	5.02	4.96
6.9	97.14	7.29	7.02	6.70	6.60	6.50	6.41	6.32	6.16	6.02	5.89	5.78	5.67	5.58	5.49	5.41	5.34	5.27	5.21	5.15	5.10
7.0	98.55	7.48	7.20	6.88	6.77	6.67	6.58	6.48	6.32	6.17	6.05	5.93	5.82	5.73	5.64	5.56	5.48	5.41	5.35	5.29	5.23
7.1	99.96	7.67	7.38	7.05	6.95	6.84	6.75	6.65	6.48	6.34	6.20	6.08	5.97	5.87	5.78	5.70	5.62	5.55	5.49	5.43	5.37
7.2	101.37	7.86	7.57	7.23	7.13	7.01	6.92	6.82	6.65	6.50	6.36	6.24	6.13	6.03	5.93	5.85	5.77	5.70	5.63	5.57	5.51
7.3	102.77	8.06	7.76	7.41	7.30	7.19	7.09	6.99	6.82	6.66	6.52	6.40	6.28	6.18	6.08	6.00	5.92	5.84	5.77	5.71	5.65
7.4	104.18	8.26	7.95	7.60	7.48	7.37	7.27	7.16	6.99	6.83	6.68	6.56	6.44	6.33	6.24	6.15	6.06	5.99	5.92	5.85	5.79
7.5	105.59	8.46	8.14	7.78	7.67	7.55	7.44	7.34	7.16	6.99	6.85	6.72	6.60	6.49	6.39	6.30	6.21	6.13	6.06	6.00	5.93
7.6	107.00	8.66	8.34	7.97	7.85	7.73	7.62	7.52	7.33	7.16	7.01	6.88	6.76	6.65	6.55	6.45	6.37	6.28	6.21	6.14	6.08
7.7	108.41	8.87	8.54	8.16	8.04	7.91	7.81	7.70	7.50	7.33	7.18	7.04	6.92	6.81	6.70	6.61	6.52	6.44	6.36	6.29	6.23
7.8	109.81	9.07	8.74	8.35	8.23	8.10	7.99	7.88	7.68	7.51	7.35	7.21	7.08	6.97	6.86	6.76	6.67	6.59	6.51	6.44	6.37
7.9	111.22	9.28	8.94	8.54	8.42	8.28	8.17	8.06	7.86	7.68	7.52	7.38	7.25	7.13	7.02	6.92	6.83	6.74	6.67	6.59	6.52
8.0	112.63	9.49	9.14	8.74	8.61	8.47	8.36	8.24	8.04	7.86	7.70	7.55	7.42	7.29	7.18	7.08	6.99	6.90	6.82	6.74	6.68

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	21.12	0.68	0.65	0.63	0.61	0.59	0.58	0.56	0.53	0.51	0.49	0.47	0.46	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.38
1.6	22.53	0.76	0.73	0.71	0.69	0.66	0.65	0.63	0.60	0.57	0.55	0.53	0.51	0.49	0.48	0.47	0.46	0.45	0.44	0.43	0.42
1.7	23.93	0.84	0.81	0.78	0.76	0.74	0.72	0.70	0.66	0.63	0.61	0.59	0.57	0.55	0.53	0.52	0.51	0.50	0.49	0.48	0.47
1.8	25.34	0.93	0.90	0.86	0.84	0.81	0.79	0.77	0.73	0.70	0.67	0.65	0.63	0.61	0.59	0.58	0.56	0.55	0.54	0.53	0.52
1.9	26.75	1.02	0.98	0.95	0.92	0.89	0.87	0.85	0.80	0.77	0.74	0.71	0.69	0.67	0.65	0.64	0.62	0.61	0.60	0.58	0.58
2.0	28.16	1.11	1.07	1.04	1.01	0.98	0.95	0.92	0.88	0.84	0.81	0.78	0.76	0.73	0.71	0.70	0.68	0.66	0.65	0.64	0.63
2.1	29.57	1.21	1.17	1.13	1.10	1.06	1.04	1.01	0.96	0.92	0.88	0.85	0.82	0.80	0.78	0.76	0.74	0.72	0.71	0.70	0.69
2.2	30.97	1.31	1.27	1.22	1.19	1.15	1.12	1.09	1.04	1.00	0.96	0.92	0.89	0.87	0.84	0.82	0.81	0.79	0.77	0.76	0.75
2.3	32.38	1.41	1.37	1.32	1.28	1.25	1.21	1.18	1.12	1.08	1.03	1.00	0.97	0.94	0.91	0.89	0.87	0.85	0.84	0.82	0.81
2.4	33.79	1.52	1.47	1.42	1.38	1.34	1.31	1.27	1.21	1.16	1.12	1.08	1.04	1.01	0.98	0.96	0.94	0.92	0.90	0.89	0.87
2.5	35.20	1.63	1.58	1.53	1.48	1.44	1.40	1.36	1.30	1.25	1.20	1.16	1.12	1.09	1.06	1.03	1.01	0.99	0.97	0.95	0.94
2.6	36.60	1.74	1.69	1.63	1.59	1.54	1.50	1.46	1.39	1.34	1.28	1.24	1.20	1.17	1.13	1.11	1.08	1.06	1.04	1.02	1.01
2.7	38.01	1.86	1.81	1.75	1.70	1.65	1.61	1.56	1.49	1.43	1.37	1.33	1.28	1.25	1.21	1.19	1.16	1.13	1.11	1.09	1.08
2.8	39.42	1.98	1.92	1.86	1.81	1.76	1.71	1.66	1.59	1.52	1.46	1.41	1.37	1.33	1.29	1.27	1.24	1.21	1.19	1.17	1.15
2.9	40.83	2.11	2.04	1.98	1.92	1.87	1.82	1.77	1.69	1.62	1.56	1.50	1.46	1.42	1.38	1.35	1.32	1.29	1.27	1.24	1.22
3.0	42.24	2.24	2.17	2.10	2.04	1.98	1.93	1.88	1.79	1.72	1.65	1.60	1.55	1.50	1.46	1.43	1.40	1.37	1.34	1.32	1.30
3.1	43.64	2.37	2.30	2.22	2.16	2.10	2.05	1.99	1.90	1.82	1.75	1.69	1.64	1.59	1.55	1.52	1.48	1.45	1.43	1.40	1.38
3.2	45.05	2.50	2.43	2.35	2.28	2.22	2.16	2.10	2.01	1.93	1.85	1.79	1.74	1.69	1.64	1.61	1.57	1.54	1.51	1.48	1.46
3.3	46.46	2.64	2.56	2.48	2.41	2.34	2.28	2.22	2.12	2.03	1.96	1.89	1.83	1.78	1.73	1.70	1.66	1.62	1.59	1.56	1.54
3.4	47.87	2.78	2.70	2.61	2.54	2.47	2.40	2.34	2.23	2.14	2.06	1.99	1.93	1.88	1.83	1.79	1.75	1.71	1.68	1.65	1.63
3.5	49.28	2.92	2.84	2.74	2.67	2.59	2.53	2.46	2.35	2.26	2.17	2.10	2.04	1.98	1.93	1.88	1.84	1.80	1.77	1.74	1.71
3.6	50.68	3.07	2.98	2.88	2.81	2.73	2.66	2.59	2.47	2.37	2.28	2.21	2.14	2.08	2.02	1.98	1.94	1.90	1.86	1.83	1.80
3.7	52.09	3.22	3.13	3.02	2.94	2.86	2.79	2.72	2.59	2.49	2.40	2.32	2.25	2.18	2.13	2.08	2.03	1.99	1.96	1.92	1.89
3.8	53.50	3.37	3.27	3.17	3.08	3.00	2.92	2.85	2.72	2.61	2.51	2.43	2.36	2.29	2.23	2.18	2.13	2.09	2.05	2.02	1.99
3.9	54.91	3.53	3.43	3.31	3.23	3.14	3.06	2.98	2.85	2.73	2.63	2.54	2.47	2.40	2.34	2.29	2.24	2.19	2.15	2.11	2.08
4.0	56.31	3.69	3.58	3.47	3.38	3.28	3.20	3.12	2.98	2.86	2.75	2.66	2.58	2.51	2.44	2.39	2.34	2.29	2.25	2.21	2.18
4.1	57.72	3.85	3.74	3.62	3.52	3.42	3.34	3.25	3.11	2.98	2.88	2.78	2.70	2.62	2.55	2.50	2.44	2.39	2.35	2.31	2.28
4.2	59.13	4.02	3.90	3.77	3.68	3.57	3.49	3.40	3.25	3.11	3.00	2.90	2.82	2.74	2.67	2.61	2.55	2.50	2.46	2.41	2.38
4.3	60.54	4.18	4.06	3.93	3.83	3.72	3.63	3.54	3.38	3.25	3.13	3.03	2.94	2.85	2.78	2.72	2.66	2.61	2.56	2.52	2.48
4.4	61.95	4.36	4.23	4.09	3.99	3.88	3.78	3.69	3.52	3.38	3.26	3.15	3.06	2.97	2.90	2.84	2.77	2.72	2.67	2.62	2.59
4.5	63.35	4.53	4.40	4.26	4.15	4.03	3.94	3.83	3.67	3.52	3.39	3.28	3.18	3.10	3.02	2.95	2.89	2.83	2.78	2.73	2.69
4.6	64.76	4.71	4.57	4.43	4.31	4.19	4.09	3.99	3.81	3.66	3.53	3.41	3.31	3.22	3.14	3.07	3.00	2.94	2.89	2.84	2.80
4.7	66.17	4.89	4.75	4.60	4.48	4.35	4.25	4.14	3.96	3.80	3.67	3.54	3.44	3.35	3.26	3.19	3.12	3.06	3.01	2.95	2.91
4.8	67.58	5.07	4.93	4.77	4.65	4.52	4.41	4.30	4.11	3.95	3.81	3.68	3.57	3.47	3.39	3.31	3.24	3.18	3.12	3.07	3.03
4.9	68.99	5.26	5.11	4.95	4.82	4.69	4.57	4.46	4.26	4.09	3.95	3.82	3.71	3.61	3.51	3.44	3.37	3.30	3.24	3.18	3.14

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	70.39	5.45	5.29	5.12	4.99	4.85	4.74	4.62	4.42	4.24	4.09	3.96	3.84	3.74	3.64	3.57	3.49	3.42	3.36	3.30	3.26
5.1	71.80	5.64	5.48	5.31	5.17	5.03	4.91	4.78	4.58	4.40	4.24	4.10	3.98	3.87	3.77	3.69	3.62	3.54	3.48	3.42	3.37
5.2	73.21	5.83	5.67	5.49	5.35	5.20	5.08	4.95	4.74	4.55	4.39	4.24	4.12	4.01	3.91	3.83	3.74	3.67	3.61	3.54	3.49
5.3	74.62	6.03	5.86	5.68	5.53	5.38	5.25	5.12	4.90	4.71	4.54	4.39	4.26	4.15	4.04	3.96	3.87	3.80	3.73	3.67	3.62
5.4	76.02	6.23	6.06	5.87	5.72	5.56	5.43	5.29	5.06	4.87	4.69	4.54	4.41	4.29	4.18	4.09	4.01	3.93	3.86	3.79	3.74
5.5	77.43	6.44	6.25	6.06	5.91	5.74	5.61	5.47	5.23	5.03	4.85	4.69	4.56	4.43	4.32	4.23	4.14	4.06	3.99	3.92	3.87
5.6	78.84	6.64	6.46	6.25	6.10	5.93	5.79	5.64	5.40	5.19	5.01	4.84	4.70	4.58	4.46	4.37	4.28	4.19	4.12	4.05	3.99
5.7	80.25	6.85	6.66	6.45	6.29	6.12	5.98	5.82	5.57	5.36	5.17	5.00	4.86	4.73	4.61	4.51	4.42	4.33	4.25	4.18	4.12
5.8	81.66	7.06	6.87	6.65	6.49	6.31	6.16	6.01	5.75	5.52	5.33	5.16	5.01	4.88	4.75	4.65	4.56	4.46	4.39	4.31	4.25
5.9	83.06	7.28	7.08	6.86	6.69	6.50	6.35	6.19	5.93	5.70	5.49	5.32	5.16	5.03	4.90	4.80	4.70	4.60	4.53	4.45	4.39
6.0	84.47	7.50	7.29	7.06	6.89	6.70	6.54	6.38	6.11	5.87	5.66	5.48	5.32	5.18	5.05	4.95	4.84	4.75	4.66	4.58	4.52
6.1	85.88	7.72	7.50	7.27	7.09	6.90	6.74	6.57	6.29	6.04	5.83	5.64	5.48	5.34	5.20	5.09	4.99	4.89	4.81	4.72	4.66
6.2	87.29	7.94	7.72	7.48	7.30	7.10	6.93	6.76	6.47	6.22	6.00	5.81	5.64	5.49	5.36	5.25	5.14	5.03	4.95	4.86	4.80
6.3	88.70	8.17	7.94	7.70	7.51	7.30	7.13	6.95	6.66	6.40	6.18	5.98	5.81	5.65	5.51	5.40	5.29	5.18	5.09	5.01	4.94
6.4	90.10	8.40	8.16	7.91	7.72	7.51	7.33	7.15	6.85	6.58	6.35	6.15	5.97	5.82	5.67	5.55	5.44	5.33	5.24	5.15	5.08
6.5	91.51	8.63	8.39	8.13	7.93	7.72	7.54	7.35	7.04	6.77	6.53	6.32	6.14	5.98	5.83	5.71	5.59	5.48	5.39	5.30	5.23
6.6	92.92	8.86	8.62	8.35	8.15	7.93	7.75	7.55	7.23	6.95	6.71	6.50	6.31	6.15	5.99	5.87	5.75	5.63	5.54	5.44	5.37
6.7	94.33	9.10	8.85	8.58	8.37	8.14	7.95	7.76	7.43	7.14	6.89	6.68	6.49	6.31	6.16	6.03	5.91	5.79	5.69	5.59	5.52
6.8	95.73	9.34	9.08	8.81	8.59	8.36	8.17	7.96	7.63	7.33	7.08	6.85	6.66	6.48	6.32	6.19	6.07	5.95	5.85	5.75	5.67
6.9	97.14	9.58	9.32	9.04	8.81	8.58	8.38	8.17	7.83	7.53	7.27	7.04	6.84	6.66	6.49	6.36	6.23	6.10	6.00	5.90	5.82
7.0	98.55	9.83	9.56	9.27	9.04	8.80	8.60	8.38	8.03	7.72	7.46	7.22	7.01	6.83	6.66	6.52	6.39	6.26	6.16	6.05	5.98
7.1	99.96	10.08	9.80	9.50	9.27	9.02	8.82	8.60	8.24	7.92	7.65	7.41	7.20	7.01	6.83	6.69	6.56	6.43	6.32	6.21	6.13
7.2	101.37	10.33	10.05	9.74	9.50	9.25	9.04	8.81	8.44	8.12	7.84	7.59	7.38	7.19	7.01	6.86	6.72	6.59	6.48	6.37	6.29
7.3	102.77	10.58	10.29	9.98	9.74	9.48	9.26	9.03	8.65	8.32	8.04	7.78	7.56	7.37	7.18	7.04	6.89	6.76	6.64	6.53	6.45
7.4	104.18	10.84	10.54	10.22	9.97	9.71	9.49	9.25	8.87	8.53	8.23	7.97	7.75	7.55	7.36	7.21	7.06	6.93	6.81	6.69	6.61
7.5	105.59	11.10	10.80	10.47	10.21	9.94	9.72	9.47	9.08	8.73	8.43	8.17	7.94	7.73	7.54	7.39	7.24	7.09	6.98	6.86	6.77
7.6	107.00	11.36	11.05	10.72	10.46	10.18	9.95	9.70	9.30	8.94	8.64	8.36	8.13	7.92	7.72	7.57	7.41	7.27	7.15	7.02	6.93
7.7	108.41	11.63	11.31	10.97	10.70	10.41	10.18	9.93	9.52	9.15	8.84	8.56	8.32	8.11	7.91	7.75	7.59	7.44	7.32	7.19	7.10
7.8	109.81	11.89	11.57	11.22	10.95	10.66	10.42	10.16	9.74	9.37	9.05	8.76	8.52	8.30	8.09	7.93	7.77	7.62	7.49	7.36	7.27
7.9	111.22	12.16	11.83	11.48	11.20	10.90	10.65	10.39	9.96	9.58	9.26	8.97	8.71	8.49	8.28	8.11	7.95	7.79	7.66	7.53	7.44
8.0	112.63	12.44	12.10	11.73	11.45	11.14	10.89	10.63	10.19	9.80	9.47	9.17	8.91	8.68	8.47	8.30	8.13	7.97	7.84	7.71	7.61

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	21.12	0.79	0.76	0.73	0.70	0.67	0.65	0.63	0.59	0.56	0.53	0.51	0.49	0.47	0.46	0.45	0.43	0.42	0.41	0.40	0.40
1.6	22.53	0.88	0.85	0.81	0.78	0.75	0.73	0.70	0.66	0.63	0.60	0.57	0.55	0.53	0.51	0.50	0.49	0.47	0.46	0.45	0.45
1.7	23.93	0.98	0.94	0.90	0.87	0.83	0.81	0.78	0.73	0.70	0.66	0.64	0.61	0.59	0.57	0.56	0.54	0.53	0.52	0.50	0.50
1.8	25.34	1.08	1.04	0.99	0.96	0.92	0.89	0.86	0.81	0.77	0.73	0.70	0.68	0.65	0.63	0.61	0.60	0.58	0.57	0.56	0.55
1.9	26.75	1.18	1.14	1.09	1.05	1.01	0.98	0.95	0.89	0.85	0.81	0.77	0.74	0.72	0.70	0.68	0.66	0.64	0.63	0.62	0.60
2.0	28.16	1.29	1.24	1.19	1.15	1.10	1.07	1.03	0.97	0.92	0.88	0.85	0.81	0.79	0.76	0.74	0.72	0.70	0.69	0.67	0.66
2.1	29.57	1.40	1.35	1.29	1.25	1.20	1.16	1.12	1.06	1.01	0.96	0.92	0.89	0.86	0.83	0.81	0.79	0.77	0.75	0.73	0.72
2.2	30.97	1.52	1.46	1.40	1.35	1.30	1.26	1.22	1.15	1.09	1.04	1.00	0.96	0.93	0.90	0.88	0.85	0.83	0.82	0.80	0.78
2.3	32.38	1.64	1.58	1.51	1.46	1.40	1.36	1.32	1.24	1.18	1.13	1.08	1.04	1.01	0.97	0.95	0.92	0.90	0.88	0.86	0.85
2.4	33.79	1.76	1.70	1.62	1.57	1.51	1.47	1.42	1.34	1.27	1.21	1.16	1.12	1.08	1.05	1.02	1.00	0.97	0.95	0.93	0.92
2.5	35.20	1.89	1.82	1.74	1.68	1.62	1.57	1.52	1.44	1.36	1.30	1.25	1.20	1.16	1.13	1.10	1.07	1.04	1.02	1.00	0.99
2.6	36.60	2.02	1.95	1.86	1.80	1.74	1.68	1.63	1.54	1.46	1.40	1.34	1.29	1.25	1.21	1.18	1.15	1.12	1.10	1.07	1.06
2.7	38.01	2.16	2.08	1.99	1.92	1.85	1.80	1.74	1.64	1.56	1.49	1.43	1.38	1.33	1.29	1.26	1.23	1.20	1.18	1.15	1.13
2.8	39.42	2.30	2.21	2.12	2.05	1.97	1.92	1.85	1.75	1.66	1.59	1.53	1.47	1.42	1.38	1.34	1.31	1.28	1.25	1.23	1.21
2.9	40.83	2.44	2.35	2.25	2.18	2.10	2.04	1.97	1.86	1.77	1.69	1.63	1.57	1.51	1.47	1.43	1.40	1.36	1.34	1.31	1.28
3.0	42.24	2.59	2.49	2.39	2.31	2.22	2.16	2.09	1.98	1.88	1.80	1.73	1.66	1.61	1.56	1.52	1.48	1.45	1.42	1.39	1.36
3.1	43.64	2.74	2.64	2.53	2.44	2.36	2.29	2.21	2.09	1.99	1.90	1.83	1.76	1.70	1.65	1.61	1.57	1.53	1.50	1.47	1.45
3.2	45.05	2.89	2.78	2.67	2.58	2.49	2.42	2.34	2.21	2.10	2.01	1.93	1.86	1.80	1.75	1.70	1.66	1.62	1.59	1.56	1.53
3.3	46.46	3.05	2.94	2.82	2.72	2.63	2.55	2.47	2.33	2.22	2.12	2.04	1.97	1.90	1.85	1.80	1.76	1.71	1.68	1.65	1.62
3.4	47.87	3.21	3.09	2.96	2.87	2.77	2.69	2.60	2.46	2.34	2.24	2.15	2.07	2.01	1.95	1.90	1.85	1.81	1.77	1.74	1.71
3.5	49.28	3.37	3.25	3.12	3.02	2.91	2.82	2.73	2.59	2.46	2.36	2.27	2.18	2.11	2.05	2.00	1.95	1.90	1.87	1.83	1.80
3.6	50.68	3.54	3.41	3.27	3.17	3.06	2.97	2.87	2.72	2.59	2.48	2.38	2.30	2.22	2.16	2.10	2.05	2.00	1.96	1.92	1.89
3.7	52.09	3.71	3.58	3.43	3.32	3.20	3.11	3.01	2.85	2.72	2.60	2.50	2.41	2.33	2.26	2.20	2.15	2.10	2.06	2.02	1.99
3.8	53.50	3.89	3.75	3.60	3.48	3.36	3.26	3.16	2.99	2.85	2.73	2.62	2.53	2.45	2.37	2.31	2.26	2.20	2.16	2.12	2.08
3.9	54.91	4.07	3.92	3.76	3.64	3.51	3.41	3.30	3.13	2.98	2.85	2.74	2.65	2.56	2.49	2.42	2.37	2.31	2.27	2.22	2.18
4.0	56.31	4.25	4.10	3.93	3.81	3.67	3.57	3.45	3.27	3.12	2.98	2.87	2.77	2.68	2.60	2.53	2.48	2.42	2.37	2.32	2.28
4.1	57.72	4.43	4.28	4.10	3.97	3.83	3.72	3.61	3.42	3.25	3.12	3.00	2.89	2.80	2.72	2.65	2.59	2.52	2.48	2.43	2.39
4.2	59.13	4.62	4.46	4.28	4.14	4.00	3.88	3.76	3.56	3.40	3.25	3.13	3.02	2.92	2.84	2.76	2.70	2.64	2.59	2.53	2.49
4.3	60.54	4.81	4.64	4.46	4.32	4.17	4.05	3.92	3.72	3.54	3.39	3.26	3.15	3.05	2.96	2.88	2.82	2.75	2.70	2.64	2.60
4.4	61.95	5.01	4.83	4.64	4.49	4.34	4.21	4.08	3.87	3.69	3.53	3.40	3.28	3.18	3.08	3.00	2.93	2.87	2.81	2.75	2.71
4.5	63.35	5.21	5.02	4.82	4.67	4.51	4.38	4.25	4.02	3.84	3.68	3.54	3.41	3.31	3.21	3.13	3.06	2.98	2.93	2.87	2.82
4.6	64.76	5.41	5.22	5.01	4.86	4.69	4.56	4.41	4.18	3.99	3.82	3.68	3.55	3.44	3.34	3.25	3.18	3.10	3.05	2.98	2.94
4.7	66.17	5.62	5.42	5.20	5.04	4.87	4.73	4.58	4.35	4.14	3.97	3.82	3.69	3.57	3.47	3.38	3.30	3.22	3.17	3.10	3.05
4.8	67.58	5.83	5.62	5.40	5.23	5.05	4.91	4.76	4.51	4.30	4.12	3.97	3.83	3.71	3.60	3.51	3.43	3.35	3.29	3.22	3.17
4.9	68.99	6.04	5.83	5.60	5.42	5.23	5.09	4.93	4.68	4.46	4.27	4.11	3.97	3.85	3.74	3.64	3.56	3.47	3.41	3.34	3.29

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	70.39	6.25	6.03	5.80	5.62	5.42	5.27	5.11	4.85	4.62	4.43	4.26	4.12	3.99	3.87	3.77	3.69	3.60	3.54	3.47	3.41
5.1	71.80	6.47	6.25	6.00	5.81	5.61	5.46	5.29	5.02	4.78	4.59	4.42	4.26	4.13	4.01	3.91	3.82	3.73	3.67	3.59	3.53
5.2	73.21	6.69	6.46	6.21	6.02	5.81	5.65	5.47	5.19	4.95	4.75	4.57	4.41	4.28	4.15	4.05	3.96	3.87	3.80	3.72	3.66
5.3	74.62	6.92	6.68	6.42	6.22	6.01	5.84	5.66	5.37	5.12	4.91	4.73	4.57	4.42	4.30	4.19	4.10	4.00	3.93	3.85	3.79
5.4	76.02	7.15	6.90	6.63	6.43	6.21	6.04	5.85	5.55	5.29	5.08	4.89	4.72	4.57	4.44	4.33	4.23	4.14	4.06	3.98	3.92
5.5	77.43	7.38	7.12	6.85	6.64	6.41	6.23	6.04	5.73	5.47	5.25	5.05	4.88	4.73	4.59	4.48	4.38	4.27	4.20	4.11	4.05
5.6	78.84	7.61	7.35	7.06	6.85	6.61	6.43	6.24	5.92	5.65	5.42	5.21	5.04	4.88	4.74	4.62	4.52	4.42	4.34	4.25	4.18
5.7	80.25	7.85	7.58	7.29	7.06	6.82	6.64	6.44	6.11	5.83	5.59	5.38	5.20	5.04	4.89	4.77	4.67	4.56	4.48	4.39	4.32
5.8	81.66	8.09	7.82	7.51	7.28	7.04	6.84	6.64	6.30	6.01	5.76	5.55	5.36	5.20	5.05	4.92	4.81	4.70	4.62	4.53	4.46
5.9	83.06	8.34	8.05	7.74	7.50	7.25	7.05	6.84	6.49	6.19	5.94	5.72	5.53	5.36	5.21	5.08	4.96	4.85	4.76	4.67	4.60
6.0	84.47	8.59	8.29	7.97	7.73	7.47	7.26	7.04	6.69	6.38	6.12	5.90	5.70	5.52	5.37	5.23	5.12	5.00	4.91	4.81	4.74
6.1	85.88	8.84	8.53	8.20	7.96	7.69	7.48	7.25	6.88	6.57	6.30	6.07	5.87	5.69	5.53	5.39	5.27	5.15	5.06	4.96	4.88
6.2	87.29	9.09	8.78	8.44	8.19	7.91	7.69	7.46	7.09	6.76	6.49	6.25	6.04	5.86	5.69	5.55	5.43	5.30	5.21	5.10	5.03
6.3	88.70	9.35	9.03	8.68	8.42	8.13	7.91	7.68	7.29	6.96	6.68	6.43	6.21	6.03	5.86	5.71	5.58	5.46	5.36	5.25	5.17
6.4	90.10	9.61	9.28	8.92	8.65	8.36	8.14	7.89	7.49	7.15	6.87	6.61	6.39	6.20	6.02	5.87	5.74	5.61	5.52	5.40	5.32
6.5	91.51	9.87	9.54	9.17	8.89	8.59	8.36	8.11	7.70	7.35	7.06	6.80	6.57	6.37	6.19	6.04	5.91	5.77	5.67	5.56	5.47
6.6	92.92	10.14	9.79	9.42	9.13	8.83	8.59	8.33	7.91	7.56	7.25	6.99	6.75	6.55	6.36	6.21	6.07	5.93	5.83	5.71	5.63
6.7	94.33	10.41	10.05	9.67	9.38	9.06	8.82	8.56	8.13	7.76	7.45	7.18	6.94	6.73	6.54	6.38	6.24	6.10	5.99	5.87	5.78
6.8	95.73	10.68	10.32	9.92	9.63	9.30	9.05	8.78	8.34	7.97	7.65	7.37	7.12	6.91	6.71	6.55	6.41	6.26	6.15	6.03	5.94
6.9	97.14	10.95	10.58	10.18	9.88	9.55	9.29	9.01	8.56	8.18	7.85	7.56	7.31	7.09	6.89	6.72	6.58	6.43	6.32	6.19	6.10
7.0	98.55	11.23	10.85	10.44	10.13	9.79	9.53	9.25	8.78	8.39	8.05	7.76	7.50	7.28	7.07	6.90	6.75	6.60	6.48	6.35	6.26
7.1	99.96	11.51	11.13	10.70	10.38	10.04	9.77	9.48	9.01	8.60	8.26	7.96	7.69	7.46	7.25	7.08	6.92	6.77	6.65	6.52	6.42
7.2	101.37	11.80	11.40	10.97	10.64	10.29	10.01	9.72	9.23	8.82	8.47	8.16	7.89	7.65	7.44	7.26	7.10	6.94	6.82	6.68	6.58
7.3	102.77	12.09	11.68	11.24	10.90	10.54	10.26	9.96	9.46	9.04	8.68	8.36	8.09	7.84	7.63	7.44	7.28	7.11	6.99	6.85	6.75
7.4	104.18	12.38	11.96	11.51	11.17	10.80	10.51	10.20	9.69	9.26	8.89	8.57	8.28	8.04	7.81	7.62	7.46	7.29	7.17	7.02	6.92
7.5	105.59	12.67	12.25	11.78	11.44	11.06	10.76	10.44	9.93	9.48	9.11	8.78	8.49	8.23	8.00	7.81	7.64	7.47	7.34	7.19	7.09
7.6	107.00	12.97	12.53	12.06	11.70	11.32	11.02	10.69	10.16	9.71	9.32	8.99	8.69	8.43	8.20	8.00	7.82	7.65	7.52	7.37	7.26
7.7	108.41	13.27	12.83	12.34	11.98	11.58	11.27	10.94	10.40	9.94	9.54	9.20	8.90	8.63	8.39	8.19	8.01	7.83	7.70	7.55	7.43
7.8	109.81	13.57	13.12	12.62	12.25	11.85	11.53	11.19	10.64	10.17	9.77	9.42	9.10	8.83	8.59	8.38	8.20	8.02	7.88	7.72	7.61
7.9	111.22	13.88	13.41	12.91	12.53	12.12	11.80	11.45	10.88	10.40	9.99	9.63	9.31	9.04	8.79	8.57	8.39	8.20	8.06	7.90	7.78
8.0	112.63	14.19	13.71	13.20	12.81	12.39	12.06	11.71	11.13	10.64	10.22	9.85	9.53	9.24	8.99	8.77	8.58	8.39	8.25	8.08	7.96

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	21.12	0.90	0.86	0.82	0.79	0.75	0.73	0.70	0.66	0.62	0.58	0.56	0.53	0.51	0.49	0.48	0.46	0.45	0.44	0.43	0.42
1.6	22.53	1.00	0.96	0.91	0.88	0.84	0.81	0.78	0.73	0.69	0.65	0.62	0.60	0.57	0.55	0.54	0.52	0.50	0.49	0.48	0.47
1.7	23.93	1.11	1.06	1.01	0.97	0.93	0.90	0.87	0.81	0.77	0.73	0.69	0.66	0.64	0.62	0.60	0.58	0.56	0.55	0.53	0.52
1.8	25.34	1.22	1.17	1.12	1.07	1.03	0.99	0.96	0.90	0.85	0.80	0.77	0.73	0.70	0.68	0.66	0.64	0.62	0.60	0.59	0.58
1.9	26.75	1.34	1.28	1.22	1.18	1.13	1.09	1.05	0.98	0.93	0.88	0.84	0.81	0.77	0.75	0.72	0.70	0.68	0.67	0.65	0.64
2.0	28.16	1.46	1.40	1.33	1.29	1.23	1.19	1.15	1.08	1.01	0.96	0.92	0.88	0.85	0.82	0.79	0.77	0.75	0.73	0.71	0.70
2.1	29.57	1.59	1.52	1.45	1.40	1.34	1.29	1.25	1.17	1.10	1.05	1.00	0.96	0.92	0.89	0.86	0.84	0.81	0.79	0.78	0.76
2.2	30.97	1.72	1.65	1.57	1.51	1.45	1.40	1.35	1.27	1.20	1.14	1.09	1.04	1.00	0.97	0.94	0.91	0.88	0.86	0.84	0.82
2.3	32.38	1.85	1.78	1.69	1.63	1.57	1.51	1.46	1.37	1.29	1.23	1.17	1.13	1.08	1.05	1.01	0.98	0.96	0.93	0.91	0.89
2.4	33.79	1.99	1.91	1.82	1.76	1.68	1.63	1.57	1.47	1.39	1.32	1.26	1.21	1.17	1.13	1.09	1.06	1.03	1.01	0.98	0.96
2.5	35.20	2.13	2.05	1.95	1.88	1.81	1.75	1.68	1.58	1.50	1.42	1.36	1.30	1.25	1.21	1.17	1.14	1.11	1.08	1.06	1.04
2.6	36.60	2.28	2.19	2.09	2.01	1.93	1.87	1.80	1.69	1.60	1.52	1.46	1.40	1.34	1.30	1.26	1.22	1.19	1.16	1.13	1.11
2.7	38.01	2.43	2.33	2.23	2.15	2.06	2.00	1.92	1.81	1.71	1.63	1.55	1.49	1.44	1.39	1.35	1.31	1.27	1.24	1.21	1.19
2.8	39.42	2.59	2.48	2.37	2.29	2.20	2.13	2.05	1.93	1.82	1.73	1.66	1.59	1.53	1.48	1.43	1.39	1.36	1.32	1.29	1.27
2.9	40.83	2.75	2.64	2.52	2.43	2.33	2.26	2.18	2.05	1.94	1.84	1.76	1.69	1.63	1.57	1.53	1.48	1.44	1.41	1.38	1.35
3.0	42.24	2.91	2.79	2.67	2.57	2.47	2.39	2.31	2.17	2.06	1.96	1.87	1.80	1.73	1.67	1.62	1.58	1.53	1.50	1.46	1.43
3.1	43.64	3.08	2.96	2.82	2.72	2.62	2.53	2.44	2.30	2.18	2.07	1.98	1.90	1.83	1.77	1.72	1.67	1.63	1.59	1.55	1.52
3.2	45.05	3.25	3.12	2.98	2.88	2.76	2.68	2.58	2.43	2.30	2.19	2.09	2.01	1.94	1.87	1.82	1.77	1.72	1.68	1.64	1.61
3.3	46.46	3.42	3.29	3.14	3.03	2.92	2.82	2.72	2.56	2.43	2.31	2.21	2.12	2.05	1.98	1.92	1.87	1.82	1.77	1.73	1.70
3.4	47.87	3.60	3.46	3.31	3.19	3.07	2.97	2.87	2.70	2.56	2.44	2.33	2.24	2.16	2.09	2.02	1.97	1.92	1.87	1.83	1.79
3.5	49.28	3.79	3.64	3.48	3.36	3.23	3.13	3.02	2.84	2.69	2.56	2.45	2.36	2.27	2.20	2.13	2.07	2.02	1.97	1.93	1.89
3.6	50.68	3.97	3.82	3.65	3.53	3.39	3.28	3.17	2.98	2.83	2.69	2.58	2.48	2.39	2.31	2.24	2.18	2.12	2.07	2.03	1.98
3.7	52.09	4.16	4.00	3.83	3.70	3.55	3.44	3.32	3.13	2.97	2.83	2.70	2.60	2.51	2.42	2.35	2.29	2.23	2.17	2.13	2.08
3.8	53.50	4.36	4.19	4.01	3.87	3.72	3.61	3.48	3.28	3.11	2.96	2.83	2.72	2.63	2.54	2.47	2.40	2.34	2.28	2.23	2.18
3.9	54.91	4.56	4.38	4.19	4.05	3.89	3.77	3.64	3.43	3.25	3.10	2.97	2.85	2.75	2.66	2.58	2.51	2.45	2.39	2.34	2.29
4.0	56.31	4.76	4.58	4.38	4.23	4.07	3.94	3.81	3.59	3.40	3.24	3.10	2.98	2.88	2.78	2.70	2.63	2.56	2.50	2.45	2.39
4.1	57.72	4.97	4.78	4.57	4.41	4.25	4.11	3.97	3.75	3.55	3.38	3.24	3.12	3.01	2.91	2.82	2.75	2.67	2.61	2.56	2.50
4.2	59.13	5.18	4.98	4.76	4.60	4.43	4.29	4.14	3.91	3.70	3.53	3.38	3.25	3.14	3.03	2.95	2.87	2.79	2.72	2.67	2.61
4.3	60.54	5.39	5.18	4.96	4.79	4.61	4.47	4.32	4.07	3.86	3.68	3.53	3.39	3.27	3.16	3.07	2.99	2.91	2.84	2.78	2.73
4.4	61.95	5.61	5.39	5.16	4.99	4.80	4.65	4.49	4.24	4.02	3.83	3.67	3.53	3.41	3.30	3.20	3.11	3.03	2.96	2.90	2.84
4.5	63.35	5.83	5.61	5.37	5.19	4.99	4.84	4.67	4.41	4.18	3.99	3.82	3.67	3.54	3.43	3.33	3.24	3.16	3.08	3.02	2.96
4.6	64.76	6.05	5.82	5.58	5.39	5.18	5.03	4.86	4.58	4.35	4.14	3.97	3.82	3.69	3.57	3.46	3.37	3.28	3.21	3.14	3.08
4.7	66.17	6.28	6.04	5.79	5.59	5.38	5.22	5.04	4.76	4.51	4.30	4.13	3.97	3.83	3.71	3.60	3.50	3.41	3.33	3.26	3.20
4.8	67.58	6.51	6.27	6.00	5.80	5.58	5.41	5.23	4.94	4.68	4.47	4.28	4.12	3.98	3.85	3.74	3.64	3.54	3.46	3.39	3.32
4.9	68.99	6.75	6.49	6.22	6.01	5.79	5.61	5.42	5.12	4.86	4.63	4.44	4.27	4.12	3.99	3.88	3.77	3.68	3.59	3.52	3.44

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3" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	70.39	6.99	6.73	6.44	6.23	5.99	5.81	5.62	5.30	5.03	4.80	4.60	4.43	4.27	4.14	4.02	3.91	3.81	3.72	3.65	3.57
5.1	71.80	7.23	6.96	6.67	6.44	6.20	6.02	5.82	5.49	5.21	4.97	4.77	4.59	4.43	4.29	4.16	4.05	3.95	3.86	3.78	3.70
5.2	73.21	7.48	7.20	6.89	6.67	6.42	6.22	6.02	5.68	5.39	5.15	4.93	4.75	4.58	4.44	4.31	4.20	4.09	3.99	3.91	3.83
5.3	74.62	7.72	7.44	7.13	6.89	6.63	6.44	6.22	5.87	5.58	5.32	5.10	4.91	4.74	4.59	4.46	4.34	4.23	4.13	4.05	3.97
5.4	76.02	7.98	7.68	7.36	7.12	6.85	6.65	6.43	6.07	5.76	5.50	5.27	5.07	4.90	4.75	4.61	4.49	4.37	4.27	4.19	4.10
5.5	77.43	8.23	7.93	7.60	7.35	7.08	6.87	6.64	6.27	5.95	5.68	5.45	5.24	5.06	4.90	4.76	4.64	4.52	4.41	4.33	4.24
5.6	78.84	8.50	8.18	7.84	7.58	7.30	7.08	6.85	6.47	6.14	5.87	5.62	5.41	5.23	5.06	4.92	4.79	4.67	4.56	4.47	4.38
5.7	80.25	8.76	8.44	8.09	7.82	7.53	7.31	7.07	6.67	6.34	6.05	5.80	5.59	5.40	5.23	5.08	4.94	4.82	4.71	4.61	4.52
5.8	81.66	9.03	8.69	8.33	8.06	7.76	7.53	7.28	6.88	6.54	6.24	5.99	5.76	5.57	5.39	5.24	5.10	4.97	4.86	4.76	4.66
5.9	83.06	9.30	8.96	8.58	8.30	8.00	7.76	7.51	7.09	6.74	6.43	6.17	5.94	5.74	5.56	5.40	5.26	5.13	5.01	4.91	4.81
6.0	84.47	9.57	9.22	8.84	8.55	8.24	7.99	7.73	7.30	6.94	6.63	6.36	6.12	5.91	5.73	5.56	5.42	5.28	5.16	5.06	4.96
6.1	85.88	9.85	9.49	9.10	8.80	8.48	8.23	7.96	7.52	7.14	6.82	6.55	6.30	6.09	5.90	5.73	5.58	5.44	5.32	5.21	5.11
6.2	87.29	10.13	9.76	9.36	9.05	8.72	8.47	8.19	7.74	7.35	7.02	6.74	6.49	6.27	6.07	5.90	5.75	5.60	5.47	5.36	5.26
6.3	88.70	10.41	10.04	9.62	9.31	8.97	8.71	8.42	7.96	7.56	7.22	6.93	6.67	6.45	6.25	6.07	5.91	5.77	5.63	5.52	5.41
6.4	90.10	10.70	10.31	9.89	9.57	9.22	8.95	8.66	8.18	7.78	7.43	7.13	6.86	6.63	6.43	6.24	6.08	5.93	5.79	5.68	5.57
6.5	91.51	10.99	10.59	10.16	9.83	9.47	9.20	8.90	8.41	7.99	7.64	7.33	7.06	6.82	6.61	6.42	6.25	6.10	5.96	5.84	5.72
6.6	92.92	11.29	10.88	10.43	10.10	9.73	9.44	9.14	8.64	8.21	7.84	7.53	7.25	7.01	6.79	6.60	6.43	6.27	6.12	6.00	5.88
6.7	94.33	11.59	11.17	10.71	10.36	9.99	9.70	9.38	8.87	8.43	8.06	7.73	7.45	7.20	6.97	6.78	6.60	6.44	6.29	6.17	6.04
6.8	95.73	11.89	11.46	10.99	10.64	10.25	9.95	9.63	9.11	8.65	8.27	7.94	7.65	7.39	7.16	6.96	6.78	6.61	6.46	6.33	6.21
6.9	97.14	12.19	11.75	11.27	10.91	10.52	10.21	9.88	9.34	8.88	8.49	8.15	7.85	7.58	7.35	7.14	6.96	6.79	6.63	6.50	6.37
7.0	98.55	12.50	12.05	11.56	11.19	10.78	10.47	10.13	9.58	9.11	8.71	8.36	8.05	7.78	7.54	7.33	7.14	6.96	6.81	6.67	6.54
7.1	99.96	12.81	12.35	11.85	11.47	11.06	10.73	10.39	9.83	9.34	8.93	8.57	8.26	7.98	7.73	7.52	7.33	7.14	6.98	6.84	6.71
7.2	101.37	13.13	12.66	12.14	11.75	11.33	11.00	10.65	10.07	9.58	9.15	8.79	8.46	8.18	7.93	7.71	7.51	7.33	7.16	7.02	6.88
7.3	102.77	13.44	12.96	12.44	12.04	11.61	11.27	10.91	10.32	9.81	9.38	9.00	8.68	8.39	8.13	7.90	7.70	7.51	7.34	7.20	7.05
7.4	104.18	13.77	13.27	12.74	12.33	11.89	11.54	11.17	10.57	10.05	9.61	9.23	8.89	8.59	8.33	8.10	7.89	7.70	7.52	7.37	7.23
7.5	105.59	14.09	13.59	13.04	12.62	12.17	11.82	11.44	10.82	10.29	9.84	9.45	9.10	8.80	8.53	8.29	8.08	7.88	7.70	7.55	7.41
7.6	107.00	14.42	13.90	13.34	12.92	12.46	12.10	11.71	11.08	10.54	10.07	9.67	9.32	9.01	8.74	8.49	8.28	8.07	7.89	7.74	7.59
7.7	108.41	14.75	14.22	13.65	13.22	12.74	12.38	11.98	11.34	10.78	10.31	9.90	9.54	9.22	8.94	8.69	8.47	8.27	8.08	7.92	7.77
7.8	109.81	15.08	14.55	13.96	13.52	13.04	12.66	12.26	11.60	11.03	10.55	10.13	9.76	9.44	9.15	8.90	8.67	8.46	8.27	8.11	7.95
7.9	111.22	15.42	14.87	14.28	13.82	13.33	12.95	12.53	11.86	11.28	10.79	10.36	9.99	9.66	9.36	9.10	8.87	8.66	8.46	8.30	8.13
8.0	112.63	15.76	15.20	14.59	14.13	13.63	13.24	12.81	12.13	11.54	11.03	10.60	10.21	9.88	9.58	9.31	9.08	8.85	8.65	8.49	8.32

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3½" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	28.46	0.41	0.39	0.37	0.36	0.36	0.35	0.35	0.34	0.33	0.32	0.31	0.31	0.30	0.29	0.29	0.29	0.28	0.28	0.27	0.27
1.6	30.36	0.46	0.44	0.42	0.41	0.40	0.39	0.39	0.38	0.37	0.36	0.35	0.34	0.34	0.33	0.32	0.32	0.32	0.31	0.31	0.30
1.7	32.26	0.51	0.49	0.46	0.45	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.37	0.37	0.36	0.36	0.35	0.35	0.34	0.34
1.8	34.16	0.56	0.54	0.51	0.50	0.49	0.49	0.48	0.46	0.45	0.44	0.43	0.42	0.42	0.41	0.40	0.40	0.39	0.38	0.38	0.37
1.9	36.05	0.62	0.59	0.56	0.55	0.54	0.53	0.53	0.51	0.50	0.49	0.48	0.47	0.46	0.45	0.44	0.44	0.43	0.42	0.42	0.41
2.0	37.95	0.68	0.65	0.62	0.61	0.59	0.59	0.58	0.56	0.55	0.53	0.52	0.51	0.50	0.49	0.48	0.48	0.47	0.46	0.46	0.45
2.1	39.85	0.74	0.71	0.67	0.66	0.65	0.64	0.63	0.61	0.60	0.58	0.57	0.56	0.55	0.54	0.53	0.52	0.51	0.51	0.50	0.49
2.2	41.75	0.80	0.77	0.73	0.72	0.70	0.69	0.68	0.66	0.65	0.63	0.62	0.61	0.59	0.58	0.57	0.57	0.56	0.55	0.54	0.54
2.3	43.64	0.87	0.83	0.79	0.78	0.76	0.75	0.74	0.72	0.70	0.68	0.67	0.66	0.64	0.63	0.62	0.61	0.60	0.60	0.59	0.58
2.4	45.54	0.93	0.89	0.85	0.84	0.82	0.81	0.80	0.77	0.76	0.74	0.72	0.71	0.69	0.68	0.67	0.66	0.65	0.64	0.64	0.63
2.5	47.44	1.00	0.96	0.91	0.90	0.88	0.87	0.86	0.83	0.81	0.79	0.78	0.76	0.75	0.73	0.72	0.71	0.70	0.69	0.68	0.68
2.6	49.34	1.07	1.03	0.98	0.96	0.95	0.93	0.92	0.89	0.87	0.85	0.83	0.82	0.80	0.79	0.78	0.76	0.75	0.74	0.74	0.73
2.7	51.23	1.15	1.10	1.05	1.03	1.01	1.00	0.98	0.96	0.93	0.91	0.89	0.87	0.86	0.84	0.83	0.82	0.81	0.80	0.79	0.78
2.8	53.13	1.22	1.17	1.12	1.10	1.08	1.06	1.05	1.02	0.99	0.97	0.95	0.93	0.92	0.90	0.89	0.87	0.86	0.85	0.84	0.83
2.9	55.03	1.30	1.25	1.19	1.17	1.15	1.13	1.12	1.09	1.06	1.03	1.01	0.99	0.98	0.96	0.94	0.93	0.92	0.91	0.90	0.88
3.0	56.93	1.38	1.33	1.26	1.24	1.22	1.20	1.19	1.15	1.13	1.10	1.08	1.06	1.04	1.02	1.00	0.99	0.98	0.96	0.95	0.94
3.1	58.82	1.47	1.41	1.34	1.32	1.29	1.28	1.26	1.22	1.19	1.17	1.14	1.12	1.10	1.08	1.07	1.05	1.04	1.02	1.01	1.00
3.2	60.72	1.55	1.49	1.42	1.39	1.37	1.35	1.33	1.29	1.26	1.23	1.21	1.19	1.16	1.15	1.13	1.11	1.10	1.08	1.07	1.06
3.3	62.62	1.64	1.57	1.50	1.47	1.45	1.43	1.41	1.37	1.33	1.30	1.28	1.25	1.23	1.21	1.19	1.18	1.16	1.14	1.13	1.12
3.4	64.52	1.73	1.66	1.58	1.55	1.53	1.50	1.48	1.44	1.41	1.38	1.35	1.32	1.30	1.28	1.26	1.24	1.22	1.21	1.19	1.18
3.5	66.42	1.82	1.74	1.66	1.64	1.61	1.58	1.56	1.52	1.48	1.45	1.42	1.39	1.37	1.35	1.33	1.31	1.29	1.27	1.26	1.24
3.6	68.31	1.91	1.83	1.75	1.72	1.69	1.67	1.64	1.60	1.56	1.53	1.49	1.47	1.44	1.42	1.39	1.37	1.36	1.34	1.32	1.31
3.7	70.21	2.00	1.93	1.83	1.81	1.78	1.75	1.72	1.68	1.64	1.60	1.57	1.54	1.51	1.49	1.47	1.44	1.43	1.41	1.39	1.38
3.8	72.11	2.10	2.02	1.92	1.89	1.86	1.84	1.81	1.76	1.72	1.68	1.65	1.62	1.59	1.56	1.54	1.52	1.50	1.48	1.46	1.44
3.9	74.01	2.20	2.11	2.02	1.98	1.95	1.92	1.89	1.84	1.80	1.76	1.73	1.69	1.66	1.64	1.61	1.59	1.57	1.55	1.53	1.51
4.0	75.90	2.30	2.21	2.11	2.08	2.04	2.01	1.98	1.93	1.88	1.84	1.81	1.77	1.74	1.71	1.69	1.66	1.64	1.62	1.60	1.58
4.1	77.80	2.40	2.31	2.20	2.17	2.13	2.10	2.07	2.02	1.97	1.93	1.89	1.85	1.82	1.79	1.76	1.74	1.72	1.69	1.68	1.66
4.2	79.70	2.51	2.41	2.30	2.26	2.23	2.20	2.16	2.11	2.06	2.01	1.97	1.93	1.90	1.87	1.84	1.82	1.79	1.77	1.75	1.73
4.3	81.60	2.62	2.52	2.40	2.36	2.32	2.29	2.26	2.20	2.15	2.10	2.06	2.02	1.98	1.95	1.92	1.90	1.87	1.85	1.83	1.81
4.4	83.49	2.73	2.62	2.50	2.46	2.42	2.39	2.35	2.29	2.24	2.19	2.14	2.10	2.07	2.04	2.00	1.98	1.95	1.93	1.90	1.88
4.5	85.39	2.84	2.73	2.60	2.56	2.52	2.48	2.45	2.38	2.33	2.28	2.23	2.19	2.15	2.12	2.09	2.06	2.03	2.01	1.98	1.96
4.6	87.29	2.95	2.84	2.71	2.66	2.62	2.58	2.55	2.48	2.42	2.37	2.32	2.28	2.24	2.21	2.17	2.14	2.11	2.09	2.06	2.04
4.7	89.19	3.07	2.95	2.81	2.77	2.72	2.69	2.65	2.58	2.52	2.46	2.41	2.37	2.33	2.29	2.26	2.23	2.20	2.17	2.15	2.12
4.8	91.08	3.18	3.06	2.92	2.88	2.83	2.79	2.75	2.68	2.62	2.56	2.51	2.46	2.42	2.38	2.35	2.31	2.28	2.26	2.23	2.21
4.9	92.98	3.30	3.17	3.03	2.98	2.93	2.89	2.85	2.78	2.71	2.66	2.60	2.56	2.51	2.47	2.44	2.40	2.37	2.34	2.31	2.29

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3½" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	94.88	3.42	3.29	3.14	3.09	3.04	3.00	2.96	2.88	2.81	2.75	2.70	2.65	2.61	2.56	2.53	2.49	2.46	2.43	2.40	2.38
5.1	96.78	3.55	3.41	3.25	3.21	3.15	3.11	3.06	2.99	2.92	2.85	2.80	2.75	2.70	2.66	2.62	2.58	2.55	2.52	2.49	2.46
5.2	98.67	3.67	3.53	3.37	3.32	3.26	3.22	3.17	3.09	3.02	2.96	2.90	2.84	2.80	2.75	2.71	2.68	2.64	2.61	2.58	2.55
5.3	100.57	3.80	3.65	3.49	3.43	3.38	3.33	3.28	3.20	3.13	3.06	3.00	2.94	2.89	2.85	2.81	2.77	2.73	2.70	2.67	2.64
5.4	102.47	3.93	3.78	3.61	3.55	3.49	3.45	3.40	3.31	3.23	3.16	3.10	3.05	2.99	2.95	2.90	2.86	2.83	2.79	2.76	2.73
5.5	104.37	4.06	3.90	3.73	3.67	3.61	3.56	3.51	3.42	3.34	3.27	3.21	3.15	3.10	3.05	3.00	2.96	2.92	2.89	2.86	2.83
5.6	106.26	4.19	4.03	3.85	3.79	3.73	3.68	3.63	3.53	3.45	3.38	3.31	3.25	3.20	3.15	3.10	3.06	3.02	2.98	2.95	2.92
5.7	108.16	4.32	4.16	3.97	3.91	3.85	3.80	3.74	3.65	3.56	3.49	3.42	3.36	3.30	3.25	3.20	3.16	3.12	3.08	3.05	3.02
5.8	110.06	4.46	4.29	4.10	4.04	3.97	3.92	3.86	3.76	3.68	3.60	3.53	3.47	3.41	3.36	3.31	3.26	3.22	3.18	3.15	3.11
5.9	111.96	4.60	4.42	4.23	4.16	4.10	4.04	3.98	3.88	3.79	3.71	3.64	3.57	3.52	3.46	3.41	3.36	3.32	3.28	3.24	3.21
6.0	113.85	4.74	4.56	4.35	4.29	4.22	4.16	4.10	4.00	3.91	3.83	3.75	3.69	3.62	3.57	3.52	3.47	3.42	3.38	3.35	3.31
6.1	115.75	4.88	4.70	4.49	4.42	4.35	4.29	4.23	4.12	4.03	3.94	3.87	3.80	3.73	3.68	3.62	3.57	3.53	3.49	3.45	3.41
6.2	117.65	5.02	4.83	4.62	4.55	4.48	4.42	4.35	4.24	4.15	4.06	3.98	3.91	3.85	3.79	3.73	3.68	3.63	3.59	3.55	3.51
6.3	119.55	5.17	4.97	4.75	4.68	4.61	4.55	4.48	4.37	4.27	4.18	4.10	4.03	3.96	3.90	3.84	3.79	3.74	3.70	3.66	3.62
6.4	121.45	5.32	5.12	4.89	4.82	4.74	4.68	4.61	4.49	4.39	4.30	4.22	4.14	4.07	4.01	3.95	3.90	3.85	3.81	3.76	3.72
6.5	123.34	5.46	5.26	5.03	4.95	4.87	4.81	4.74	4.62	4.52	4.42	4.34	4.26	4.19	4.13	4.07	4.01	3.96	3.91	3.87	3.83
6.6	125.24	5.62	5.41	5.17	5.09	5.01	4.94	4.87	4.75	4.64	4.55	4.46	4.38	4.31	4.24	4.18	4.12	4.07	4.02	3.98	3.94
6.7	127.14	5.77	5.55	5.31	5.23	5.15	5.08	5.01	4.88	4.77	4.67	4.58	4.50	4.43	4.36	4.30	4.24	4.19	4.14	4.09	4.05
6.8	129.04	5.92	5.70	5.45	5.37	5.29	5.22	5.14	5.01	4.90	4.80	4.71	4.62	4.55	4.48	4.41	4.35	4.30	4.25	4.20	4.16
6.9	130.93	6.08	5.85	5.60	5.51	5.43	5.35	5.28	5.15	5.03	4.93	4.83	4.75	4.67	4.60	4.53	4.47	4.42	4.36	4.32	4.27
7.0	132.83	6.24	6.01	5.74	5.66	5.57	5.49	5.42	5.28	5.16	5.06	4.96	4.87	4.79	4.72	4.65	4.59	4.53	4.48	4.43	4.38
7.1	134.73	6.40	6.16	5.89	5.80	5.71	5.64	5.56	5.42	5.30	5.19	5.09	5.00	4.92	4.84	4.77	4.71	4.65	4.60	4.55	4.50
7.2	136.63	6.56	6.32	6.04	5.95	5.86	5.78	5.70	5.56	5.43	5.32	5.22	5.13	5.04	4.97	4.90	4.83	4.77	4.72	4.66	4.62
7.3	138.52	6.72	6.48	6.19	6.10	6.01	5.93	5.84	5.70	5.57	5.46	5.35	5.26	5.17	5.09	5.02	4.96	4.89	4.84	4.78	4.73
7.4	140.42	6.89	6.64	6.35	6.25	6.15	6.07	5.99	5.84	5.71	5.59	5.49	5.39	5.30	5.22	5.15	5.08	5.02	4.96	4.90	4.85
7.5	142.32	7.06	6.80	6.50	6.40	6.30	6.22	6.13	5.98	5.85	5.73	5.62	5.52	5.43	5.35	5.27	5.21	5.14	5.08	5.02	4.97
7.6	144.22	7.23	6.96	6.66	6.56	6.46	6.37	6.28	6.13	5.99	5.87	5.76	5.66	5.56	5.48	5.40	5.33	5.27	5.20	5.15	5.09
7.7	146.11	7.40	7.13	6.82	6.72	6.61	6.52	6.43	6.28	6.13	6.01	5.90	5.79	5.70	5.61	5.53	5.46	5.39	5.33	5.27	5.22
7.8	148.01	7.57	7.29	6.98	6.87	6.77	6.68	6.58	6.42	6.28	6.15	6.04	5.93	5.83	5.75	5.66	5.59	5.52	5.46	5.40	5.34
7.9	149.91	7.75	7.46	7.14	7.03	6.92	6.83	6.74	6.57	6.43	6.29	6.18	6.07	5.97	5.88	5.80	5.72	5.65	5.59	5.52	5.47
8.0	151.81	7.92	7.63	7.30	7.19	7.08	6.99	6.89	6.72	6.57	6.44	6.32	6.21	6.11	6.02	5.93	5.85	5.78	5.71	5.65	5.60

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3½" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	28.46	0.56	0.54	0.52	0.51	0.49	0.48	0.46	0.44	0.42	0.41	0.39	0.38	0.37	0.36	0.35	0.34	0.33	0.33	0.32	0.31
1.6	30.36	0.62	0.60	0.58	0.57	0.55	0.53	0.52	0.49	0.47	0.45	0.44	0.42	0.41	0.40	0.39	0.38	0.37	0.37	0.36	0.35
1.7	32.26	0.69	0.67	0.65	0.63	0.61	0.59	0.58	0.55	0.53	0.51	0.49	0.47	0.46	0.44	0.43	0.42	0.42	0.41	0.40	0.39
1.8	34.16	0.76	0.74	0.72	0.70	0.67	0.66	0.64	0.61	0.58	0.56	0.54	0.52	0.51	0.49	0.48	0.47	0.46	0.45	0.44	0.44
1.9	36.05	0.84	0.81	0.79	0.76	0.74	0.72	0.70	0.67	0.64	0.61	0.59	0.57	0.56	0.54	0.53	0.52	0.51	0.50	0.49	0.48
2.0	37.95	0.92	0.89	0.86	0.83	0.81	0.79	0.77	0.73	0.70	0.67	0.65	0.63	0.61	0.59	0.58	0.57	0.55	0.54	0.53	0.53
2.1	39.85	1.00	0.97	0.93	0.91	0.88	0.86	0.84	0.80	0.76	0.73	0.71	0.69	0.67	0.65	0.63	0.62	0.60	0.59	0.58	0.57
2.2	41.75	1.08	1.05	1.01	0.99	0.96	0.93	0.91	0.86	0.83	0.80	0.77	0.74	0.72	0.70	0.69	0.67	0.66	0.64	0.63	0.62
2.3	43.64	1.17	1.13	1.09	1.06	1.03	1.01	0.98	0.93	0.89	0.86	0.83	0.80	0.78	0.76	0.74	0.73	0.71	0.70	0.69	0.68
2.4	45.54	1.26	1.22	1.18	1.15	1.11	1.08	1.06	1.01	0.96	0.93	0.90	0.87	0.84	0.82	0.80	0.78	0.77	0.75	0.74	0.73
2.5	47.44	1.35	1.31	1.27	1.23	1.19	1.16	1.13	1.08	1.04	1.00	0.96	0.93	0.91	0.88	0.86	0.84	0.83	0.81	0.80	0.78
2.6	49.34	1.44	1.40	1.35	1.32	1.28	1.25	1.21	1.16	1.11	1.07	1.03	1.00	0.97	0.95	0.93	0.90	0.89	0.87	0.85	0.84
2.7	51.23	1.54	1.50	1.45	1.41	1.37	1.33	1.30	1.24	1.19	1.14	1.10	1.07	1.04	1.01	0.99	0.97	0.95	0.93	0.91	0.90
2.8	53.13	1.64	1.59	1.54	1.50	1.46	1.42	1.38	1.32	1.27	1.22	1.18	1.14	1.11	1.08	1.06	1.03	1.01	0.99	0.97	0.96
2.9	55.03	1.75	1.69	1.64	1.60	1.55	1.51	1.47	1.40	1.35	1.30	1.25	1.21	1.18	1.15	1.12	1.10	1.08	1.06	1.04	1.02
3.0	56.93	1.85	1.80	1.74	1.69	1.64	1.60	1.56	1.49	1.43	1.38	1.33	1.29	1.25	1.22	1.19	1.17	1.14	1.12	1.10	1.09
3.1	58.82	1.96	1.90	1.84	1.79	1.74	1.70	1.65	1.58	1.52	1.46	1.41	1.37	1.33	1.29	1.27	1.24	1.21	1.19	1.17	1.15
3.2	60.72	2.07	2.01	1.95	1.90	1.84	1.80	1.75	1.67	1.60	1.54	1.49	1.45	1.41	1.37	1.34	1.31	1.28	1.26	1.24	1.22
3.3	62.62	2.19	2.12	2.05	2.00	1.94	1.90	1.85	1.76	1.69	1.63	1.58	1.53	1.49	1.45	1.42	1.39	1.36	1.33	1.31	1.29
3.4	64.52	2.30	2.24	2.16	2.11	2.05	2.00	1.95	1.86	1.78	1.72	1.66	1.61	1.57	1.53	1.49	1.46	1.43	1.41	1.38	1.36
3.5	66.42	2.42	2.35	2.28	2.22	2.15	2.10	2.05	1.96	1.88	1.81	1.75	1.70	1.65	1.61	1.57	1.54	1.51	1.48	1.45	1.43
3.6	68.31	2.55	2.47	2.39	2.33	2.26	2.21	2.15	2.06	1.97	1.90	1.84	1.78	1.74	1.69	1.65	1.62	1.59	1.56	1.53	1.51
3.7	70.21	2.67	2.59	2.51	2.45	2.38	2.32	2.26	2.16	2.07	2.00	1.93	1.87	1.82	1.78	1.74	1.70	1.67	1.64	1.61	1.59
3.8	72.11	2.80	2.72	2.63	2.56	2.49	2.43	2.37	2.26	2.17	2.09	2.03	1.97	1.91	1.86	1.82	1.78	1.75	1.72	1.69	1.66
3.9	74.01	2.93	2.84	2.75	2.68	2.61	2.54	2.48	2.37	2.28	2.19	2.12	2.06	2.00	1.95	1.91	1.87	1.83	1.80	1.77	1.74
4.0	75.90	3.06	2.97	2.88	2.80	2.73	2.66	2.59	2.48	2.38	2.29	2.22	2.15	2.10	2.04	2.00	1.96	1.92	1.88	1.85	1.82
4.1	77.80	3.19	3.10	3.00	2.93	2.85	2.78	2.71	2.59	2.49	2.40	2.32	2.25	2.19	2.13	2.09	2.04	2.00	1.97	1.93	1.91
4.2	79.70	3.33	3.24	3.13	3.06	2.97	2.90	2.82	2.70	2.60	2.50	2.42	2.35	2.29	2.23	2.18	2.13	2.09	2.06	2.02	1.99
4.3	81.60	3.47	3.37	3.27	3.18	3.10	3.02	2.94	2.82	2.71	2.61	2.52	2.45	2.38	2.32	2.27	2.23	2.18	2.14	2.11	2.08
4.4	83.49	3.61	3.51	3.40	3.32	3.22	3.15	3.07	2.93	2.82	2.72	2.63	2.55	2.48	2.42	2.37	2.32	2.27	2.23	2.20	2.17
4.5	85.39	3.76	3.65	3.54	3.45	3.35	3.28	3.19	3.05	2.93	2.83	2.74	2.66	2.59	2.52	2.47	2.42	2.37	2.33	2.29	2.26
4.6	87.29	3.91	3.80	3.68	3.59	3.49	3.40	3.32	3.17	3.05	2.94	2.85	2.76	2.69	2.62	2.57	2.51	2.46	2.42	2.38	2.35
4.7	89.19	4.06	3.94	3.82	3.72	3.62	3.54	3.45	3.30	3.17	3.06	2.96	2.87	2.80	2.73	2.67	2.61	2.56	2.52	2.47	2.44
4.8	91.08	4.21	4.09	3.96	3.86	3.76	3.67	3.58	3.42	3.29	3.17	3.07	2.98	2.90	2.83	2.77	2.71	2.66	2.61	2.57	2.53
4.9	92.98	4.37	4.24	4.11	4.01	3.90	3.81	3.71	3.55	3.41	3.29	3.19	3.10	3.01	2.94	2.88	2.82	2.76	2.71	2.67	2.63

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Recommended Head Loss Design Range for Distribution Piping

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3½" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	94.88	4.52	4.40	4.26	4.15	4.04	3.95	3.85	3.68	3.54	3.41	3.30	3.21	3.12	3.05	2.98	2.92	2.86	2.81	2.76	2.73
5.1	96.78	4.68	4.55	4.41	4.30	4.18	4.09	3.98	3.81	3.67	3.54	3.42	3.33	3.24	3.16	3.09	3.03	2.97	2.92	2.87	2.83
5.2	98.67	4.84	4.71	4.56	4.45	4.33	4.23	4.12	3.95	3.79	3.66	3.54	3.44	3.35	3.27	3.20	3.13	3.07	3.02	2.97	2.93
5.3	100.57	5.01	4.87	4.72	4.60	4.48	4.37	4.26	4.08	3.93	3.79	3.67	3.56	3.47	3.38	3.31	3.24	3.18	3.13	3.07	3.03
5.4	102.47	5.18	5.03	4.88	4.76	4.63	4.52	4.41	4.22	4.06	3.92	3.79	3.68	3.59	3.50	3.42	3.35	3.29	3.23	3.18	3.14
5.5	104.37	5.35	5.20	5.04	4.91	4.78	4.67	4.55	4.36	4.19	4.05	3.92	3.81	3.71	3.61	3.54	3.47	3.40	3.34	3.28	3.24
5.6	106.26	5.52	5.37	5.20	5.07	4.93	4.82	4.70	4.50	4.33	4.18	4.05	3.93	3.83	3.73	3.66	3.58	3.51	3.45	3.39	3.35
5.7	108.16	5.69	5.54	5.37	5.23	5.09	4.98	4.85	4.65	4.47	4.31	4.18	4.06	3.95	3.85	3.77	3.70	3.62	3.56	3.50	3.46
5.8	110.06	5.87	5.71	5.53	5.40	5.25	5.13	5.00	4.79	4.61	4.45	4.31	4.19	4.08	3.98	3.89	3.81	3.74	3.68	3.61	3.57
5.9	111.96	6.05	5.88	5.70	5.56	5.41	5.29	5.16	4.94	4.75	4.59	4.44	4.32	4.20	4.10	4.02	3.93	3.86	3.79	3.73	3.68
6.0	113.85	6.23	6.06	5.87	5.73	5.58	5.45	5.31	5.09	4.90	4.73	4.58	4.45	4.33	4.23	4.14	4.05	3.98	3.91	3.84	3.79
6.1	115.75	6.41	6.24	6.05	5.90	5.74	5.61	5.47	5.24	5.04	4.87	4.72	4.58	4.46	4.35	4.26	4.18	4.10	4.03	3.96	3.91
6.2	117.65	6.60	6.42	6.22	6.07	5.91	5.78	5.63	5.40	5.19	5.01	4.86	4.72	4.60	4.48	4.39	4.30	4.22	4.15	4.08	4.03
6.3	119.55	6.79	6.60	6.40	6.25	6.08	5.94	5.79	5.55	5.34	5.16	5.00	4.86	4.73	4.61	4.52	4.43	4.34	4.27	4.20	4.14
6.4	121.45	6.98	6.79	6.58	6.42	6.25	6.11	5.96	5.71	5.49	5.31	5.14	5.00	4.87	4.75	4.65	4.56	4.47	4.39	4.32	4.26
6.5	123.34	7.17	6.98	6.77	6.60	6.43	6.28	6.13	5.87	5.65	5.46	5.28	5.14	5.00	4.88	4.78	4.68	4.59	4.52	4.44	4.38
6.6	125.24	7.37	7.17	6.95	6.78	6.60	6.45	6.29	6.03	5.80	5.61	5.43	5.28	5.14	5.02	4.92	4.82	4.72	4.64	4.57	4.51
6.7	127.14	7.57	7.36	7.14	6.97	6.78	6.63	6.46	6.20	5.96	5.76	5.58	5.42	5.28	5.15	5.05	4.95	4.85	4.77	4.69	4.63
6.8	129.04	7.77	7.56	7.33	7.15	6.96	6.80	6.64	6.36	6.12	5.91	5.73	5.57	5.43	5.29	5.19	5.08	4.98	4.90	4.82	4.76
6.9	130.93	7.97	7.75	7.52	7.34	7.14	6.98	6.81	6.53	6.28	6.07	5.88	5.72	5.57	5.43	5.33	5.22	5.12	5.03	4.95	4.89
7.0	132.83	8.17	7.95	7.71	7.53	7.33	7.16	6.99	6.70	6.45	6.23	6.04	5.87	5.72	5.58	5.47	5.35	5.25	5.17	5.08	5.01
7.1	134.73	8.38	8.15	7.91	7.72	7.51	7.35	7.17	6.87	6.61	6.39	6.19	6.02	5.86	5.72	5.61	5.49	5.39	5.30	5.21	5.15
7.2	136.63	8.59	8.36	8.11	7.91	7.70	7.53	7.35	7.05	6.78	6.55	6.35	6.17	6.01	5.87	5.75	5.63	5.53	5.44	5.35	5.28
7.3	138.52	8.80	8.56	8.31	8.11	7.89	7.72	7.53	7.22	6.95	6.72	6.51	6.33	6.16	6.02	5.90	5.78	5.67	5.57	5.48	5.41
7.4	140.42	9.02	8.77	8.51	8.31	8.09	7.91	7.72	7.40	7.12	6.88	6.67	6.48	6.32	6.16	6.04	5.92	5.81	5.71	5.62	5.55
7.5	142.32	9.23	8.98	8.72	8.51	8.28	8.10	7.90	7.58	7.29	7.05	6.83	6.64	6.47	6.32	6.19	6.07	5.95	5.85	5.76	5.68
7.6	144.22	9.45	9.20	8.92	8.71	8.48	8.29	8.09	7.76	7.47	7.22	6.99	6.80	6.63	6.47	6.34	6.21	6.09	5.99	5.90	5.82
7.7	146.11	9.67	9.41	9.13	8.91	8.68	8.49	8.28	7.94	7.65	7.39	7.16	6.96	6.79	6.62	6.49	6.36	6.24	6.14	6.04	5.96
7.8	148.01	9.89	9.63	9.34	9.12	8.88	8.68	8.47	8.13	7.83	7.56	7.33	7.13	6.95	6.78	6.64	6.51	6.39	6.28	6.18	6.10
7.9	149.91	10.12	9.85	9.56	9.33	9.08	8.88	8.67	8.31	8.01	7.74	7.50	7.29	7.11	6.94	6.80	6.66	6.54	6.43	6.32	6.24
8.0	151.81	10.35	10.07	9.77	9.54	9.29	9.08	8.86	8.50	8.19	7.91	7.67	7.46	7.27	7.10	6.95	6.82	6.69	6.58	6.47	6.39

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Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	28.46	0.65	0.63	0.60	0.58	0.56	0.54	0.52	0.49	0.46	0.44	0.42	0.41	0.39	0.38	0.37	0.36	0.35	0.34	0.34	0.33
1.6	30.36	0.73	0.70	0.67	0.65	0.62	0.60	0.58	0.55	0.52	0.50	0.47	0.46	0.44	0.43	0.41	0.40	0.39	0.39	0.38	0.37
1.7	32.26	0.81	0.78	0.74	0.72	0.69	0.67	0.65	0.61	0.58	0.55	0.53	0.51	0.49	0.47	0.46	0.45	0.44	0.43	0.42	0.41
1.8	34.16	0.89	0.86	0.82	0.79	0.76	0.74	0.71	0.67	0.64	0.61	0.58	0.56	0.54	0.53	0.51	0.50	0.49	0.48	0.47	0.46
1.9	36.05	0.98	0.94	0.90	0.87	0.83	0.81	0.78	0.74	0.70	0.67	0.64	0.62	0.60	0.58	0.56	0.55	0.53	0.52	0.51	0.50
2.0	37.95	1.07	1.02	0.98	0.95	0.91	0.88	0.85	0.81	0.77	0.73	0.70	0.68	0.65	0.63	0.62	0.60	0.59	0.57	0.56	0.55
2.1	39.85	1.16	1.11	1.07	1.03	0.99	0.96	0.93	0.88	0.83	0.80	0.77	0.74	0.71	0.69	0.67	0.65	0.64	0.63	0.61	0.60
2.2	41.75	1.25	1.21	1.16	1.12	1.08	1.04	1.01	0.95	0.91	0.87	0.83	0.80	0.77	0.75	0.73	0.71	0.69	0.68	0.67	0.65
2.3	43.64	1.35	1.30	1.25	1.21	1.16	1.13	1.09	1.03	0.98	0.94	0.90	0.86	0.84	0.81	0.79	0.77	0.75	0.74	0.72	0.71
2.4	45.54	1.46	1.40	1.34	1.30	1.25	1.21	1.17	1.11	1.05	1.01	0.97	0.93	0.90	0.87	0.85	0.83	0.81	0.79	0.78	0.76
2.5	47.44	1.56	1.50	1.44	1.39	1.34	1.30	1.26	1.19	1.13	1.08	1.04	1.00	0.97	0.94	0.91	0.89	0.87	0.85	0.84	0.82
2.6	49.34	1.67	1.61	1.54	1.49	1.44	1.39	1.35	1.28	1.21	1.16	1.11	1.07	1.04	1.01	0.98	0.96	0.93	0.92	0.90	0.88
2.7	51.23	1.78	1.72	1.65	1.59	1.53	1.49	1.44	1.36	1.30	1.24	1.19	1.15	1.11	1.08	1.05	1.02	1.00	0.98	0.96	0.94
2.8	53.13	1.90	1.83	1.75	1.70	1.63	1.59	1.54	1.45	1.38	1.32	1.27	1.22	1.18	1.15	1.12	1.09	1.07	1.05	1.02	1.01
2.9	55.03	2.02	1.94	1.86	1.80	1.74	1.69	1.63	1.54	1.47	1.41	1.35	1.30	1.26	1.22	1.19	1.16	1.13	1.11	1.09	1.07
3.0	56.93	2.14	2.06	1.98	1.91	1.84	1.79	1.73	1.64	1.56	1.49	1.44	1.38	1.34	1.30	1.26	1.24	1.21	1.18	1.16	1.14
3.1	58.82	2.26	2.18	2.09	2.02	1.95	1.90	1.83	1.74	1.65	1.58	1.52	1.47	1.42	1.38	1.34	1.31	1.28	1.25	1.23	1.21
3.2	60.72	2.39	2.30	2.21	2.14	2.06	2.00	1.94	1.84	1.75	1.67	1.61	1.55	1.50	1.46	1.42	1.39	1.35	1.33	1.30	1.28
3.3	62.62	2.52	2.43	2.33	2.26	2.18	2.11	2.05	1.94	1.85	1.77	1.70	1.64	1.59	1.54	1.50	1.46	1.43	1.40	1.37	1.35
3.4	64.52	2.65	2.56	2.45	2.38	2.29	2.23	2.16	2.04	1.94	1.86	1.79	1.73	1.67	1.62	1.58	1.54	1.51	1.48	1.45	1.43
3.5	66.42	2.79	2.69	2.58	2.50	2.41	2.34	2.27	2.15	2.05	1.96	1.89	1.82	1.76	1.71	1.66	1.63	1.59	1.56	1.53	1.50
3.6	68.31	2.93	2.82	2.71	2.63	2.53	2.46	2.38	2.26	2.15	2.06	1.98	1.91	1.85	1.80	1.75	1.71	1.67	1.64	1.60	1.58
3.7	70.21	3.07	2.96	2.84	2.75	2.66	2.58	2.50	2.37	2.26	2.16	2.08	2.01	1.94	1.89	1.84	1.80	1.75	1.72	1.69	1.66
3.8	72.11	3.22	3.10	2.98	2.88	2.78	2.71	2.62	2.48	2.37	2.27	2.18	2.10	2.04	1.98	1.93	1.88	1.84	1.81	1.77	1.74
3.9	74.01	3.36	3.25	3.12	3.02	2.91	2.83	2.74	2.60	2.48	2.37	2.28	2.20	2.13	2.07	2.02	1.97	1.93	1.89	1.85	1.82
4.0	75.90	3.52	3.39	3.26	3.15	3.04	2.96	2.87	2.72	2.59	2.48	2.39	2.31	2.23	2.17	2.11	2.06	2.02	1.98	1.94	1.91
4.1	77.80	3.67	3.54	3.40	3.29	3.18	3.09	2.99	2.84	2.71	2.59	2.50	2.41	2.33	2.27	2.21	2.16	2.11	2.07	2.03	1.99
4.2	79.70	3.83	3.69	3.55	3.44	3.32	3.22	3.12	2.96	2.82	2.71	2.61	2.51	2.44	2.37	2.31	2.25	2.20	2.16	2.12	2.08
4.3	81.60	3.99	3.85	3.69	3.58	3.46	3.36	3.26	3.09	2.94	2.82	2.72	2.62	2.54	2.47	2.40	2.35	2.30	2.25	2.21	2.17
4.4	83.49	4.15	4.00	3.84	3.73	3.60	3.50	3.39	3.22	3.07	2.94	2.83	2.73	2.65	2.57	2.51	2.45	2.39	2.35	2.30	2.26
4.5	85.39	4.31	4.16	4.00	3.88	3.74	3.64	3.53	3.35	3.19	3.06	2.94	2.84	2.76	2.68	2.61	2.55	2.49	2.45	2.40	2.36
4.6	87.29	4.48	4.32	4.15	4.03	3.89	3.78	3.67	3.48	3.32	3.18	3.06	2.96	2.87	2.78	2.71	2.65	2.59	2.54	2.49	2.45
4.7	89.19	4.65	4.49	4.31	4.18	4.04	3.93	3.81	3.61	3.45	3.30	3.18	3.07	2.98	2.89	2.82	2.76	2.69	2.64	2.59	2.55
4.8	91.08	4.82	4.66	4.48	4.34	4.19	4.08	3.95	3.75	3.58	3.43	3.30	3.19	3.09	3.00	2.93	2.86	2.80	2.75	2.69	2.65
4.9	92.98	5.00	4.83	4.64	4.50	4.35	4.23	4.10	3.89	3.71	3.56	3.43	3.31	3.21	3.12	3.04	2.97	2.90	2.85	2.79	2.75

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3½" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	94.88	5.18	5.00	4.81	4.66	4.50	4.38	4.25	4.03	3.84	3.69	3.55	3.43	3.33	3.23	3.15	3.08	3.01	2.96	2.90	2.85
5.1	96.78	5.36	5.18	4.98	4.82	4.66	4.53	4.40	4.17	3.98	3.82	3.68	3.55	3.45	3.35	3.26	3.19	3.12	3.06	3.00	2.95
5.2	98.67	5.55	5.36	5.15	4.99	4.82	4.69	4.55	4.32	4.12	3.95	3.81	3.68	3.57	3.47	3.38	3.30	3.23	3.17	3.11	3.06
5.3	100.57	5.73	5.54	5.32	5.16	4.99	4.85	4.71	4.47	4.26	4.09	3.94	3.81	3.69	3.59	3.50	3.42	3.34	3.28	3.22	3.17
5.4	102.47	5.92	5.72	5.50	5.33	5.15	5.01	4.86	4.62	4.41	4.23	4.07	3.94	3.82	3.71	3.62	3.54	3.45	3.39	3.33	3.27
5.5	104.37	6.11	5.91	5.68	5.51	5.32	5.18	5.02	4.77	4.55	4.37	4.21	4.07	3.94	3.83	3.74	3.65	3.57	3.51	3.44	3.38
5.6	106.26	6.31	6.10	5.86	5.68	5.49	5.35	5.19	4.92	4.70	4.51	4.35	4.20	4.07	3.96	3.86	3.77	3.69	3.62	3.55	3.50
5.7	108.16	6.51	6.29	6.05	5.86	5.67	5.51	5.35	5.08	4.85	4.66	4.49	4.33	4.20	4.08	3.98	3.90	3.81	3.74	3.67	3.61
5.8	110.06	6.71	6.48	6.23	6.05	5.84	5.69	5.52	5.24	5.00	4.80	4.63	4.47	4.34	4.21	4.11	4.02	3.93	3.86	3.78	3.73
5.9	111.96	6.91	6.68	6.42	6.23	6.02	5.86	5.69	5.40	5.16	4.95	4.77	4.61	4.47	4.35	4.24	4.15	4.05	3.98	3.90	3.84
6.0	113.85	7.12	6.88	6.61	6.42	6.20	6.04	5.86	5.56	5.31	5.10	4.92	4.75	4.61	4.48	4.37	4.27	4.18	4.10	4.02	3.96
6.1	115.75	7.33	7.08	6.81	6.61	6.39	6.21	6.03	5.73	5.47	5.25	5.06	4.89	4.75	4.61	4.50	4.40	4.30	4.23	4.14	4.08
6.2	117.65	7.54	7.28	7.01	6.80	6.57	6.40	6.21	5.90	5.63	5.41	5.21	5.04	4.89	4.75	4.63	4.53	4.43	4.35	4.27	4.20
6.3	119.55	7.75	7.49	7.21	6.99	6.76	6.58	6.38	6.07	5.79	5.56	5.36	5.18	5.03	4.89	4.77	4.66	4.56	4.48	4.39	4.32
6.4	121.45	7.97	7.70	7.41	7.19	6.95	6.76	6.56	6.24	5.96	5.72	5.52	5.33	5.17	5.03	4.91	4.80	4.69	4.61	4.52	4.45
6.5	123.34	8.18	7.91	7.61	7.39	7.14	6.95	6.75	6.41	6.13	5.88	5.67	5.48	5.32	5.17	5.04	4.93	4.82	4.74	4.65	4.58
6.6	125.24	8.41	8.13	7.82	7.59	7.34	7.14	6.93	6.59	6.29	6.04	5.83	5.63	5.47	5.31	5.18	5.07	4.96	4.87	4.78	4.70
6.7	127.14	8.63	8.34	8.03	7.79	7.53	7.33	7.12	6.77	6.46	6.21	5.99	5.79	5.61	5.46	5.33	5.21	5.09	5.01	4.91	4.83
6.8	129.04	8.86	8.56	8.24	8.00	7.73	7.53	7.31	6.95	6.64	6.37	6.15	5.94	5.77	5.61	5.47	5.35	5.23	5.14	5.04	4.96
6.9	130.93	9.09	8.78	8.45	8.20	7.93	7.72	7.50	7.13	6.81	6.54	6.31	6.10	5.92	5.76	5.62	5.49	5.37	5.28	5.18	5.10
7.0	132.83	9.32	9.01	8.67	8.42	8.14	7.92	7.69	7.31	6.99	6.71	6.47	6.26	6.07	5.91	5.76	5.64	5.51	5.42	5.31	5.23
7.1	134.73	9.55	9.23	8.89	8.63	8.35	8.12	7.89	7.50	7.17	6.88	6.64	6.42	6.23	6.06	5.91	5.78	5.66	5.56	5.45	5.37
7.2	136.63	9.79	9.46	9.11	8.84	8.55	8.33	8.09	7.69	7.35	7.06	6.81	6.58	6.39	6.21	6.06	5.93	5.80	5.70	5.59	5.51
7.3	138.52	10.03	9.70	9.33	9.06	8.76	8.53	8.29	7.88	7.53	7.23	6.98	6.75	6.55	6.37	6.22	6.08	5.95	5.85	5.73	5.64
7.4	140.42	10.27	9.93	9.56	9.28	8.98	8.74	8.49	8.07	7.72	7.41	7.15	6.91	6.71	6.53	6.37	6.23	6.09	5.99	5.87	5.79
7.5	142.32	10.51	10.17	9.79	9.50	9.19	8.95	8.69	8.27	7.90	7.59	7.32	7.08	6.87	6.69	6.53	6.39	6.24	6.14	6.02	5.93
7.6	144.22	10.76	10.41	10.02	9.73	9.41	9.16	8.90	8.46	8.09	7.77	7.50	7.25	7.04	6.85	6.68	6.54	6.39	6.29	6.16	6.07
7.7	146.11	11.01	10.65	10.25	9.95	9.63	9.38	9.11	8.66	8.28	7.96	7.68	7.42	7.21	7.01	6.84	6.70	6.55	6.44	6.31	6.22
7.8	148.01	11.26	10.89	10.49	10.18	9.85	9.59	9.32	8.86	8.47	8.14	7.86	7.60	7.38	7.17	7.00	6.85	6.70	6.59	6.46	6.36
7.9	149.91	11.52	11.14	10.73	10.41	10.08	9.81	9.53	9.07	8.67	8.33	8.04	7.77	7.55	7.34	7.17	7.01	6.86	6.74	6.61	6.51
8.0	151.81	11.77	11.39	10.97	10.65	10.30	10.03	9.74	9.27	8.87	8.52	8.22	7.95	7.72	7.51	7.33	7.17	7.01	6.90	6.76	6.66

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3½" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	28.46	0.74	0.71	0.67	0.65	0.62	0.60	0.58	0.54	0.51	0.48	0.46	0.44	0.43	0.41	0.40	0.39	0.37	0.36	0.36	0.35
1.6	30.36	0.82	0.79	0.75	0.72	0.69	0.67	0.65	0.60	0.57	0.54	0.52	0.49	0.48	0.46	0.44	0.43	0.42	0.41	0.40	0.39
1.7	32.26	0.91	0.88	0.83	0.80	0.77	0.74	0.72	0.67	0.63	0.60	0.57	0.55	0.53	0.51	0.49	0.48	0.47	0.45	0.44	0.43
1.8	34.16	1.01	0.96	0.92	0.89	0.85	0.82	0.79	0.74	0.70	0.66	0.63	0.61	0.59	0.56	0.55	0.53	0.52	0.50	0.49	0.48
1.9	36.05	1.10	1.06	1.01	0.97	0.93	0.90	0.87	0.81	0.77	0.73	0.70	0.67	0.64	0.62	0.60	0.58	0.57	0.55	0.54	0.53
2.0	37.95	1.20	1.15	1.10	1.06	1.02	0.98	0.95	0.89	0.84	0.80	0.76	0.73	0.70	0.68	0.66	0.64	0.62	0.61	0.59	0.58
2.1	39.85	1.31	1.25	1.20	1.15	1.11	1.07	1.03	0.97	0.91	0.87	0.83	0.80	0.77	0.74	0.72	0.70	0.68	0.66	0.65	0.63
2.2	41.75	1.41	1.36	1.29	1.25	1.20	1.16	1.12	1.05	0.99	0.94	0.90	0.86	0.83	0.80	0.78	0.76	0.74	0.72	0.70	0.69
2.3	43.64	1.52	1.46	1.40	1.35	1.29	1.25	1.21	1.13	1.07	1.02	0.97	0.93	0.90	0.87	0.84	0.82	0.80	0.78	0.76	0.74
2.4	45.54	1.64	1.57	1.50	1.45	1.39	1.35	1.30	1.22	1.15	1.10	1.05	1.01	0.97	0.94	0.91	0.88	0.86	0.84	0.82	0.80
2.5	47.44	1.76	1.69	1.61	1.55	1.49	1.44	1.39	1.31	1.24	1.18	1.13	1.08	1.04	1.01	0.98	0.95	0.92	0.90	0.88	0.86
2.6	49.34	1.88	1.80	1.72	1.66	1.60	1.55	1.49	1.40	1.33	1.26	1.21	1.16	1.12	1.08	1.05	1.02	0.99	0.97	0.95	0.93
2.7	51.23	2.00	1.92	1.84	1.77	1.70	1.65	1.59	1.50	1.42	1.35	1.29	1.24	1.19	1.15	1.12	1.09	1.06	1.03	1.01	0.99
2.8	53.13	2.13	2.05	1.96	1.89	1.82	1.76	1.70	1.60	1.51	1.44	1.38	1.32	1.27	1.23	1.19	1.16	1.13	1.10	1.08	1.06
2.9	55.03	2.26	2.18	2.08	2.01	1.93	1.87	1.80	1.70	1.61	1.53	1.46	1.41	1.36	1.31	1.27	1.24	1.20	1.17	1.15	1.12
3.0	56.93	2.40	2.31	2.20	2.13	2.05	1.98	1.91	1.80	1.70	1.62	1.55	1.49	1.44	1.39	1.35	1.31	1.28	1.25	1.22	1.19
3.1	58.82	2.54	2.44	2.33	2.25	2.16	2.10	2.02	1.91	1.81	1.72	1.65	1.58	1.52	1.47	1.43	1.39	1.35	1.32	1.29	1.27
3.2	60.72	2.68	2.58	2.46	2.38	2.29	2.22	2.14	2.01	1.91	1.82	1.74	1.67	1.61	1.56	1.51	1.47	1.43	1.40	1.37	1.34
3.3	62.62	2.82	2.72	2.60	2.51	2.41	2.34	2.26	2.13	2.01	1.92	1.84	1.77	1.70	1.65	1.60	1.55	1.51	1.48	1.45	1.42
3.4	64.52	2.97	2.86	2.73	2.64	2.54	2.46	2.38	2.24	2.12	2.02	1.94	1.86	1.80	1.74	1.69	1.64	1.60	1.56	1.53	1.49
3.5	66.42	3.12	3.01	2.88	2.78	2.67	2.59	2.50	2.36	2.23	2.13	2.04	1.96	1.89	1.83	1.77	1.73	1.68	1.64	1.61	1.57
3.6	68.31	3.28	3.15	3.02	2.92	2.80	2.72	2.63	2.48	2.35	2.24	2.14	2.06	1.99	1.92	1.87	1.82	1.77	1.73	1.69	1.65
3.7	70.21	3.44	3.31	3.16	3.06	2.94	2.85	2.75	2.60	2.46	2.35	2.25	2.16	2.09	2.02	1.96	1.91	1.86	1.81	1.77	1.74
3.8	72.11	3.60	3.46	3.31	3.20	3.08	2.99	2.89	2.72	2.58	2.46	2.36	2.27	2.19	2.12	2.05	2.00	1.95	1.90	1.86	1.82
3.9	74.01	3.76	3.62	3.47	3.35	3.22	3.12	3.02	2.85	2.70	2.58	2.47	2.37	2.29	2.22	2.15	2.09	2.04	1.99	1.95	1.91
4.0	75.90	3.93	3.78	3.62	3.50	3.37	3.27	3.16	2.98	2.82	2.69	2.58	2.48	2.40	2.32	2.25	2.19	2.13	2.08	2.04	2.00
4.1	77.80	4.10	3.95	3.78	3.65	3.52	3.41	3.29	3.11	2.95	2.81	2.70	2.59	2.50	2.42	2.35	2.29	2.23	2.18	2.13	2.09
4.2	79.70	4.28	4.12	3.94	3.81	3.67	3.56	3.44	3.24	3.08	2.94	2.81	2.71	2.61	2.53	2.45	2.39	2.33	2.27	2.23	2.18
4.3	81.60	4.45	4.29	4.10	3.97	3.82	3.70	3.58	3.38	3.21	3.06	2.93	2.82	2.72	2.64	2.56	2.49	2.43	2.37	2.32	2.28
4.4	83.49	4.63	4.46	4.27	4.13	3.98	3.86	3.73	3.52	3.34	3.19	3.05	2.94	2.84	2.75	2.67	2.60	2.53	2.47	2.42	2.37
4.5	85.39	4.82	4.64	4.44	4.29	4.13	4.01	3.88	3.66	3.47	3.32	3.18	3.06	2.95	2.86	2.78	2.70	2.63	2.57	2.52	2.47
4.6	87.29	5.00	4.82	4.61	4.46	4.30	4.17	4.03	3.80	3.61	3.45	3.30	3.18	3.07	2.97	2.89	2.81	2.74	2.68	2.62	2.57
4.7	89.19	5.19	5.00	4.79	4.63	4.46	4.33	4.18	3.95	3.75	3.58	3.43	3.30	3.19	3.09	3.00	2.92	2.85	2.78	2.72	2.67
4.8	91.08	5.38	5.18	4.97	4.80	4.63	4.49	4.34	4.10	3.89	3.72	3.56	3.43	3.31	3.21	3.11	3.03	2.96	2.89	2.83	2.77
4.9	92.98	5.58	5.37	5.15	4.98	4.80	4.65	4.50	4.25	4.04	3.85	3.70	3.56	3.44	3.33	3.23	3.15	3.07	3.00	2.94	2.88

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

3½" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	94.88	5.78	5.56	5.33	5.16	4.97	4.82	4.66	4.40	4.18	3.99	3.83	3.69	3.56	3.45	3.35	3.26	3.18	3.11	3.04	2.98
5.1	96.78	5.98	5.76	5.52	5.34	5.14	4.99	4.83	4.56	4.33	4.14	3.97	3.82	3.69	3.57	3.47	3.38	3.30	3.22	3.15	3.09
5.2	98.67	6.18	5.96	5.71	5.52	5.32	5.16	4.99	4.72	4.48	4.28	4.11	3.95	3.82	3.70	3.59	3.50	3.41	3.33	3.27	3.20
5.3	100.57	6.39	6.16	5.90	5.71	5.50	5.34	5.16	4.88	4.64	4.43	4.25	4.09	3.95	3.83	3.72	3.62	3.53	3.45	3.38	3.31
5.4	102.47	6.60	6.36	6.10	5.90	5.68	5.52	5.33	5.04	4.79	4.58	4.39	4.23	4.08	3.96	3.84	3.74	3.65	3.57	3.50	3.43
5.5	104.37	6.81	6.56	6.29	6.09	5.87	5.70	5.51	5.21	4.95	4.73	4.54	4.37	4.22	4.09	3.97	3.87	3.77	3.69	3.61	3.54
5.6	106.26	7.03	6.77	6.49	6.28	6.06	5.88	5.69	5.38	5.11	4.88	4.68	4.51	4.36	4.22	4.10	4.00	3.90	3.81	3.73	3.66
5.7	108.16	7.25	6.98	6.70	6.48	6.25	6.06	5.87	5.55	5.27	5.04	4.83	4.65	4.50	4.36	4.23	4.13	4.02	3.93	3.85	3.78
5.8	110.06	7.47	7.20	6.90	6.68	6.44	6.25	6.05	5.72	5.44	5.19	4.98	4.80	4.64	4.49	4.37	4.26	4.15	4.05	3.97	3.90
5.9	111.96	7.69	7.42	7.11	6.88	6.63	6.44	6.23	5.89	5.60	5.35	5.14	4.95	4.78	4.63	4.50	4.39	4.28	4.18	4.10	4.02
6.0	113.85	7.92	7.63	7.32	7.09	6.83	6.63	6.42	6.07	5.77	5.52	5.29	5.10	4.93	4.78	4.64	4.52	4.41	4.31	4.22	4.14
6.1	115.75	8.15	7.86	7.54	7.30	7.03	6.83	6.61	6.25	5.94	5.68	5.45	5.25	5.08	4.92	4.78	4.66	4.54	4.44	4.35	4.27
6.2	117.65	8.38	8.08	7.75	7.51	7.24	7.03	6.80	6.43	6.12	5.85	5.61	5.41	5.22	5.06	4.92	4.80	4.68	4.57	4.48	4.39
6.3	119.55	8.62	8.31	7.97	7.72	7.44	7.23	6.99	6.62	6.29	6.01	5.77	5.56	5.38	5.21	5.06	4.94	4.81	4.70	4.61	4.52
6.4	121.45	8.86	8.54	8.20	7.93	7.65	7.43	7.19	6.80	6.47	6.18	5.94	5.72	5.53	5.36	5.21	5.08	4.95	4.84	4.74	4.65
6.5	123.34	9.10	8.78	8.42	8.15	7.86	7.63	7.39	6.99	6.65	6.36	6.10	5.88	5.68	5.51	5.36	5.22	5.09	4.98	4.88	4.78
6.6	125.24	9.34	9.01	8.65	8.37	8.07	7.84	7.59	7.18	6.83	6.53	6.27	6.04	5.84	5.66	5.51	5.37	5.23	5.12	5.01	4.92
6.7	127.14	9.59	9.25	8.88	8.60	8.29	8.05	7.79	7.37	7.02	6.71	6.44	6.21	6.00	5.82	5.66	5.51	5.38	5.26	5.15	5.05
6.8	129.04	9.84	9.49	9.11	8.82	8.51	8.26	8.00	7.57	7.20	6.89	6.61	6.37	6.16	5.97	5.81	5.66	5.52	5.40	5.29	5.19
6.9	130.93	10.10	9.74	9.35	9.05	8.73	8.48	8.21	7.77	7.39	7.07	6.79	6.54	6.32	6.13	5.96	5.81	5.67	5.54	5.43	5.33
7.0	132.83	10.35	9.98	9.58	9.28	8.95	8.70	8.42	7.97	7.58	7.25	6.96	6.71	6.49	6.29	6.12	5.96	5.82	5.69	5.58	5.47
7.1	134.73	10.61	10.23	9.82	9.51	9.18	8.92	8.63	8.17	7.77	7.44	7.14	6.88	6.66	6.45	6.28	6.12	5.97	5.83	5.72	5.61
7.2	136.63	10.87	10.49	10.07	9.75	9.41	9.14	8.85	8.37	7.97	7.62	7.32	7.06	6.82	6.62	6.43	6.27	6.12	5.98	5.87	5.75
7.3	138.52	11.13	10.74	10.31	9.99	9.64	9.36	9.06	8.58	8.17	7.81	7.50	7.23	7.00	6.78	6.60	6.43	6.27	6.13	6.01	5.90
7.4	140.42	11.40	11.00	10.56	10.23	9.87	9.59	9.28	8.79	8.37	8.00	7.69	7.41	7.17	6.95	6.76	6.59	6.43	6.28	6.16	6.04
7.5	142.32	11.67	11.26	10.81	10.47	10.10	9.82	9.51	9.00	8.57	8.20	7.87	7.59	7.34	7.12	6.92	6.75	6.59	6.44	6.31	6.19
7.6	144.22	11.94	11.52	11.07	10.72	10.34	10.05	9.73	9.22	8.77	8.39	8.06	7.77	7.52	7.29	7.09	6.91	6.74	6.59	6.47	6.34
7.7	146.11	12.22	11.79	11.32	10.97	10.58	10.28	9.96	9.43	8.98	8.59	8.25	7.96	7.70	7.46	7.26	7.08	6.91	6.75	6.62	6.49
7.8	148.01	12.50	12.06	11.58	11.22	10.83	10.52	10.19	9.65	9.18	8.79	8.44	8.14	7.88	7.64	7.43	7.24	7.07	6.91	6.78	6.65
7.9	149.91	12.78	12.33	11.84	11.47	11.07	10.76	10.42	9.87	9.39	8.99	8.64	8.33	8.06	7.81	7.60	7.41	7.23	7.07	6.93	6.80
8.0	151.81	13.06	12.60	12.11	11.73	11.32	11.00	10.65	10.09	9.61	9.19	8.83	8.52	8.24	7.99	7.77	7.58	7.40	7.23	7.09	6.96

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

4" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	36.88	0.35	0.33	0.32	0.31	0.30	0.30	0.29	0.29	0.28	0.27	0.27	0.26	0.26	0.25	0.25	0.24	0.24	0.24	0.23	0.23
1.6	39.34	0.39	0.37	0.35	0.35	0.34	0.34	0.33	0.32	0.31	0.31	0.30	0.29	0.29	0.28	0.28	0.27	0.27	0.27	0.26	0.26
1.7	41.80	0.43	0.41	0.39	0.39	0.38	0.37	0.37	0.36	0.35	0.34	0.33	0.33	0.32	0.31	0.31	0.30	0.30	0.30	0.29	0.29
1.8	44.26	0.48	0.46	0.44	0.43	0.42	0.41	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.35	0.34	0.34	0.33	0.33	0.32	0.32
1.9	46.72	0.53	0.50	0.48	0.47	0.46	0.46	0.45	0.44	0.43	0.42	0.41	0.40	0.39	0.38	0.38	0.37	0.37	0.36	0.36	0.35
2.0	49.17	0.58	0.55	0.52	0.52	0.51	0.50	0.49	0.48	0.47	0.45	0.45	0.44	0.43	0.42	0.41	0.41	0.40	0.40	0.39	0.39
2.1	51.63	0.63	0.60	0.57	0.56	0.55	0.54	0.54	0.52	0.51	0.50	0.49	0.48	0.47	0.46	0.45	0.45	0.44	0.43	0.43	0.42
2.2	54.09	0.68	0.65	0.62	0.61	0.60	0.59	0.58	0.57	0.55	0.54	0.53	0.52	0.51	0.50	0.49	0.48	0.48	0.47	0.47	0.46
2.3	56.55	0.74	0.71	0.67	0.66	0.65	0.64	0.63	0.61	0.60	0.58	0.57	0.56	0.55	0.54	0.53	0.52	0.52	0.51	0.50	0.50
2.4	59.01	0.79	0.76	0.73	0.71	0.70	0.69	0.68	0.66	0.65	0.63	0.62	0.61	0.59	0.58	0.57	0.57	0.56	0.55	0.54	0.54
2.5	61.47	0.85	0.82	0.78	0.77	0.75	0.74	0.73	0.71	0.69	0.68	0.66	0.65	0.64	0.63	0.62	0.61	0.60	0.59	0.59	0.58
2.6	63.93	0.92	0.88	0.84	0.82	0.81	0.80	0.78	0.76	0.74	0.73	0.71	0.70	0.69	0.67	0.66	0.65	0.65	0.64	0.63	0.62
2.7	66.38	0.98	0.94	0.89	0.88	0.86	0.85	0.84	0.82	0.80	0.78	0.76	0.75	0.73	0.72	0.71	0.70	0.69	0.68	0.67	0.67
2.8	68.84	1.04	1.00	0.95	0.94	0.92	0.91	0.90	0.87	0.85	0.83	0.81	0.80	0.78	0.77	0.76	0.75	0.74	0.73	0.72	0.71
2.9	71.30	1.11	1.07	1.02	1.00	0.98	0.97	0.95	0.93	0.91	0.88	0.87	0.85	0.83	0.82	0.81	0.80	0.79	0.78	0.77	0.76
3.0	73.76	1.18	1.13	1.08	1.06	1.04	1.03	1.01	0.99	0.96	0.94	0.92	0.90	0.89	0.87	0.86	0.85	0.84	0.82	0.82	0.81
3.1	76.22	1.25	1.20	1.14	1.12	1.11	1.09	1.07	1.05	1.02	1.00	0.98	0.96	0.94	0.93	0.91	0.90	0.89	0.88	0.86	0.86
3.2	78.68	1.32	1.27	1.21	1.19	1.17	1.15	1.14	1.11	1.08	1.06	1.03	1.01	1.00	0.98	0.97	0.95	0.94	0.93	0.92	0.91
3.3	81.14	1.40	1.34	1.28	1.26	1.24	1.22	1.20	1.17	1.14	1.12	1.09	1.07	1.05	1.04	1.02	1.01	0.99	0.98	0.97	0.96
3.4	83.60	1.47	1.41	1.35	1.33	1.30	1.29	1.27	1.23	1.20	1.18	1.15	1.13	1.11	1.09	1.08	1.06	1.05	1.03	1.02	1.01
3.5	86.05	1.55	1.49	1.42	1.40	1.37	1.35	1.33	1.30	1.27	1.24	1.22	1.19	1.17	1.15	1.14	1.12	1.10	1.09	1.08	1.07
3.6	88.51	1.63	1.57	1.49	1.47	1.44	1.42	1.40	1.37	1.33	1.30	1.28	1.25	1.23	1.21	1.19	1.18	1.16	1.15	1.13	1.12
3.7	90.97	1.71	1.64	1.57	1.54	1.52	1.50	1.47	1.44	1.40	1.37	1.34	1.32	1.30	1.27	1.26	1.24	1.22	1.21	1.19	1.18
3.8	93.43	1.79	1.72	1.64	1.62	1.59	1.57	1.55	1.51	1.47	1.44	1.41	1.38	1.36	1.34	1.32	1.30	1.28	1.27	1.25	1.24
3.9	95.89	1.88	1.80	1.72	1.69	1.67	1.64	1.62	1.58	1.54	1.51	1.48	1.45	1.42	1.40	1.38	1.36	1.34	1.33	1.31	1.30
4.0	98.35	1.96	1.89	1.80	1.77	1.74	1.72	1.69	1.65	1.61	1.58	1.55	1.52	1.49	1.47	1.45	1.42	1.41	1.39	1.37	1.36
4.1	100.81	2.05	1.97	1.88	1.85	1.82	1.80	1.77	1.73	1.69	1.65	1.62	1.59	1.56	1.53	1.51	1.49	1.47	1.45	1.44	1.42
4.2	103.27	2.14	2.06	1.97	1.94	1.90	1.88	1.85	1.80	1.76	1.72	1.69	1.66	1.63	1.60	1.58	1.56	1.54	1.52	1.50	1.48
4.3	105.72	2.23	2.15	2.05	2.02	1.99	1.96	1.93	1.88	1.84	1.80	1.76	1.73	1.70	1.67	1.65	1.62	1.60	1.58	1.57	1.55
4.4	108.18	2.33	2.24	2.14	2.10	2.07	2.04	2.01	1.96	1.91	1.87	1.84	1.80	1.77	1.74	1.72	1.69	1.67	1.65	1.63	1.61
4.5	110.64	2.42	2.33	2.22	2.19	2.15	2.12	2.09	2.04	1.99	1.95	1.91	1.88	1.84	1.82	1.79	1.76	1.74	1.72	1.70	1.68
4.6	113.10	2.52	2.42	2.31	2.28	2.24	2.21	2.18	2.12	2.07	2.03	1.99	1.95	1.92	1.89	1.86	1.84	1.81	1.79	1.77	1.75
4.7	115.56	2.62	2.52	2.40	2.37	2.33	2.30	2.26	2.21	2.15	2.11	2.07	2.03	2.00	1.96	1.94	1.91	1.88	1.86	1.84	1.82
4.8	118.02	2.72	2.61	2.50	2.46	2.42	2.39	2.35	2.29	2.24	2.19	2.15	2.11	2.07	2.04	2.01	1.98	1.96	1.93	1.91	1.89
4.9	120.48	2.82	2.71	2.59	2.55	2.51	2.48	2.44	2.38	2.32	2.27	2.23	2.19	2.15	2.12	2.09	2.06	2.03	2.01	1.98	1.96

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

4" Uponor PEX-a — 100% Water — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	122.94	2.92	2.81	2.69	2.64	2.60	2.57	2.53	2.47	2.41	2.36	2.31	2.27	2.23	2.20	2.16	2.14	2.11	2.08	2.06	2.04
5.1	125.39	3.03	2.91	2.78	2.74	2.70	2.66	2.62	2.56	2.50	2.44	2.40	2.35	2.31	2.28	2.24	2.21	2.18	2.16	2.13	2.11
5.2	127.85	3.13	3.02	2.88	2.84	2.79	2.75	2.71	2.65	2.59	2.53	2.48	2.44	2.40	2.36	2.32	2.29	2.26	2.24	2.21	2.19
5.3	130.31	3.24	3.12	2.98	2.94	2.89	2.85	2.81	2.74	2.68	2.62	2.57	2.52	2.48	2.44	2.41	2.37	2.34	2.32	2.29	2.26
5.4	132.77	3.35	3.23	3.08	3.04	2.99	2.95	2.91	2.83	2.77	2.71	2.66	2.61	2.57	2.53	2.49	2.46	2.42	2.40	2.37	2.34
5.5	135.23	3.46	3.33	3.19	3.14	3.09	3.05	3.00	2.93	2.86	2.80	2.75	2.70	2.65	2.61	2.57	2.54	2.51	2.48	2.45	2.42
5.6	137.69	3.58	3.44	3.29	3.24	3.19	3.15	3.10	3.02	2.96	2.89	2.84	2.79	2.74	2.70	2.66	2.62	2.59	2.56	2.53	2.50
5.7	140.15	3.69	3.55	3.40	3.35	3.29	3.25	3.20	3.12	3.05	2.99	2.93	2.88	2.83	2.79	2.75	2.71	2.67	2.64	2.61	2.59
5.8	142.60	3.81	3.67	3.50	3.45	3.40	3.35	3.30	3.22	3.15	3.08	3.02	2.97	2.92	2.88	2.83	2.80	2.76	2.73	2.70	2.67
5.9	145.06	3.93	3.78	3.61	3.56	3.50	3.46	3.41	3.32	3.25	3.18	3.12	3.06	3.01	2.97	2.92	2.88	2.85	2.81	2.78	2.75
6.0	147.52	4.05	3.90	3.72	3.67	3.61	3.56	3.51	3.42	3.35	3.28	3.21	3.16	3.11	3.06	3.01	2.97	2.94	2.90	2.87	2.84
6.1	149.98	4.17	4.01	3.84	3.78	3.72	3.67	3.62	3.53	3.45	3.38	3.31	3.25	3.20	3.15	3.11	3.06	3.03	2.99	2.96	2.93
6.2	152.44	4.29	4.13	3.95	3.89	3.83	3.78	3.73	3.63	3.55	3.48	3.41	3.35	3.30	3.25	3.20	3.16	3.12	3.08	3.05	3.01
6.3	154.90	4.42	4.25	4.06	4.00	3.94	3.89	3.83	3.74	3.66	3.58	3.51	3.45	3.39	3.34	3.29	3.25	3.21	3.17	3.14	3.10
6.4	157.36	4.54	4.37	4.18	4.12	4.06	4.00	3.95	3.85	3.76	3.68	3.61	3.55	3.49	3.44	3.39	3.34	3.30	3.26	3.23	3.19
6.5	159.82	4.67	4.50	4.30	4.24	4.17	4.11	4.06	3.96	3.87	3.79	3.72	3.65	3.59	3.54	3.49	3.44	3.40	3.36	3.32	3.29
6.6	162.27	4.80	4.62	4.42	4.35	4.29	4.23	4.17	4.07	3.98	3.89	3.82	3.75	3.69	3.64	3.58	3.54	3.49	3.45	3.41	3.38
6.7	164.73	4.93	4.75	4.54	4.47	4.40	4.35	4.28	4.18	4.09	4.00	3.93	3.86	3.79	3.74	3.68	3.64	3.59	3.55	3.51	3.47
6.8	167.19	5.06	4.88	4.66	4.59	4.52	4.46	4.40	4.29	4.20	4.11	4.03	3.96	3.90	3.84	3.78	3.73	3.69	3.65	3.61	3.57
6.9	169.65	5.20	5.01	4.79	4.72	4.64	4.58	4.52	4.41	4.31	4.22	4.14	4.07	4.00	3.94	3.89	3.84	3.79	3.74	3.70	3.66
7.0	172.11	5.33	5.14	4.91	4.84	4.77	4.70	4.64	4.52	4.42	4.33	4.25	4.18	4.11	4.05	3.99	3.94	3.89	3.84	3.80	3.76
7.1	174.57	5.47	5.27	5.04	4.97	4.89	4.82	4.76	4.64	4.54	4.44	4.36	4.29	4.22	4.15	4.09	4.04	3.99	3.94	3.90	3.86
7.2	177.03	5.61	5.40	5.17	5.09	5.01	4.95	4.88	4.76	4.65	4.56	4.47	4.40	4.32	4.26	4.20	4.14	4.09	4.05	4.00	3.96
7.3	179.49	5.75	5.54	5.30	5.22	5.14	5.07	5.00	4.88	4.77	4.67	4.59	4.51	4.43	4.37	4.31	4.25	4.20	4.15	4.10	4.06
7.4	181.94	5.89	5.67	5.43	5.35	5.27	5.20	5.13	5.00	4.89	4.79	4.70	4.62	4.55	4.48	4.41	4.36	4.30	4.25	4.21	4.16
7.5	184.40	6.03	5.81	5.56	5.48	5.40	5.33	5.25	5.12	5.01	4.91	4.82	4.73	4.66	4.59	4.52	4.46	4.41	4.36	4.31	4.27
7.6	186.86	6.18	5.95	5.70	5.61	5.53	5.45	5.38	5.25	5.13	5.03	4.93	4.85	4.77	4.70	4.63	4.57	4.52	4.47	4.42	4.37
7.7	189.32	6.32	6.09	5.83	5.75	5.66	5.59	5.51	5.37	5.26	5.15	5.05	4.97	4.89	4.81	4.75	4.68	4.63	4.57	4.52	4.48
7.8	191.78	6.47	6.24	5.97	5.88	5.79	5.72	5.64	5.50	5.38	5.27	5.17	5.08	5.00	4.93	4.86	4.80	4.74	4.68	4.63	4.58
7.9	194.24	6.62	6.38	6.11	6.02	5.93	5.85	5.77	5.63	5.51	5.39	5.29	5.20	5.12	5.04	4.97	4.91	4.85	4.79	4.74	4.69
8.0	196.70	6.77	6.53	6.25	6.16	6.06	5.98	5.90	5.76	5.63	5.52	5.42	5.32	5.24	5.16	5.09	5.02	4.96	4.90	4.85	4.80

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

4" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	36.88	0.47	0.46	0.44	0.43	0.42	0.41	0.39	0.38	0.36	0.35	0.33	0.32	0.31	0.30	0.30	0.29	0.28	0.28	0.27	0.27
1.6	39.34	0.53	0.51	0.49	0.48	0.47	0.45	0.44	0.42	0.40	0.39	0.37	0.36	0.35	0.34	0.33	0.33	0.32	0.31	0.31	0.30
1.7	41.80	0.59	0.57	0.55	0.53	0.52	0.50	0.49	0.47	0.45	0.43	0.42	0.40	0.39	0.38	0.37	0.36	0.35	0.35	0.34	0.34
1.8	44.26	0.65	0.63	0.61	0.59	0.57	0.56	0.54	0.52	0.49	0.48	0.46	0.44	0.43	0.42	0.41	0.40	0.39	0.39	0.38	0.37
1.9	46.72	0.71	0.69	0.67	0.65	0.63	0.61	0.60	0.57	0.54	0.52	0.51	0.49	0.48	0.46	0.45	0.44	0.43	0.42	0.42	0.41
2.0	49.17	0.78	0.75	0.73	0.71	0.69	0.67	0.65	0.62	0.60	0.57	0.55	0.54	0.52	0.51	0.49	0.48	0.47	0.46	0.46	0.45
2.1	51.63	0.85	0.82	0.79	0.77	0.75	0.73	0.71	0.68	0.65	0.62	0.60	0.58	0.57	0.55	0.54	0.53	0.52	0.51	0.50	0.49
2.2	54.09	0.92	0.89	0.86	0.84	0.81	0.79	0.77	0.74	0.70	0.68	0.65	0.63	0.62	0.60	0.59	0.57	0.56	0.55	0.54	0.53
2.3	56.55	0.99	0.96	0.93	0.90	0.88	0.86	0.83	0.80	0.76	0.73	0.71	0.69	0.67	0.65	0.63	0.62	0.61	0.60	0.59	0.58
2.4	59.01	1.07	1.04	1.00	0.97	0.95	0.92	0.90	0.86	0.82	0.79	0.76	0.74	0.72	0.70	0.68	0.67	0.66	0.64	0.63	0.62
2.5	61.47	1.15	1.11	1.08	1.05	1.02	0.99	0.96	0.92	0.88	0.85	0.82	0.80	0.77	0.75	0.74	0.72	0.71	0.69	0.68	0.67
2.6	63.93	1.23	1.19	1.15	1.12	1.09	1.06	1.03	0.99	0.95	0.91	0.88	0.85	0.83	0.81	0.79	0.77	0.76	0.74	0.73	0.72
2.7	66.38	1.31	1.27	1.23	1.20	1.16	1.13	1.10	1.05	1.01	0.97	0.94	0.91	0.89	0.86	0.85	0.83	0.81	0.80	0.78	0.77
2.8	68.84	1.40	1.35	1.31	1.28	1.24	1.21	1.18	1.12	1.08	1.04	1.00	0.97	0.95	0.92	0.90	0.88	0.86	0.85	0.83	0.82
2.9	71.30	1.48	1.44	1.39	1.36	1.32	1.29	1.25	1.20	1.15	1.11	1.07	1.04	1.01	0.98	0.96	0.94	0.92	0.90	0.89	0.88
3.0	73.76	1.57	1.53	1.48	1.44	1.40	1.37	1.33	1.27	1.22	1.17	1.14	1.10	1.07	1.04	1.02	1.00	0.98	0.96	0.94	0.93
3.1	76.22	1.67	1.62	1.57	1.53	1.48	1.45	1.41	1.35	1.29	1.24	1.20	1.17	1.14	1.11	1.08	1.06	1.04	1.02	1.00	0.99
3.2	78.68	1.76	1.71	1.66	1.61	1.57	1.53	1.49	1.42	1.37	1.32	1.27	1.24	1.20	1.17	1.15	1.12	1.10	1.08	1.06	1.04
3.3	81.14	1.86	1.80	1.75	1.70	1.65	1.61	1.57	1.50	1.44	1.39	1.34	1.31	1.27	1.24	1.21	1.18	1.16	1.14	1.12	1.10
3.4	83.60	1.96	1.90	1.84	1.79	1.74	1.70	1.66	1.58	1.52	1.47	1.42	1.38	1.34	1.30	1.28	1.25	1.22	1.20	1.18	1.17
3.5	86.05	2.06	2.00	1.94	1.89	1.83	1.79	1.74	1.67	1.60	1.54	1.49	1.45	1.41	1.37	1.34	1.32	1.29	1.27	1.24	1.23
3.6	88.51	2.16	2.10	2.04	1.98	1.93	1.88	1.83	1.75	1.68	1.62	1.57	1.52	1.48	1.44	1.41	1.38	1.36	1.33	1.31	1.29
3.7	90.97	2.27	2.21	2.14	2.08	2.02	1.98	1.92	1.84	1.77	1.70	1.65	1.60	1.56	1.52	1.49	1.45	1.42	1.40	1.38	1.36
3.8	93.43	2.38	2.31	2.24	2.18	2.12	2.07	2.02	1.93	1.85	1.79	1.73	1.68	1.63	1.59	1.56	1.53	1.49	1.47	1.44	1.42
3.9	95.89	2.49	2.42	2.34	2.28	2.22	2.17	2.11	2.02	1.94	1.87	1.81	1.76	1.71	1.67	1.63	1.60	1.57	1.54	1.51	1.49
4.0	98.35	2.60	2.53	2.45	2.39	2.32	2.27	2.21	2.11	2.03	1.96	1.90	1.84	1.79	1.75	1.71	1.67	1.64	1.61	1.58	1.56
4.1	100.81	2.72	2.64	2.56	2.49	2.42	2.37	2.31	2.21	2.12	2.05	1.98	1.92	1.87	1.82	1.79	1.75	1.71	1.68	1.65	1.63
4.2	103.27	2.83	2.75	2.67	2.60	2.53	2.47	2.41	2.30	2.21	2.14	2.07	2.01	1.95	1.90	1.86	1.83	1.79	1.76	1.73	1.71
4.3	105.72	2.95	2.87	2.78	2.71	2.64	2.58	2.51	2.40	2.31	2.23	2.16	2.09	2.04	1.99	1.95	1.90	1.87	1.83	1.80	1.78
4.4	108.18	3.08	2.99	2.90	2.82	2.75	2.68	2.61	2.50	2.41	2.32	2.25	2.18	2.12	2.07	2.03	1.99	1.95	1.91	1.88	1.85
4.5	110.64	3.20	3.11	3.01	2.94	2.86	2.79	2.72	2.61	2.50	2.42	2.34	2.27	2.21	2.16	2.11	2.07	2.03	1.99	1.96	1.93
4.6	113.10	3.32	3.23	3.13	3.05	2.97	2.90	2.83	2.71	2.60	2.51	2.43	2.36	2.30	2.24	2.20	2.15	2.11	2.07	2.04	2.01
4.7	115.56	3.45	3.36	3.25	3.17	3.09	3.02	2.94	2.81	2.71	2.61	2.53	2.46	2.39	2.33	2.28	2.24	2.19	2.15	2.12	2.09
4.8	118.02	3.58	3.48	3.38	3.29	3.20	3.13	3.05	2.92	2.81	2.71	2.62	2.55	2.48	2.42	2.37	2.32	2.28	2.24	2.20	2.17
4.9	120.48	3.72	3.61	3.50	3.41	3.32	3.25	3.16	3.03	2.91	2.81	2.72	2.65	2.58	2.51	2.46	2.41	2.36	2.32	2.28	2.25

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

4" Uponor PEX-a — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	122.94	3.85	3.74	3.63	3.54	3.44	3.36	3.28	3.14	3.02	2.92	2.82	2.74	2.67	2.60	2.55	2.50	2.45	2.41	2.37	2.34
5.1	125.39	3.99	3.88	3.76	3.66	3.57	3.48	3.40	3.25	3.13	3.02	2.93	2.84	2.77	2.70	2.64	2.59	2.54	2.50	2.45	2.42
5.2	127.85	4.12	4.01	3.89	3.79	3.69	3.61	3.52	3.37	3.24	3.13	3.03	2.94	2.87	2.80	2.74	2.68	2.63	2.59	2.54	2.51
5.3	130.31	4.26	4.15	4.02	3.92	3.82	3.73	3.64	3.48	3.35	3.24	3.13	3.05	2.97	2.89	2.83	2.78	2.72	2.68	2.63	2.60
5.4	132.77	4.41	4.29	4.16	4.05	3.95	3.86	3.76	3.60	3.47	3.35	3.24	3.15	3.07	2.99	2.93	2.87	2.81	2.77	2.72	2.69
5.5	135.23	4.55	4.43	4.29	4.19	4.08	3.98	3.88	3.72	3.58	3.46	3.35	3.25	3.17	3.09	3.03	2.97	2.91	2.86	2.81	2.78
5.6	137.69	4.70	4.57	4.43	4.32	4.21	4.11	4.01	3.84	3.70	3.57	3.46	3.36	3.27	3.19	3.13	3.07	3.01	2.96	2.91	2.87
5.7	140.15	4.85	4.72	4.57	4.46	4.34	4.24	4.14	3.97	3.82	3.69	3.57	3.47	3.38	3.30	3.23	3.16	3.10	3.05	3.00	2.96
5.8	142.60	5.00	4.86	4.72	4.60	4.48	4.38	4.27	4.09	3.94	3.80	3.68	3.58	3.49	3.40	3.33	3.27	3.20	3.15	3.10	3.06
5.9	145.06	5.15	5.01	4.86	4.74	4.62	4.51	4.40	4.22	4.06	3.92	3.80	3.69	3.60	3.51	3.44	3.37	3.30	3.25	3.19	3.15
6.0	147.52	5.31	5.16	5.01	4.89	4.76	4.65	4.53	4.35	4.18	4.04	3.91	3.80	3.71	3.62	3.54	3.47	3.40	3.35	3.29	3.25
6.1	149.98	5.46	5.31	5.16	5.03	4.90	4.79	4.67	4.48	4.31	4.16	4.03	3.92	3.82	3.73	3.65	3.58	3.51	3.45	3.39	3.35
6.2	152.44	5.62	5.47	5.31	5.18	5.04	4.93	4.81	4.61	4.44	4.28	4.15	4.04	3.93	3.84	3.76	3.68	3.61	3.55	3.49	3.45
6.3	154.90	5.78	5.63	5.46	5.33	5.19	5.07	4.95	4.74	4.56	4.41	4.27	4.15	4.05	3.95	3.87	3.79	3.72	3.66	3.60	3.55
6.4	157.36	5.95	5.79	5.61	5.48	5.33	5.21	5.09	4.88	4.69	4.54	4.39	4.27	4.16	4.06	3.98	3.90	3.83	3.76	3.70	3.65
6.5	159.82	6.11	5.95	5.77	5.63	5.48	5.36	5.23	5.01	4.83	4.66	4.52	4.39	4.28	4.18	4.09	4.01	3.93	3.87	3.81	3.76
6.6	162.27	6.28	6.11	5.93	5.78	5.63	5.51	5.37	5.15	4.96	4.79	4.64	4.52	4.40	4.29	4.21	4.12	4.04	3.98	3.91	3.86
6.7	164.73	6.45	6.27	6.09	5.94	5.78	5.66	5.52	5.29	5.10	4.92	4.77	4.64	4.52	4.41	4.32	4.24	4.16	4.09	4.02	3.97
6.8	167.19	6.62	6.44	6.25	6.10	5.94	5.81	5.67	5.43	5.23	5.06	4.90	4.76	4.64	4.53	4.44	4.35	4.27	4.20	4.13	4.08
6.9	169.65	6.79	6.61	6.41	6.26	6.09	5.96	5.82	5.58	5.37	5.19	5.03	4.89	4.77	4.65	4.56	4.47	4.38	4.31	4.24	4.19
7.0	172.11	6.96	6.78	6.58	6.42	6.25	6.11	5.97	5.72	5.51	5.33	5.16	5.02	4.89	4.77	4.68	4.59	4.50	4.43	4.35	4.30
7.1	174.57	7.14	6.95	6.75	6.58	6.41	6.27	6.12	5.87	5.65	5.46	5.29	5.15	5.02	4.90	4.80	4.71	4.62	4.54	4.47	4.41
7.2	177.03	7.32	7.13	6.91	6.75	6.57	6.43	6.27	6.02	5.80	5.60	5.43	5.28	5.15	5.02	4.92	4.83	4.73	4.66	4.58	4.52
7.3	179.49	7.50	7.30	7.09	6.92	6.74	6.59	6.43	6.17	5.94	5.74	5.57	5.41	5.28	5.15	5.05	4.95	4.85	4.78	4.70	4.64
7.4	181.94	7.68	7.48	7.26	7.09	6.90	6.75	6.59	6.32	6.09	5.88	5.70	5.55	5.41	5.28	5.17	5.07	4.97	4.89	4.81	4.75
7.5	184.40	7.87	7.66	7.43	7.26	7.07	6.91	6.75	6.47	6.24	6.03	5.84	5.68	5.54	5.41	5.30	5.20	5.10	5.02	4.93	4.87
7.6	186.86	8.05	7.84	7.61	7.43	7.24	7.08	6.91	6.63	6.38	6.17	5.98	5.82	5.67	5.54	5.43	5.32	5.22	5.14	5.05	4.99
7.7	189.32	8.24	8.02	7.79	7.61	7.41	7.25	7.07	6.79	6.54	6.32	6.13	5.96	5.81	5.67	5.56	5.45	5.35	5.26	5.17	5.11
7.8	191.78	8.43	8.21	7.97	7.78	7.58	7.41	7.24	6.94	6.69	6.47	6.27	6.10	5.95	5.80	5.69	5.58	5.47	5.38	5.30	5.23
7.9	194.24	8.63	8.40	8.15	7.96	7.75	7.58	7.40	7.10	6.84	6.62	6.42	6.24	6.08	5.94	5.82	5.71	5.60	5.51	5.42	5.35
8.0	196.70	8.82	8.59	8.34	8.14	7.93	7.76	7.57	7.27	7.00	6.77	6.56	6.38	6.22	6.08	5.96	5.84	5.73	5.64	5.55	5.48

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

4" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	36.88	0.55	0.53	0.51	0.49	0.47	0.46	0.44	0.42	0.39	0.38	0.36	0.35	0.34	0.32	0.32	0.31	0.30	0.29	0.29	0.28
1.6	39.34	0.62	0.59	0.57	0.55	0.53	0.51	0.49	0.46	0.44	0.42	0.40	0.39	0.38	0.36	0.35	0.34	0.34	0.33	0.32	0.32
1.7	41.80	0.68	0.66	0.63	0.61	0.58	0.57	0.55	0.52	0.49	0.47	0.45	0.43	0.42	0.40	0.39	0.38	0.37	0.37	0.36	0.35
1.8	44.26	0.75	0.72	0.69	0.67	0.64	0.63	0.60	0.57	0.54	0.52	0.50	0.48	0.46	0.45	0.44	0.42	0.41	0.41	0.40	0.39
1.9	46.72	0.83	0.79	0.76	0.74	0.71	0.69	0.66	0.63	0.60	0.57	0.55	0.53	0.51	0.49	0.48	0.47	0.46	0.45	0.44	0.43
2.0	49.17	0.90	0.87	0.83	0.80	0.77	0.75	0.73	0.69	0.65	0.62	0.60	0.58	0.56	0.54	0.53	0.51	0.50	0.49	0.48	0.47
2.1	51.63	0.98	0.94	0.90	0.87	0.84	0.82	0.79	0.75	0.71	0.68	0.65	0.63	0.61	0.59	0.57	0.56	0.54	0.53	0.52	0.51
2.2	54.09	1.06	1.02	0.98	0.95	0.91	0.89	0.86	0.81	0.77	0.74	0.71	0.68	0.66	0.64	0.62	0.61	0.59	0.58	0.57	0.56
2.3	56.55	1.15	1.10	1.06	1.02	0.99	0.96	0.93	0.88	0.83	0.80	0.76	0.74	0.71	0.69	0.67	0.66	0.64	0.63	0.62	0.60
2.4	59.01	1.23	1.19	1.14	1.10	1.06	1.03	1.00	0.94	0.90	0.86	0.82	0.79	0.77	0.75	0.73	0.71	0.69	0.68	0.66	0.65
2.5	61.47	1.32	1.27	1.22	1.18	1.14	1.11	1.07	1.01	0.96	0.92	0.89	0.85	0.83	0.80	0.78	0.76	0.74	0.73	0.71	0.70
2.6	63.93	1.42	1.36	1.31	1.27	1.22	1.19	1.15	1.09	1.03	0.99	0.95	0.92	0.89	0.86	0.84	0.82	0.80	0.78	0.77	0.75
2.7	66.38	1.51	1.46	1.40	1.35	1.30	1.27	1.23	1.16	1.10	1.06	1.02	0.98	0.95	0.92	0.90	0.87	0.85	0.84	0.82	0.81
2.8	68.84	1.61	1.55	1.49	1.44	1.39	1.35	1.31	1.24	1.18	1.13	1.08	1.04	1.01	0.98	0.96	0.93	0.91	0.89	0.87	0.86
2.9	71.30	1.71	1.65	1.58	1.53	1.48	1.43	1.39	1.31	1.25	1.20	1.15	1.11	1.08	1.04	1.02	0.99	0.97	0.95	0.93	0.92
3.0	73.76	1.81	1.75	1.68	1.62	1.57	1.52	1.47	1.40	1.33	1.27	1.22	1.18	1.14	1.11	1.08	1.05	1.03	1.01	0.99	0.97
3.1	76.22	1.92	1.85	1.77	1.72	1.66	1.61	1.56	1.48	1.41	1.35	1.30	1.25	1.21	1.18	1.15	1.12	1.09	1.07	1.05	1.03
3.2	78.68	2.03	1.95	1.88	1.82	1.75	1.70	1.65	1.56	1.49	1.43	1.37	1.32	1.28	1.24	1.21	1.18	1.16	1.13	1.11	1.09
3.3	81.14	2.14	2.06	1.98	1.92	1.85	1.80	1.74	1.65	1.57	1.51	1.45	1.40	1.35	1.31	1.28	1.25	1.22	1.20	1.17	1.16
3.4	83.60	2.25	2.17	2.08	2.02	1.95	1.89	1.83	1.74	1.66	1.59	1.53	1.47	1.43	1.39	1.35	1.32	1.29	1.26	1.24	1.22
3.5	86.05	2.37	2.28	2.19	2.12	2.05	1.99	1.93	1.83	1.74	1.67	1.61	1.55	1.50	1.46	1.42	1.39	1.36	1.33	1.30	1.28
3.6	88.51	2.49	2.40	2.30	2.23	2.15	2.09	2.03	1.92	1.83	1.76	1.69	1.63	1.58	1.53	1.50	1.46	1.43	1.40	1.37	1.35
3.7	90.97	2.61	2.51	2.42	2.34	2.26	2.20	2.13	2.02	1.92	1.84	1.77	1.71	1.66	1.61	1.57	1.53	1.50	1.47	1.44	1.42
3.8	93.43	2.73	2.63	2.53	2.45	2.37	2.30	2.23	2.12	2.02	1.93	1.86	1.80	1.74	1.69	1.65	1.61	1.57	1.54	1.51	1.49
3.9	95.89	2.86	2.76	2.65	2.57	2.48	2.41	2.33	2.21	2.11	2.02	1.95	1.88	1.82	1.77	1.73	1.69	1.65	1.62	1.58	1.56
4.0	98.35	2.98	2.88	2.77	2.68	2.59	2.52	2.44	2.32	2.21	2.12	2.04	1.97	1.91	1.85	1.81	1.76	1.72	1.69	1.66	1.63
4.1	100.81	3.11	3.01	2.89	2.80	2.70	2.63	2.55	2.42	2.31	2.21	2.13	2.06	1.99	1.94	1.89	1.84	1.80	1.77	1.73	1.71
4.2	103.27	3.25	3.14	3.01	2.92	2.82	2.74	2.66	2.52	2.41	2.31	2.22	2.15	2.08	2.02	1.97	1.93	1.88	1.85	1.81	1.78
4.3	105.72	3.38	3.27	3.14	3.04	2.94	2.86	2.77	2.63	2.51	2.41	2.32	2.24	2.17	2.11	2.06	2.01	1.96	1.93	1.89	1.86
4.4	108.18	3.52	3.40	3.27	3.17	3.06	2.98	2.89	2.74	2.61	2.51	2.42	2.33	2.26	2.20	2.14	2.09	2.05	2.01	1.97	1.94
4.5	110.64	3.66	3.54	3.40	3.30	3.18	3.10	3.00	2.85	2.72	2.61	2.51	2.43	2.35	2.29	2.23	2.18	2.13	2.09	2.05	2.02
4.6	113.10	3.81	3.67	3.53	3.43	3.31	3.22	3.12	2.96	2.83	2.71	2.61	2.53	2.45	2.38	2.32	2.27	2.22	2.18	2.13	2.10
4.7	115.56	3.95	3.82	3.67	3.56	3.44	3.34	3.24	3.08	2.94	2.82	2.72	2.62	2.54	2.47	2.41	2.36	2.30	2.26	2.22	2.18
4.8	118.02	4.10	3.96	3.81	3.69	3.57	3.47	3.37	3.20	3.05	2.93	2.82	2.72	2.64	2.57	2.50	2.45	2.39	2.35	2.30	2.27
4.9	120.48	4.25	4.10	3.95	3.83	3.70	3.60	3.49	3.31	3.16	3.04	2.93	2.83	2.74	2.66	2.60	2.54	2.48	2.44	2.39	2.35

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Recommended Head Loss Design Range for Distribution Piping

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4" Uponor PEX-a — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	122.94	4.40	4.25	4.09	3.97	3.83	3.73	3.62	3.44	3.28	3.15	3.03	2.93	2.84	2.76	2.69	2.63	2.57	2.53	2.48	2.44
5.1	125.39	4.56	4.40	4.23	4.11	3.97	3.86	3.75	3.56	3.40	3.26	3.14	3.04	2.94	2.86	2.79	2.73	2.67	2.62	2.57	2.53
5.2	127.85	4.71	4.55	4.38	4.25	4.11	4.00	3.88	3.68	3.52	3.38	3.25	3.14	3.05	2.96	2.89	2.83	2.76	2.71	2.66	2.62
5.3	130.31	4.87	4.71	4.53	4.39	4.25	4.13	4.01	3.81	3.64	3.49	3.36	3.25	3.15	3.07	2.99	2.92	2.86	2.81	2.75	2.71
5.4	132.77	5.03	4.86	4.68	4.54	4.39	4.27	4.14	3.94	3.76	3.61	3.48	3.36	3.26	3.17	3.09	3.02	2.96	2.91	2.85	2.80
5.5	135.23	5.20	5.02	4.83	4.69	4.53	4.41	4.28	4.07	3.88	3.73	3.59	3.47	3.37	3.28	3.20	3.13	3.06	3.00	2.94	2.90
5.6	137.69	5.36	5.18	4.99	4.84	4.68	4.55	4.42	4.20	4.01	3.85	3.71	3.59	3.48	3.38	3.30	3.23	3.16	3.10	3.04	2.99
5.7	140.15	5.53	5.35	5.14	4.99	4.83	4.70	4.56	4.33	4.14	3.97	3.83	3.70	3.59	3.49	3.41	3.33	3.26	3.20	3.14	3.09
5.8	142.60	5.70	5.51	5.30	5.15	4.98	4.84	4.70	4.47	4.27	4.10	3.95	3.82	3.71	3.60	3.52	3.44	3.36	3.30	3.24	3.19
5.9	145.06	5.88	5.68	5.47	5.30	5.13	4.99	4.85	4.61	4.40	4.23	4.07	3.94	3.82	3.72	3.63	3.55	3.47	3.41	3.34	3.29
6.0	147.52	6.05	5.85	5.63	5.46	5.28	5.14	4.99	4.75	4.53	4.36	4.20	4.06	3.94	3.83	3.74	3.66	3.57	3.51	3.44	3.39
6.1	149.98	6.23	6.02	5.79	5.62	5.44	5.30	5.14	4.89	4.67	4.49	4.32	4.18	4.06	3.95	3.85	3.77	3.68	3.62	3.55	3.49
6.2	152.44	6.41	6.20	5.96	5.79	5.60	5.45	5.29	5.03	4.81	4.62	4.45	4.31	4.18	4.06	3.96	3.88	3.79	3.73	3.65	3.60
6.3	154.90	6.59	6.37	6.13	5.95	5.76	5.61	5.44	5.17	4.95	4.75	4.58	4.43	4.30	4.18	4.08	3.99	3.90	3.84	3.76	3.70
6.4	157.36	6.77	6.55	6.30	6.12	5.92	5.76	5.60	5.32	5.09	4.89	4.71	4.56	4.42	4.30	4.20	4.11	4.02	3.95	3.87	3.81
6.5	159.82	6.96	6.73	6.48	6.29	6.08	5.92	5.75	5.47	5.23	5.02	4.84	4.69	4.55	4.42	4.32	4.22	4.13	4.06	3.98	3.92
6.6	162.27	7.15	6.91	6.66	6.46	6.25	6.09	5.91	5.62	5.37	5.16	4.98	4.82	4.67	4.55	4.44	4.34	4.24	4.17	4.09	4.03
6.7	164.73	7.34	7.10	6.83	6.64	6.42	6.25	6.07	5.77	5.52	5.30	5.11	4.95	4.80	4.67	4.56	4.46	4.36	4.29	4.20	4.14
6.8	167.19	7.53	7.29	7.01	6.81	6.59	6.42	6.23	5.93	5.67	5.44	5.25	5.08	4.93	4.80	4.68	4.58	4.48	4.40	4.32	4.25
6.9	169.65	7.73	7.47	7.20	6.99	6.76	6.58	6.39	6.08	5.82	5.59	5.39	5.21	5.06	4.92	4.81	4.70	4.60	4.52	4.43	4.37
7.0	172.11	7.93	7.67	7.38	7.17	6.94	6.75	6.56	6.24	5.97	5.73	5.53	5.35	5.19	5.05	4.93	4.83	4.72	4.64	4.55	4.48
7.1	174.57	8.13	7.86	7.57	7.35	7.11	6.93	6.73	6.40	6.12	5.88	5.67	5.49	5.33	5.18	5.06	4.95	4.84	4.76	4.67	4.60
7.2	177.03	8.33	8.06	7.76	7.53	7.29	7.10	6.90	6.56	6.27	6.03	5.82	5.63	5.46	5.32	5.19	5.08	4.97	4.88	4.79	4.72
7.3	179.49	8.53	8.25	7.95	7.72	7.47	7.28	7.07	6.72	6.43	6.18	5.96	5.77	5.60	5.45	5.32	5.21	5.09	5.01	4.91	4.84
7.4	181.94	8.74	8.45	8.14	7.91	7.65	7.45	7.24	6.89	6.59	6.33	6.11	5.91	5.74	5.58	5.45	5.34	5.22	5.13	5.03	4.96
7.5	184.40	8.95	8.65	8.34	8.10	7.84	7.63	7.41	7.06	6.75	6.49	6.26	6.06	5.88	5.72	5.58	5.47	5.35	5.26	5.15	5.08
7.6	186.86	9.16	8.86	8.53	8.29	8.02	7.81	7.59	7.22	6.91	6.64	6.41	6.20	6.02	5.86	5.72	5.60	5.48	5.38	5.28	5.20
7.7	189.32	9.37	9.06	8.73	8.48	8.21	8.00	7.77	7.39	7.07	6.80	6.56	6.35	6.16	6.00	5.86	5.73	5.61	5.51	5.41	5.33
7.8	191.78	9.58	9.27	8.93	8.68	8.40	8.18	7.95	7.57	7.24	6.96	6.71	6.50	6.31	6.14	5.99	5.87	5.74	5.64	5.53	5.45
7.9	194.24	9.80	9.48	9.14	8.87	8.59	8.37	8.13	7.74	7.40	7.12	6.87	6.65	6.46	6.28	6.13	6.00	5.87	5.78	5.66	5.58
8.0	196.70	10.02	9.70	9.34	9.07	8.78	8.56	8.31	7.91	7.57	7.28	7.03	6.80	6.60	6.43	6.27	6.14	6.01	5.91	5.79	5.71

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4" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	36.88	0.62	0.60	0.57	0.55	0.53	0.51	0.49	0.46	0.43	0.41	0.39	0.38	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.30
1.6	39.34	0.70	0.67	0.64	0.61	0.59	0.57	0.55	0.51	0.48	0.46	0.44	0.42	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.33
1.7	41.80	0.77	0.74	0.71	0.68	0.65	0.63	0.61	0.57	0.54	0.51	0.49	0.47	0.45	0.43	0.42	0.41	0.40	0.39	0.38	0.37
1.8	44.26	0.85	0.81	0.78	0.75	0.72	0.70	0.67	0.63	0.59	0.56	0.54	0.52	0.50	0.48	0.47	0.45	0.44	0.43	0.42	0.41
1.9	46.72	0.93	0.89	0.85	0.82	0.79	0.76	0.74	0.69	0.65	0.62	0.59	0.57	0.55	0.53	0.51	0.50	0.48	0.47	0.46	0.45
2.0	49.17	1.02	0.98	0.93	0.90	0.86	0.83	0.80	0.76	0.71	0.68	0.65	0.62	0.60	0.58	0.56	0.55	0.53	0.52	0.51	0.49
2.1	51.63	1.10	1.06	1.01	0.98	0.94	0.91	0.87	0.82	0.78	0.74	0.71	0.68	0.65	0.63	0.61	0.59	0.58	0.56	0.55	0.54
2.2	54.09	1.19	1.15	1.10	1.06	1.01	0.98	0.95	0.89	0.84	0.80	0.77	0.74	0.71	0.69	0.66	0.65	0.63	0.61	0.60	0.59
2.3	56.55	1.29	1.24	1.18	1.14	1.10	1.06	1.02	0.96	0.91	0.87	0.83	0.80	0.77	0.74	0.72	0.70	0.68	0.66	0.65	0.63
2.4	59.01	1.39	1.33	1.27	1.23	1.18	1.14	1.10	1.04	0.98	0.93	0.89	0.86	0.83	0.80	0.77	0.75	0.73	0.72	0.70	0.69
2.5	61.47	1.49	1.43	1.36	1.32	1.27	1.23	1.18	1.11	1.05	1.00	0.96	0.92	0.89	0.86	0.83	0.81	0.79	0.77	0.75	0.74
2.6	63.93	1.59	1.53	1.46	1.41	1.35	1.31	1.27	1.19	1.13	1.07	1.03	0.99	0.95	0.92	0.89	0.87	0.85	0.82	0.81	0.79
2.7	66.38	1.70	1.63	1.56	1.50	1.45	1.40	1.35	1.27	1.21	1.15	1.10	1.06	1.02	0.98	0.95	0.93	0.90	0.88	0.86	0.85
2.8	68.84	1.80	1.73	1.66	1.60	1.54	1.49	1.44	1.36	1.28	1.22	1.17	1.13	1.09	1.05	1.02	0.99	0.96	0.94	0.92	0.90
2.9	71.30	1.92	1.84	1.76	1.70	1.64	1.59	1.53	1.44	1.37	1.30	1.25	1.20	1.16	1.12	1.08	1.05	1.03	1.00	0.98	0.96
3.0	73.76	2.03	1.95	1.87	1.80	1.74	1.68	1.62	1.53	1.45	1.38	1.32	1.27	1.23	1.19	1.15	1.12	1.09	1.06	1.04	1.02
3.1	76.22	2.15	2.07	1.98	1.91	1.84	1.78	1.72	1.62	1.54	1.46	1.40	1.35	1.30	1.26	1.22	1.19	1.16	1.13	1.11	1.08
3.2	78.68	2.27	2.18	2.09	2.02	1.94	1.88	1.82	1.71	1.62	1.55	1.48	1.43	1.38	1.33	1.29	1.26	1.22	1.19	1.17	1.15
3.3	81.14	2.39	2.30	2.20	2.13	2.05	1.98	1.92	1.81	1.71	1.63	1.57	1.51	1.45	1.41	1.36	1.33	1.29	1.26	1.24	1.21
3.4	83.60	2.52	2.42	2.32	2.24	2.16	2.09	2.02	1.90	1.81	1.72	1.65	1.59	1.53	1.48	1.44	1.40	1.36	1.33	1.30	1.28
3.5	86.05	2.65	2.55	2.44	2.36	2.27	2.20	2.12	2.00	1.90	1.81	1.74	1.67	1.61	1.56	1.51	1.47	1.44	1.40	1.37	1.35
3.6	88.51	2.78	2.67	2.56	2.47	2.38	2.31	2.23	2.11	2.00	1.91	1.83	1.76	1.69	1.64	1.59	1.55	1.51	1.47	1.44	1.41
3.7	90.97	2.91	2.80	2.68	2.60	2.50	2.42	2.34	2.21	2.10	2.00	1.92	1.84	1.78	1.72	1.67	1.63	1.59	1.55	1.52	1.49
3.8	93.43	3.05	2.94	2.81	2.72	2.62	2.54	2.45	2.31	2.20	2.10	2.01	1.93	1.87	1.81	1.75	1.71	1.66	1.62	1.59	1.56
3.9	95.89	3.19	3.07	2.94	2.84	2.74	2.66	2.57	2.42	2.30	2.19	2.10	2.02	1.95	1.89	1.84	1.79	1.74	1.70	1.67	1.63
4.0	98.35	3.33	3.21	3.07	2.97	2.86	2.78	2.68	2.53	2.40	2.29	2.20	2.12	2.04	1.98	1.92	1.87	1.82	1.78	1.74	1.71
4.1	100.81	3.48	3.35	3.21	3.10	2.99	2.90	2.80	2.64	2.51	2.40	2.30	2.21	2.14	2.07	2.01	1.96	1.91	1.86	1.82	1.79
4.2	103.27	3.62	3.49	3.34	3.23	3.11	3.02	2.92	2.76	2.62	2.50	2.40	2.31	2.23	2.16	2.10	2.04	1.99	1.94	1.90	1.87
4.3	105.72	3.77	3.64	3.48	3.37	3.25	3.15	3.04	2.88	2.73	2.61	2.50	2.41	2.32	2.25	2.19	2.13	2.08	2.03	1.99	1.95
4.4	108.18	3.93	3.78	3.63	3.51	3.38	3.28	3.17	2.99	2.84	2.72	2.60	2.51	2.42	2.35	2.28	2.22	2.16	2.11	2.07	2.03
4.5	110.64	4.08	3.93	3.77	3.65	3.51	3.41	3.30	3.12	2.96	2.83	2.71	2.61	2.52	2.44	2.37	2.31	2.25	2.20	2.15	2.11
4.6	113.10	4.24	4.09	3.92	3.79	3.65	3.54	3.43	3.24	3.08	2.94	2.82	2.71	2.62	2.54	2.47	2.40	2.34	2.29	2.24	2.20
4.7	115.56	4.40	4.24	4.07	3.93	3.79	3.68	3.56	3.36	3.19	3.05	2.93	2.82	2.72	2.64	2.56	2.50	2.43	2.38	2.33	2.28
4.8	118.02	4.57	4.40	4.22	4.08	3.93	3.82	3.69	3.49	3.32	3.17	3.04	2.93	2.83	2.74	2.66	2.59	2.53	2.47	2.42	2.37
4.9	120.48	4.73	4.56	4.37	4.23	4.08	3.96	3.83	3.62	3.44	3.29	3.15	3.04	2.93	2.84	2.76	2.69	2.62	2.56	2.51	2.46

Continued on next page

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

4" Uponor PEX-a — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	122.94	4.90	4.72	4.53	4.38	4.22	4.10	3.97	3.75	3.56	3.40	3.27	3.15	3.04	2.95	2.86	2.79	2.72	2.66	2.60	2.55
5.1	125.39	5.07	4.89	4.69	4.54	4.37	4.24	4.11	3.88	3.69	3.53	3.38	3.26	3.15	3.05	2.97	2.89	2.82	2.75	2.70	2.64
5.2	127.85	5.24	5.06	4.85	4.69	4.52	4.39	4.25	4.02	3.82	3.65	3.50	3.37	3.26	3.16	3.07	2.99	2.92	2.85	2.79	2.74
5.3	130.31	5.42	5.23	5.01	4.85	4.68	4.54	4.39	4.16	3.95	3.78	3.62	3.49	3.37	3.27	3.18	3.10	3.02	2.95	2.89	2.83
5.4	132.77	5.60	5.40	5.18	5.01	4.83	4.69	4.54	4.29	4.08	3.90	3.75	3.61	3.49	3.38	3.29	3.20	3.12	3.05	2.99	2.93
5.5	135.23	5.78	5.57	5.35	5.18	4.99	4.85	4.69	4.44	4.22	4.03	3.87	3.73	3.60	3.49	3.39	3.31	3.23	3.15	3.09	3.03
5.6	137.69	5.96	5.75	5.52	5.34	5.15	5.00	4.84	4.58	4.35	4.16	4.00	3.85	3.72	3.61	3.51	3.42	3.33	3.26	3.19	3.13
5.7	140.15	6.15	5.93	5.69	5.51	5.31	5.16	4.99	4.72	4.49	4.30	4.12	3.97	3.84	3.72	3.62	3.53	3.44	3.36	3.30	3.23
5.8	142.60	6.34	6.11	5.87	5.68	5.48	5.32	5.15	4.87	4.63	4.43	4.25	4.10	3.96	3.84	3.73	3.64	3.55	3.47	3.40	3.33
5.9	145.06	6.53	6.30	6.04	5.85	5.64	5.48	5.31	5.02	4.78	4.57	4.38	4.23	4.09	3.96	3.85	3.75	3.66	3.58	3.51	3.44
6.0	147.52	6.72	6.48	6.22	6.03	5.81	5.65	5.46	5.17	4.92	4.70	4.52	4.35	4.21	4.08	3.97	3.87	3.77	3.69	3.61	3.54
6.1	149.98	6.92	6.67	6.41	6.20	5.98	5.81	5.63	5.33	5.07	4.84	4.65	4.48	4.34	4.20	4.09	3.98	3.89	3.80	3.72	3.65
6.2	152.44	7.12	6.87	6.59	6.38	6.16	5.98	5.79	5.48	5.21	4.99	4.79	4.62	4.46	4.33	4.21	4.10	4.00	3.91	3.83	3.76
6.3	154.90	7.32	7.06	6.78	6.56	6.33	6.15	5.96	5.64	5.36	5.13	4.93	4.75	4.59	4.45	4.33	4.22	4.12	4.03	3.95	3.87
6.4	157.36	7.52	7.26	6.97	6.75	6.51	6.32	6.12	5.80	5.52	5.28	5.07	4.89	4.72	4.58	4.45	4.34	4.24	4.14	4.06	3.98
6.5	159.82	7.73	7.46	7.16	6.93	6.69	6.50	6.29	5.96	5.67	5.42	5.21	5.02	4.86	4.71	4.58	4.47	4.36	4.26	4.18	4.10
6.6	162.27	7.94	7.66	7.35	7.12	6.87	6.68	6.46	6.12	5.83	5.57	5.35	5.16	4.99	4.84	4.71	4.59	4.48	4.38	4.29	4.21
6.7	164.73	8.15	7.86	7.55	7.31	7.05	6.85	6.64	6.29	5.98	5.72	5.50	5.30	5.13	4.97	4.84	4.71	4.60	4.50	4.41	4.33
6.8	167.19	8.36	8.07	7.75	7.50	7.24	7.04	6.81	6.45	6.14	5.88	5.65	5.44	5.27	5.11	4.97	4.84	4.72	4.62	4.53	4.44
6.9	169.65	8.57	8.27	7.95	7.70	7.43	7.22	6.99	6.62	6.30	6.03	5.80	5.59	5.40	5.24	5.10	4.97	4.85	4.74	4.65	4.56
7.0	172.11	8.79	8.49	8.15	7.90	7.62	7.40	7.17	6.79	6.47	6.19	5.95	5.73	5.55	5.38	5.23	5.10	4.98	4.87	4.77	4.68
7.1	174.57	9.01	8.70	8.35	8.09	7.81	7.59	7.35	6.97	6.63	6.35	6.10	5.88	5.69	5.52	5.37	5.23	5.11	4.99	4.90	4.80
7.2	177.03	9.24	8.91	8.56	8.30	8.01	7.78	7.54	7.14	6.80	6.51	6.25	6.03	5.83	5.66	5.50	5.37	5.24	5.12	5.02	4.93
7.3	179.49	9.46	9.13	8.77	8.50	8.20	7.97	7.72	7.32	6.97	6.67	6.41	6.18	5.98	5.80	5.64	5.50	5.37	5.25	5.15	5.05
7.4	181.94	9.69	9.35	8.98	8.70	8.40	8.17	7.91	7.49	7.14	6.83	6.57	6.33	6.13	5.94	5.78	5.64	5.50	5.38	5.28	5.18
7.5	184.40	9.92	9.57	9.20	8.91	8.60	8.36	8.10	7.68	7.31	7.00	6.72	6.49	6.28	6.09	5.92	5.78	5.64	5.51	5.41	5.30
7.6	186.86	10.15	9.80	9.41	9.12	8.81	8.56	8.29	7.86	7.48	7.16	6.89	6.64	6.43	6.23	6.06	5.91	5.77	5.65	5.54	5.43
7.7	189.32	10.38	10.02	9.63	9.33	9.01	8.76	8.49	8.04	7.66	7.33	7.05	6.80	6.58	6.38	6.21	6.06	5.91	5.78	5.67	5.56
7.8	191.78	10.62	10.25	9.85	9.55	9.22	8.96	8.68	8.23	7.84	7.50	7.21	6.96	6.73	6.53	6.35	6.20	6.05	5.92	5.80	5.69
7.9	194.24	10.86	10.48	10.07	9.76	9.43	9.16	8.88	8.42	8.02	7.67	7.38	7.12	6.89	6.68	6.50	6.34	6.19	6.05	5.94	5.83
8.0	196.70	11.10	10.72	10.30	9.98	9.64	9.37	9.08	8.61	8.20	7.85	7.55	7.28	7.04	6.84	6.65	6.49	6.33	6.19	6.07	5.96

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

½" Uponor MLC — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.29	0.0060	0.0056	0.0052	0.0051	0.0050	0.0049	0.0048	0.0046	0.0044	0.0042	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036	0.0036	0.0035	0.0034	0.0034
0.6	0.35	0.0081	0.0076	0.0071	0.0069	0.0067	0.0066	0.0065	0.0062	0.0060	0.0058	0.0056	0.0055	0.0053	0.0052	0.0051	0.0050	0.0049	0.0048	0.0047	0.0046
0.7	0.41	0.0105	0.0099	0.0092	0.0090	0.0087	0.0086	0.0084	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0065	0.0063	0.0062	0.0061	0.0060
0.8	0.47	0.0131	0.0123	0.0115	0.0112	0.0109	0.0107	0.0105	0.0101	0.0097	0.0094	0.0092	0.0089	0.0087	0.0085	0.0083	0.0082	0.0080	0.0079	0.0077	0.0076
0.9	0.53	0.0159	0.0150	0.0140	0.0137	0.0134	0.0131	0.0128	0.0123	0.0119	0.0115	0.0112	0.0109	0.0107	0.0104	0.0102	0.0100	0.0098	0.0096	0.0095	0.0093
1.0	0.59	0.0190	0.0179	0.0167	0.0164	0.0160	0.0157	0.0153	0.0148	0.0143	0.0138	0.0134	0.0131	0.0128	0.0125	0.0122	0.0120	0.0118	0.0116	0.0114	0.0112
1.1	0.65	0.0223	0.0210	0.0197	0.0192	0.0188	0.0184	0.0180	0.0174	0.0168	0.0163	0.0158	0.0154	0.0151	0.0147	0.0144	0.0142	0.0139	0.0137	0.0134	0.0132
1.2	0.71	0.0258	0.0244	0.0228	0.0223	0.0218	0.0214	0.0209	0.0202	0.0195	0.0189	0.0184	0.0179	0.0175	0.0171	0.0168	0.0165	0.0162	0.0159	0.0156	0.0154
1.3	0.76	0.0295	0.0279	0.0261	0.0256	0.0250	0.0245	0.0240	0.0231	0.0224	0.0217	0.0211	0.0206	0.0201	0.0197	0.0193	0.0189	0.0186	0.0183	0.0180	0.0177
1.4	0.82	0.0334	0.0316	0.0296	0.0290	0.0284	0.0278	0.0273	0.0263	0.0255	0.0247	0.0240	0.0234	0.0229	0.0224	0.0219	0.0215	0.0212	0.0208	0.0205	0.0202
1.5	0.88	0.0376	0.0356	0.0333	0.0326	0.0319	0.0313	0.0307	0.0296	0.0287	0.0278	0.0271	0.0264	0.0258	0.0253	0.0248	0.0243	0.0239	0.0235	0.0231	0.0228
1.6	0.94	0.0419	0.0397	0.0372	0.0365	0.0356	0.0350	0.0343	0.0331	0.0321	0.0311	0.0303	0.0296	0.0289	0.0283	0.0277	0.0272	0.0267	0.0263	0.0259	0.0255
1.7	1.00	0.0465	0.0440	0.0413	0.0405	0.0396	0.0388	0.0381	0.0368	0.0356	0.0346	0.0337	0.0328	0.0321	0.0314	0.0308	0.0302	0.0297	0.0292	0.0288	0.0284
1.8	1.06	0.0512	0.0485	0.0456	0.0446	0.0436	0.0428	0.0420	0.0406	0.0393	0.0382	0.0372	0.0363	0.0355	0.0347	0.0340	0.0334	0.0328	0.0323	0.0318	0.0314
1.9	1.12	0.0561	0.0532	0.0500	0.0490	0.0479	0.0470	0.0461	0.0445	0.0432	0.0419	0.0409	0.0399	0.0390	0.0382	0.0374	0.0367	0.0361	0.0355	0.0350	0.0345
2.0	1.18	0.0612	0.0581	0.0546	0.0535	0.0523	0.0514	0.0504	0.0487	0.0472	0.0459	0.0447	0.0436	0.0426	0.0418	0.0409	0.0402	0.0395	0.0389	0.0383	0.0378
2.1	1.23	0.0666	0.0632	0.0594	0.0582	0.0569	0.0559	0.0548	0.0530	0.0514	0.0499	0.0486	0.0475	0.0464	0.0455	0.0446	0.0438	0.0431	0.0424	0.0418	0.0412
2.2	1.29	0.0721	0.0684	0.0643	0.0630	0.0617	0.0606	0.0594	0.0574	0.0557	0.0541	0.0528	0.0515	0.0504	0.0493	0.0484	0.0475	0.0467	0.0460	0.0453	0.0447
2.3	1.35	0.0777	0.0738	0.0694	0.0681	0.0666	0.0654	0.0642	0.0620	0.0602	0.0585	0.0570	0.0557	0.0544	0.0533	0.0523	0.0514	0.0505	0.0498	0.0490	0.0484
2.4	1.41	0.0836	0.0794	0.0747	0.0732	0.0717	0.0704	0.0691	0.0668	0.0648	0.0630	0.0614	0.0600	0.0587	0.0575	0.0564	0.0554	0.0545	0.0536	0.0529	0.0521
2.5	1.47	0.0897	0.0852	0.0802	0.0786	0.0769	0.0756	0.0742	0.0717	0.0696	0.0677	0.0660	0.0644	0.0630	0.0618	0.0606	0.0595	0.0585	0.0576	0.0568	0.0560
2.6	1.53	0.0959	0.0911	0.0858	0.0841	0.0823	0.0809	0.0794	0.0768	0.0745	0.0725	0.0706	0.0690	0.0675	0.0662	0.0649	0.0638	0.0627	0.0618	0.0609	0.0601
2.7	1.59	0.1023	0.0973	0.0916	0.0898	0.0879	0.0864	0.0848	0.0820	0.0796	0.0774	0.0755	0.0737	0.0721	0.0707	0.0694	0.0682	0.0671	0.0660	0.0651	0.0642
2.8	1.65	0.1089	0.1035	0.0975	0.0956	0.0936	0.0920	0.0903	0.0874	0.0848	0.0825	0.0804	0.0786	0.0769	0.0754	0.0740	0.0727	0.0715	0.0704	0.0694	0.0685
2.9	1.70	0.1157	0.1100	0.1036	0.1016	0.0995	0.0978	0.0960	0.0929	0.0902	0.0877	0.0855	0.0836	0.0818	0.0802	0.0787	0.0774	0.0761	0.0749	0.0739	0.0729
3.0	1.76	0.1226	0.1166	0.1099	0.1078	0.1056	0.1037	0.1018	0.0985	0.0957	0.0931	0.0908	0.0887	0.0868	0.0851	0.0836	0.0821	0.0808	0.0796	0.0784	0.0774
3.1	1.82	0.1297	0.1234	0.1163	0.1141	0.1117	0.1098	0.1078	0.1043	0.1013	0.0986	0.0962	0.0940	0.0920	0.0902	0.0885	0.0870	0.0856	0.0843	0.0831	0.0820
3.2	1.88	0.1370	0.1304	0.1229	0.1206	0.1181	0.1161	0.1139	0.1103	0.1071	0.1042	0.1017	0.0994	0.0973	0.0954	0.0936	0.0921	0.0906	0.0892	0.0880	0.0868
3.3	1.94	0.1444	0.1375	0.1296	0.1272	0.1246	0.1224	0.1202	0.1164	0.1130	0.1100	0.1073	0.1049	0.1027	0.1007	0.0989	0.0972	0.0956	0.0942	0.0929	0.0917
3.4	2.00	0.1521	0.1448	0.1365	0.1339	0.1312	0.1290	0.1266	0.1226	0.1191	0.1159	0.1131	0.1106	0.1083	0.1062	0.1042	0.1025	0.1008	0.0993	0.0979	0.0967
3.5	2.06	0.1598	0.1522	0.1436	0.1409	0.1380	0.1357	0.1332	0.1290	0.1253	0.1220	0.1190	0.1164	0.1139	0.1117	0.1097	0.1079	0.1061	0.1046	0.1031	0.1018
3.6	2.12	0.1678	0.1598	0.1508	0.1479	0.1450	0.1425	0.1399	0.1355	0.1316	0.1282	0.1251	0.1223	0.1197	0.1174	0.1153	0.1134	0.1116	0.1099	0.1084	0.1070
3.7	2.17		0.1676	0.1582	0.1552	0.1521	0.1495	0.1468	0.1422	0.1381	0.1345	0.1313	0.1283	0.1257	0.1233	0.1211	0.1190	0.1171	0.1154	0.1138	0.1123
3.8	2.23			0.1657	0.1626	0.1593	0.1566	0.1538	0.1490	0.1447	0.1410	0.1376	0.1345	0.1317	0.1292	0.1269	0.1248	0.1228	0.1210	0.1194	0.1178
3.9	2.29					0.1667	0.1639	0.1610	0.1559	0.1515	0.1476	0.1440	0.1408	0.1379	0.1353	0.1329	0.1307	0.1286	0.1267	0.1250	0.1234

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" Uponor MLC — 100% Water — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	2.35							0.1682	0.1630	0.1584	0.1543	0.1506	0.1473	0.1442	0.1415	0.1390	0.1367	0.1345	0.1326	0.1308	0.1291
4.1	2.41									0.1654	0.1611	0.1573	0.1538	0.1507	0.1478	0.1452	0.1428	0.1406	0.1385	0.1366	0.1349
4.2	2.47										0.1681	0.1641	0.1605	0.1573	0.1543	0.1515	0.1491	0.1467	0.1446	0.1426	0.1408
4.3	2.53												0.1673	0.1639	0.1609	0.1580	0.1554	0.1530	0.1508	0.1487	0.1468
4.4	2.59														0.1676	0.1646	0.1619	0.1594	0.1571	0.1550	0.1530
4.5	2.65																0.1685	0.1659	0.1635	0.1613	0.1592
4.6	2.70																			0.1677	0.1656

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" Uponor MLC — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.29	0.00944	0.00900	0.00854	0.00819	0.00782	0.00752	0.00721	0.00671	0.00630	0.00594	0.00564	0.00538	0.00516	0.00496	0.00480	0.00464	0.00450	0.00438	0.00426	0.00418
0.6	0.35	0.01261	0.01204	0.01143	0.01098	0.01049	0.01011	0.00970	0.00905	0.00850	0.00803	0.00763	0.00730	0.00700	0.00673	0.00652	0.00631	0.00612	0.00596	0.00581	0.00569
0.7	0.41	0.01613	0.01541	0.01466	0.01408	0.01348	0.01299	0.01248	0.01166	0.01097	0.01038	0.00987	0.00944	0.00907	0.00872	0.00845	0.00819	0.00795	0.00775	0.00755	0.00740
0.8	0.47	0.01998	0.01912	0.01820	0.01750	0.01676	0.01617	0.01554	0.01454	0.01369	0.01297	0.01235	0.01182	0.01135	0.01093	0.01060	0.01027	0.00998	0.00973	0.00949	0.00930
0.9	0.53	0.02417	0.02314	0.02204	0.02121	0.02033	0.01962	0.01887	0.01767	0.01666	0.01579	0.01505	0.01442	0.01386	0.01335	0.01295	0.01256	0.01220	0.01190	0.01161	0.01139
1.0	0.59	0.02867	0.02746	0.02618	0.02520	0.02417	0.02334	0.02247	0.02106	0.01986	0.01885	0.01797	0.01723	0.01657	0.01597	0.01549	0.01503	0.01461	0.01426	0.01391	0.01365
1.1	0.65	0.03347	0.03208	0.03061	0.02948	0.02829	0.02733	0.02631	0.02469	0.02330	0.02213	0.02111	0.02024	0.01948	0.01878	0.01823	0.01770	0.01720	0.01679	0.01639	0.01609
1.2	0.71	0.03857	0.03699	0.03531	0.03402	0.03266	0.03157	0.03041	0.02855	0.02697	0.02562	0.02446	0.02347	0.02259	0.02179	0.02116	0.02054	0.01997	0.01950	0.01904	0.01869
1.3	0.76	0.04396	0.04218	0.04029	0.03883	0.03730	0.03606	0.03476	0.03265	0.03086	0.02934	0.02801	0.02689	0.02589	0.02499	0.02427	0.02357	0.02292	0.02239	0.02186	0.02147
1.4	0.82	0.04964	0.04765	0.04553	0.04391	0.04219	0.04080	0.03934	0.03698	0.03497	0.03326	0.03177	0.03051	0.02939	0.02837	0.02756	0.02677	0.02605	0.02544	0.02485	0.02440
1.5	0.88	0.05560	0.05338	0.05104	0.04923	0.04732	0.04578	0.04415	0.04153	0.03929	0.03739	0.03573	0.03432	0.03307	0.03194	0.03103	0.03015	0.02934	0.02867	0.02800	0.02750
1.6	0.94	0.06183	0.05939	0.05680	0.05481	0.05270	0.05100	0.04920	0.04630	0.04383	0.04172	0.03988	0.03832	0.03694	0.03568	0.03468	0.03370	0.03280	0.03206	0.03132	0.03076
1.7	1.00	0.06833	0.06565	0.06281	0.06063	0.05831	0.05645	0.05447	0.05129	0.04857	0.04625	0.04423	0.04251	0.04099	0.03960	0.03850	0.03742	0.03643	0.03561	0.03479	0.03418
1.8	1.06	0.07509	0.07218	0.06908	0.06669	0.06417	0.06213	0.05997	0.05649	0.05352	0.05098	0.04877	0.04689	0.04522	0.04370	0.04249	0.04131	0.04022	0.03932	0.03842	0.03776
1.9	1.12	0.08212	0.07895	0.07559	0.07300	0.07025	0.06804	0.06569	0.06190	0.05867	0.05590	0.05349	0.05145	0.04962	0.04797	0.04665	0.04536	0.04418	0.04319	0.04221	0.04148
2.0	1.18	0.08941	0.08598	0.08234	0.07954	0.07657	0.07417	0.07163	0.06752	0.06402	0.06102	0.05840	0.05618	0.05421	0.05241	0.05098	0.04958	0.04829	0.04722	0.04616	0.04536
2.1	1.23	0.09695	0.09326	0.08934	0.08631	0.08311	0.08052	0.07778	0.07335	0.06956	0.06632	0.06350	0.06110	0.05896	0.05702	0.05547	0.05396	0.05256	0.05140	0.05025	0.04939
2.2	1.29	0.10474	0.10078	0.09657	0.09332	0.08987	0.08709	0.08414	0.07938	0.07531	0.07182	0.06878	0.06619	0.06389	0.06179	0.06013	0.05850	0.05699	0.05574	0.05450	0.05357
2.3	1.35	0.11278	0.10854	0.10403	0.10055	0.09686	0.09388	0.09072	0.08561	0.08124	0.07750	0.07424	0.07146	0.06898	0.06674	0.06494	0.06319	0.06157	0.06023	0.05889	0.05790
2.4	1.41	0.12107	0.11654	0.11172	0.10801	0.10406	0.10088	0.09750	0.09204	0.08737	0.08336	0.07987	0.07690	0.07425	0.07184	0.06992	0.06804	0.06631	0.06487	0.06344	0.06237
2.5	1.47	0.12960	0.12478	0.11965	0.11569	0.11149	0.10809	0.10449	0.09867	0.09368	0.08941	0.08568	0.08251	0.07968	0.07711	0.07506	0.07305	0.07120	0.06966	0.06813	0.06699
2.6	1.53	0.13837	0.13325	0.12780	0.12359	0.11912	0.11551	0.11169	0.10549	0.10019	0.09564	0.09167	0.08829	0.08528	0.08254	0.08035	0.07821	0.07624	0.07460	0.07297	0.07175
2.7	1.59	0.14737	0.14195	0.13617	0.13171	0.12697	0.12314	0.11908	0.11251	0.10687	0.10204	0.09783	0.09424	0.09104	0.08813	0.08580	0.08353	0.08143	0.07968	0.07795	0.07666
2.8	1.65	0.15662	0.15088	0.14477	0.14005	0.13503	0.13098	0.12668	0.11972	0.11375	0.10863	0.10416	0.10036	0.09696	0.09387	0.09141	0.08900	0.08677	0.08492	0.08308	0.08171
2.9	1.70	0.16610	0.16004	0.15358	0.14860	0.14330	0.13902	0.13448	0.12711	0.12080	0.11539	0.11067	0.10664	0.10305	0.09978	0.09717	0.09462	0.09225	0.09029	0.08835	0.08689
3.0	1.76		0.16943	0.16262	0.15736	0.15178	0.14726	0.14247	0.13470	0.12804	0.12233	0.11734	0.11309	0.10929	0.10584	0.10308	0.10038	0.09789	0.09582	0.09376	0.09222
3.1	1.82				0.16634	0.16046	0.15570	0.15066	0.14248	0.13546	0.12944	0.12418	0.11970	0.11569	0.11205	0.10914	0.10630	0.10367	0.10148	0.09931	0.09769
3.2	1.88					0.16935	0.16435	0.15904	0.15044	0.14306	0.13672	0.13119	0.12647	0.12226	0.11842	0.11536	0.11237	0.10959	0.10729	0.10500	0.10329
3.3	1.94							0.16762	0.15858	0.15083	0.14418	0.13836	0.13340	0.12897	0.12494	0.12173	0.11858	0.11566	0.11324	0.11083	0.10903
3.4	2.00								0.16691	0.15878	0.15180	0.14570	0.14050	0.13585	0.13162	0.12824	0.12493	0.12187	0.11933	0.11680	0.11491
3.5	2.06									0.16691	0.15960	0.15321	0.14775	0.14288	0.13844	0.13490	0.13144	0.12822	0.12556	0.12291	0.12093
3.6	2.12										0.16756	0.16087	0.15516	0.15006	0.14542	0.14171	0.13808	0.13472	0.13193	0.12915	0.12707
3.7	2.17											0.16870	0.16273	0.15740	0.15255	0.14867	0.14487	0.14135	0.13843	0.13553	0.13336
3.8	2.23													0.16489	0.15982	0.15577	0.15180	0.14813	0.14508	0.14204	0.13977
3.9	2.29														0.16724	0.16301	0.15888	0.15504	0.15186	0.14869	0.14632

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" Uponor MLC — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	2.35																0.16609	0.16209	0.15878	0.15547	0.15301
4.1	2.41																	0.16928	0.16583	0.16239	0.15982
4.2	2.47																			0.16944	0.16676

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" Uponor MLC — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.29	0.01168	0.01101	0.01029	0.00977	0.00921	0.00880	0.00836	0.00767	0.00710	0.00664	0.00625	0.00591	0.00562	0.00537	0.00516	0.00498	0.00480	0.00503	0.00487	0.00472
0.6	0.35	0.01552	0.01464	0.01371	0.01303	0.01232	0.01178	0.01120	0.01030	0.00956	0.00895	0.00843	0.00799	0.00761	0.00728	0.00700	0.00676	0.00653	0.00682	0.00662	0.00642
0.7	0.41	0.01976	0.01867	0.01751	0.01666	0.01577	0.01509	0.01437	0.01324	0.01230	0.01154	0.01089	0.01032	0.00984	0.00942	0.00907	0.00877	0.00847	0.00884	0.00858	0.00833
0.8	0.47	0.02439	0.02307	0.02167	0.02064	0.01955	0.01872	0.01785	0.01647	0.01533	0.01439	0.01359	0.01290	0.01231	0.01179	0.01136	0.01099	0.01062	0.01108	0.01076	0.01045
0.9	0.53	0.02940	0.02784	0.02617	0.02495	0.02365	0.02267	0.02163	0.01998	0.01862	0.01749	0.01654	0.01571	0.01501	0.01439	0.01387	0.01342	0.01297	0.01353	0.01314	0.01277
1.0	0.59	0.03477	0.03295	0.03100	0.02958	0.02807	0.02692	0.02570	0.02377	0.02217	0.02085	0.01973	0.01875	0.01793	0.01719	0.01658	0.01605	0.01552	0.01618	0.01572	0.01528
1.1	0.65	0.04049	0.03840	0.03616	0.03452	0.03278	0.03146	0.03005	0.02782	0.02597	0.02445	0.02315	0.02202	0.02106	0.02021	0.01949	0.01888	0.01827	0.01903	0.01850	0.01799
1.2	0.71	0.04656	0.04418	0.04164	0.03977	0.03779	0.03628	0.03468	0.03213	0.03002	0.02828	0.02680	0.02550	0.02440	0.02342	0.02261	0.02190	0.02120	0.02207	0.02147	0.02088
1.3	0.76	0.05295	0.05028	0.04742	0.04532	0.04308	0.04138	0.03958	0.03670	0.03432	0.03234	0.03066	0.02920	0.02795	0.02684	0.02591	0.02512	0.02432	0.02531	0.02462	0.02395
1.4	0.82	0.05968	0.05669	0.05351	0.05116	0.04866	0.04676	0.04474	0.04152	0.03885	0.03664	0.03475	0.03310	0.03170	0.03046	0.02941	0.02852	0.02762	0.02873	0.02796	0.02720
1.5	0.88	0.06672	0.06342	0.05989	0.05728	0.05451	0.05240	0.05016	0.04658	0.04361	0.04115	0.03905	0.03721	0.03565	0.03427	0.03310	0.03210	0.03110	0.03234	0.03147	0.03063
1.6	0.94	0.07408	0.07044	0.06655	0.06369	0.06064	0.05831	0.05583	0.05189	0.04860	0.04588	0.04356	0.04153	0.03980	0.03826	0.03697	0.03586	0.03475	0.03613	0.03517	0.03423
1.7	1.00	0.08174	0.07777	0.07351	0.07037	0.06702	0.06447	0.06176	0.05743	0.05382	0.05083	0.04828	0.04604	0.04414	0.04245	0.04103	0.03980	0.03858	0.04010	0.03904	0.03801
1.8	1.06	0.08971	0.08538	0.08075	0.07733	0.07368	0.07089	0.06793	0.06320	0.05926	0.05599	0.05320	0.05075	0.04867	0.04682	0.04526	0.04392	0.04258	0.04424	0.04308	0.04195
1.9	1.12	0.09798	0.09329	0.08826	0.08455	0.08058	0.07756	0.07434	0.06920	0.06492	0.06136	0.05832	0.05566	0.05339	0.05137	0.04967	0.04821	0.04675	0.04856	0.04729	0.04606
2.0	1.18	0.10655	0.10148	0.09604	0.09203	0.08775	0.08448	0.08100	0.07543	0.07079	0.06694	0.06364	0.06075	0.05830	0.05610	0.05426	0.05267	0.05108	0.05305	0.05168	0.05034
2.1	1.23	0.11540	0.10994	0.10410	0.09978	0.09516	0.09164	0.08789	0.08189	0.07688	0.07272	0.06916	0.06604	0.06338	0.06101	0.05902	0.05730	0.05559	0.05771	0.05623	0.05478
2.2	1.29	0.12454	0.11869	0.11242	0.10778	0.10283	0.09904	0.09501	0.08857	0.08318	0.07870	0.07488	0.07152	0.06865	0.06610	0.06396	0.06210	0.06025	0.06254	0.06094	0.05938
2.3	1.35	0.13396	0.12771	0.12100	0.11604	0.11074	0.10668	0.10237	0.09546	0.08969	0.08489	0.08078	0.07718	0.07410	0.07136	0.06906	0.06707	0.06508	0.06754	0.06582	0.06414
2.4	1.41	0.14366	0.13700	0.12984	0.12455	0.11889	0.11456	0.10995	0.10257	0.09641	0.09127	0.08688	0.08302	0.07973	0.07680	0.07433	0.07220	0.07007	0.07270	0.07086	0.06907
2.5	1.47	0.15364	0.14655	0.13894	0.13330	0.12728	0.12267	0.11776	0.10990	0.10332	0.09785	0.09316	0.08905	0.08554	0.08240	0.07977	0.07749	0.07522	0.07803	0.07606	0.07414
2.6	1.53	0.16390	0.15637	0.14829	0.14231	0.13591	0.13101	0.12580	0.11744	0.11045	0.10462	0.09963	0.09525	0.09152	0.08818	0.08537	0.08295	0.08052	0.08352	0.08142	0.07938
2.7	1.59		0.16645	0.15789	0.15156	0.14478	0.13959	0.13405	0.12519	0.11777	0.11159	0.10629	0.10164	0.09767	0.09412	0.09114	0.08857	0.08598	0.08917	0.08694	0.08477
2.8	1.65			0.16774	0.16105	0.15388	0.14839	0.14253	0.13315	0.12529	0.11874	0.11313	0.10820	0.10399	0.10024	0.09707	0.09434	0.09160	0.09498	0.09262	0.09031
2.9	1.70					0.16321	0.15741	0.15123	0.14132	0.13301	0.12609	0.12016	0.11494	0.11049	0.10651	0.10316	0.10027	0.09737	0.10095	0.09845	0.09601
3.0	1.76						0.16666	0.16014	0.14969	0.14093	0.13362	0.12736	0.12186	0.11716	0.11295	0.10942	0.10636	0.10330	0.10708	0.10443	0.10185
3.1	1.82							0.16926	0.15826	0.14904	0.14134	0.13475	0.12894	0.12399	0.11956	0.11583	0.11261	0.10938	0.11336	0.11057	0.10785
3.2	1.88								0.16704	0.15734	0.14925	0.14231	0.13620	0.13099	0.12633	0.12240	0.11901	0.11561	0.11980	0.11686	0.11400
3.3	1.94									0.16584	0.15734	0.15005	0.14363	0.13816	0.13326	0.12913	0.12556	0.12199	0.12640	0.12331	0.12029
3.4	2.00										0.16561	0.15796	0.15124	0.14549	0.14034	0.13601	0.13227	0.12851	0.13314	0.12990	0.12674
3.5	2.06											0.16605	0.15901	0.15298	0.14759	0.14305	0.13913	0.13519	0.14004	0.13664	0.13333
3.6	2.12												0.16694	0.16064	0.15500	0.15025	0.14614	0.14202	0.14709	0.14354	0.14006
3.7	2.17													0.16846	0.16256	0.15759	0.15330	0.14899	0.15430	0.15057	0.14694
3.8	2.23															0.16509	0.16061	0.15610	0.16165	0.15776	0.15397
3.9	2.29																0.16806	0.16337	0.16915	0.16509	0.16113
4.0	2.35																				0.16845

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

½" Uponor MLC — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.29	0.01405	0.01317	0.01225	0.01157	0.01085	0.01031	0.00974	0.00886	0.00813	0.00754	0.00704	0.00662	0.00626	0.00595	0.00568	0.00545	0.00523	0.00504	0.00489	0.00474
0.6	0.35	0.01857	0.01744	0.01625	0.01537	0.01444	0.01374	0.01301	0.01186	0.01091	0.01013	0.00948	0.00893	0.00845	0.00804	0.00769	0.00738	0.00710	0.00685	0.00664	0.00644
0.7	0.41	0.02356	0.02215	0.02067	0.01958	0.01842	0.01755	0.01663	0.01519	0.01400	0.01303	0.01221	0.01151	0.01091	0.01039	0.00994	0.00955	0.00919	0.00888	0.00861	0.00836
0.8	0.47	0.02898	0.02729	0.02549	0.02417	0.02278	0.02172	0.02060	0.01885	0.01740	0.01621	0.01521	0.01435	0.01362	0.01298	0.01243	0.01196	0.01151	0.01112	0.01080	0.01048
0.9	0.53	0.03483	0.03283	0.03071	0.02914	0.02749	0.02623	0.02490	0.02282	0.02110	0.01967	0.01848	0.01746	0.01658	0.01582	0.01515	0.01458	0.01405	0.01358	0.01319	0.01281
1.0	0.59	0.04109	0.03876	0.03629	0.03447	0.03254	0.03108	0.02953	0.02709	0.02508	0.02341	0.02201	0.02081	0.01977	0.01888	0.01810	0.01742	0.01679	0.01624	0.01578	0.01533
1.1	0.65	0.04774	0.04508	0.04224	0.04015	0.03793	0.03625	0.03447	0.03166	0.02934	0.02741	0.02579	0.02440	0.02320	0.02216	0.02126	0.02047	0.01975	0.01910	0.01856	0.01804
1.2	0.71	0.05478	0.05176	0.04854	0.04617	0.04365	0.04174	0.03971	0.03652	0.03387	0.03167	0.02981	0.02822	0.02686	0.02567	0.02463	0.02373	0.02290	0.02215	0.02154	0.02094
1.3	0.76	0.06219	0.05880	0.05519	0.05253	0.04969	0.04754	0.04525	0.04165	0.03866	0.03618	0.03408	0.03228	0.03074	0.02938	0.02821	0.02719	0.02624	0.02540	0.02470	0.02403
1.4	0.82	0.06997	0.06620	0.06217	0.05920	0.05604	0.05364	0.05109	0.04706	0.04371	0.04093	0.03858	0.03657	0.03483	0.03331	0.03200	0.03085	0.02979	0.02884	0.02805	0.02729
1.5	0.88	0.07810	0.07393	0.06949	0.06620	0.06270	0.06003	0.05721	0.05274	0.04902	0.04593	0.04332	0.04107	0.03914	0.03745	0.03598	0.03470	0.03352	0.03246	0.03158	0.03073
1.6	0.94	0.08659	0.08201	0.07712	0.07351	0.06965	0.06672	0.06360	0.05868	0.05458	0.05117	0.04828	0.04580	0.04366	0.04179	0.04017	0.03875	0.03743	0.03626	0.03529	0.03435
1.7	1.00	0.09543	0.09042	0.08508	0.08112	0.07690	0.07369	0.07028	0.06488	0.06038	0.05664	0.05347	0.05074	0.04839	0.04633	0.04454	0.04299	0.04153	0.04024	0.03917	0.03813
1.8	1.06	0.10460	0.09916	0.09334	0.08904	0.08445	0.08095	0.07723	0.07134	0.06643	0.06234	0.05888	0.05589	0.05332	0.05107	0.04911	0.04741	0.04582	0.04440	0.04323	0.04209
1.9	1.12	0.11411	0.10822	0.10192	0.09725	0.09227	0.08848	0.08444	0.07805	0.07272	0.06827	0.06450	0.06126	0.05846	0.05601	0.05387	0.05201	0.05028	0.04874	0.04746	0.04621
2.0	1.18	0.12395	0.11759	0.11080	0.10576	0.10038	0.09628	0.09192	0.08501	0.07924	0.07442	0.07034	0.06683	0.06380	0.06113	0.05882	0.05680	0.05492	0.05325	0.05185	0.05050
2.1	1.23	0.13411	0.12728	0.11998	0.11456	0.10877	0.10436	0.09966	0.09222	0.08600	0.08080	0.07640	0.07260	0.06933	0.06645	0.06395	0.06177	0.05974	0.05793	0.05642	0.05496
2.2	1.29	0.14459	0.13728	0.12945	0.12364	0.11744	0.11270	0.10766	0.09967	0.09298	0.08740	0.08266	0.07858	0.07505	0.07196	0.06927	0.06692	0.06473	0.06277	0.06115	0.05957
2.3	1.35	0.15539	0.14758	0.13921	0.13300	0.12637	0.12131	0.11591	0.10736	0.10019	0.09421	0.08914	0.08476	0.08097	0.07765	0.07476	0.07224	0.06989	0.06779	0.06604	0.06435
2.4	1.41	0.16650	0.15818	0.14927	0.14265	0.13557	0.13017	0.12442	0.11528	0.10763	0.10124	0.09581	0.09113	0.08709	0.08353	0.08044	0.07774	0.07522	0.07297	0.07110	0.06929
2.5	1.47		0.16908	0.15960	0.15257	0.14504	0.13929	0.13317	0.12344	0.11529	0.10848	0.10270	0.09770	0.09339	0.08959	0.08629	0.08341	0.08072	0.07832	0.07632	0.07438
2.6	1.53				0.16276	0.15477	0.14867	0.14217	0.13183	0.12318	0.11593	0.10978	0.10447	0.09987	0.09584	0.09232	0.08925	0.08638	0.08383	0.08170	0.07964
2.7	1.59					0.16476	0.15830	0.15141	0.14046	0.13128	0.12359	0.11707	0.11142	0.10655	0.10226	0.09853	0.09526	0.09222	0.08950	0.08724	0.08504
2.8	1.65						0.16818	0.16089	0.14931	0.13959	0.13146	0.12455	0.11857	0.11341	0.10886	0.10490	0.10144	0.09821	0.09533	0.09293	0.09060
2.9	1.70								0.15839	0.14813	0.13953	0.13223	0.12591	0.12045	0.11564	0.11145	0.10779	0.10437	0.10132	0.09878	0.09632
3.0	1.76								0.16769	0.15687	0.14781	0.14010	0.13344	0.12767	0.12260	0.11817	0.11431	0.11070	0.10747	0.10479	0.10218
3.1	1.82									0.16583	0.15629	0.14817	0.14115	0.13507	0.12973	0.12506	0.12099	0.11718	0.11378	0.11095	0.10820
3.2	1.88										0.16497	0.15643	0.14904	0.14265	0.13703	0.13212	0.12783	0.12382	0.12024	0.11726	0.11437
3.3	1.94											0.16488	0.15713	0.15041	0.14450	0.13935	0.13484	0.13062	0.12686	0.12373	0.12068
3.4	2.00												0.16539	0.15835	0.15215	0.14674	0.14201	0.13758	0.13364	0.13034	0.12715
3.5	2.06													0.16646	0.15996	0.15429	0.14933	0.14470	0.14056	0.13711	0.13376
3.6	2.12														0.16795	0.16201	0.15682	0.15197	0.14764	0.14402	0.14052
3.7	2.17															0.16990	0.16447	0.15940	0.15487	0.15109	0.14742
3.8	2.23																	0.16698	0.16225	0.15830	0.15447
3.9	2.29																		0.16978	0.16565	0.16166
4.0	2.35																				0.16899

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor MLC — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.48	0.0043	0.0040	0.0038	0.0037	0.0036	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0028	0.0027	0.0026	0.0026	0.0025	0.0025	0.0025
0.6	0.58	0.0058	0.0055	0.0051	0.0050	0.0049	0.0048	0.0047	0.0045	0.0043	0.0042	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036	0.0036	0.0035	0.0034	0.0034
0.7	0.67	0.0075	0.0071	0.0066	0.0065	0.0063	0.0062	0.0061	0.0058	0.0056	0.0055	0.0053	0.0052	0.0050	0.0049	0.0048	0.0047	0.0046	0.0046	0.0045	0.0044
0.8	0.77	0.0094	0.0089	0.0083	0.0081	0.0079	0.0078	0.0076	0.0073	0.0071	0.0069	0.0067	0.0065	0.0063	0.0062	0.0061	0.0060	0.0058	0.0057	0.0057	0.0056
0.9	0.87	0.0115	0.0108	0.0101	0.0099	0.0097	0.0095	0.0093	0.0090	0.0087	0.0084	0.0082	0.0080	0.0078	0.0076	0.0075	0.0073	0.0072	0.0071	0.0069	0.0068
1.0	0.96	0.0137	0.0130	0.0121	0.0119	0.0116	0.0114	0.0111	0.0107	0.0104	0.0101	0.0098	0.0096	0.0093	0.0091	0.0090	0.0088	0.0086	0.0085	0.0083	0.0082
1.1	1.06	0.0161	0.0152	0.0143	0.0140	0.0137	0.0134	0.0131	0.0127	0.0123	0.0119	0.0116	0.0113	0.0110	0.0108	0.0106	0.0104	0.0102	0.0100	0.0099	0.0097
1.2	1.15	0.0187	0.0177	0.0166	0.0162	0.0159	0.0156	0.0152	0.0147	0.0142	0.0138	0.0135	0.0131	0.0128	0.0126	0.0123	0.0121	0.0119	0.0117	0.0115	0.0113
1.3	1.25	0.0214	0.0202	0.0190	0.0186	0.0182	0.0178	0.0175	0.0169	0.0164	0.0159	0.0155	0.0151	0.0147	0.0144	0.0141	0.0139	0.0136	0.0134	0.0132	0.0130
1.4	1.35	0.0242	0.0230	0.0216	0.0211	0.0207	0.0203	0.0199	0.0192	0.0186	0.0181	0.0176	0.0172	0.0168	0.0164	0.0161	0.0158	0.0155	0.0153	0.0151	0.0148
1.5	1.44	0.0272	0.0258	0.0243	0.0238	0.0233	0.0228	0.0224	0.0216	0.0210	0.0204	0.0198	0.0194	0.0189	0.0185	0.0182	0.0178	0.0175	0.0173	0.0170	0.0168
1.6	1.54	0.0304	0.0289	0.0271	0.0266	0.0260	0.0255	0.0250	0.0242	0.0234	0.0228	0.0222	0.0217	0.0212	0.0207	0.0203	0.0200	0.0196	0.0193	0.0190	0.0188
1.7	1.64	0.0337	0.0320	0.0301	0.0295	0.0289	0.0283	0.0278	0.0269	0.0260	0.0253	0.0247	0.0241	0.0236	0.0231	0.0226	0.0222	0.0218	0.0215	0.0212	0.0209
1.8	1.73	0.0372	0.0353	0.0332	0.0325	0.0319	0.0313	0.0307	0.0297	0.0288	0.0280	0.0273	0.0266	0.0260	0.0255	0.0250	0.0246	0.0242	0.0238	0.0234	0.0231
1.9	1.83	0.0408	0.0388	0.0365	0.0357	0.0350	0.0344	0.0337	0.0326	0.0316	0.0307	0.0300	0.0293	0.0286	0.0280	0.0275	0.0270	0.0266	0.0262	0.0258	0.0254
2.0	1.92	0.0445	0.0423	0.0398	0.0390	0.0382	0.0375	0.0368	0.0356	0.0346	0.0336	0.0328	0.0320	0.0313	0.0307	0.0301	0.0296	0.0291	0.0286	0.0282	0.0278
2.1	2.02	0.0484	0.0460	0.0433	0.0425	0.0416	0.0409	0.0401	0.0388	0.0376	0.0366	0.0357	0.0349	0.0341	0.0334	0.0328	0.0322	0.0317	0.0312	0.0308	0.0304
2.2	2.12	0.0524	0.0499	0.0470	0.0461	0.0451	0.0443	0.0435	0.0421	0.0408	0.0397	0.0387	0.0378	0.0370	0.0363	0.0356	0.0350	0.0344	0.0339	0.0334	0.0330
2.3	2.21	0.0566	0.0538	0.0507	0.0497	0.0487	0.0479	0.0470	0.0455	0.0441	0.0429	0.0419	0.0409	0.0400	0.0392	0.0385	0.0379	0.0372	0.0367	0.0361	0.0357
2.4	2.31	0.0609	0.0579	0.0546	0.0535	0.0524	0.0515	0.0506	0.0490	0.0475	0.0463	0.0451	0.0441	0.0431	0.0423	0.0415	0.0408	0.0401	0.0395	0.0390	0.0385
2.5	2.41	0.0653	0.0622	0.0586	0.0575	0.0563	0.0553	0.0543	0.0526	0.0511	0.0497	0.0485	0.0474	0.0464	0.0455	0.0446	0.0439	0.0431	0.0425	0.0419	0.0413
2.6	2.50	0.0699	0.0665	0.0627	0.0615	0.0603	0.0592	0.0582	0.0563	0.0547	0.0532	0.0519	0.0507	0.0497	0.0487	0.0478	0.0470	0.0462	0.0456	0.0449	0.0443
2.7	2.60	0.0746	0.0710	0.0670	0.0657	0.0644	0.0633	0.0621	0.0602	0.0584	0.0569	0.0555	0.0542	0.0531	0.0521	0.0511	0.0503	0.0494	0.0487	0.0480	0.0474
2.8	2.69	0.0794	0.0756	0.0713	0.0700	0.0686	0.0674	0.0662	0.0641	0.0623	0.0606	0.0592	0.0578	0.0566	0.0555	0.0545	0.0536	0.0527	0.0520	0.0512	0.0506
2.9	2.79	0.0844	0.0804	0.0758	0.0744	0.0729	0.0717	0.0704	0.0682	0.0662	0.0645	0.0629	0.0615	0.0602	0.0591	0.0580	0.0570	0.0561	0.0553	0.0545	0.0538
3.0	2.89	0.0894	0.0852	0.0804	0.0789	0.0773	0.0760	0.0747	0.0723	0.0703	0.0684	0.0668	0.0653	0.0640	0.0627	0.0616	0.0606	0.0596	0.0587	0.0579	0.0572
3.1	2.98	0.0947	0.0902	0.0852	0.0836	0.0819	0.0805	0.0791	0.0766	0.0744	0.0725	0.0708	0.0692	0.0678	0.0665	0.0653	0.0642	0.0632	0.0623	0.0614	0.0606
3.2	3.08	0.1000	0.0953	0.0900	0.0883	0.0866	0.0851	0.0836	0.0810	0.0787	0.0767	0.0748	0.0732	0.0717	0.0703	0.0691	0.0679	0.0668	0.0659	0.0650	0.0641
3.3	3.18	0.1055	0.1005	0.0950	0.0932	0.0913	0.0898	0.0882	0.0855	0.0831	0.0809	0.0790	0.0773	0.0757	0.0743	0.0729	0.0717	0.0706	0.0696	0.0686	0.0677
3.4	3.27	0.1111	0.1059	0.1000	0.0982	0.0962	0.0946	0.0930	0.0901	0.0876	0.0853	0.0833	0.0815	0.0798	0.0783	0.0769	0.0756	0.0744	0.0734	0.0724	0.0714
3.5	3.37	0.1168	0.1114	0.1052	0.1033	0.1012	0.0996	0.0978	0.0948	0.0921	0.0898	0.0877	0.0857	0.0840	0.0824	0.0810	0.0796	0.0784	0.0773	0.0762	0.0752
3.6	3.46	0.1226	0.1169	0.1105	0.1085	0.1064	0.1046	0.1028	0.0996	0.0968	0.0943	0.0921	0.0901	0.0883	0.0866	0.0851	0.0837	0.0824	0.0812	0.0801	0.0791
3.7	3.56	0.1286	0.1226	0.1159	0.1138	0.1116	0.1097	0.1078	0.1045	0.1016	0.0990	0.0967	0.0946	0.0927	0.0910	0.0894	0.0879	0.0865	0.0853	0.0841	0.0831
3.8	3.66	0.1347	0.1285	0.1215	0.1192	0.1169	0.1150	0.1130	0.1095	0.1065	0.1038	0.1014	0.0992	0.0972	0.0954	0.0937	0.0922	0.0907	0.0894	0.0882	0.0871
3.9	3.75	0.1409	0.1344	0.1271	0.1248	0.1224	0.1204	0.1183	0.1147	0.1115	0.1087	0.1061	0.1038	0.1017	0.0999	0.0981	0.0965	0.0950	0.0937	0.0924	0.0913

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor MLC — 100% Water — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	3.85	0.1472	0.1405	0.1328	0.1304	0.1279	0.1258	0.1236	0.1199	0.1166	0.1136	0.1110	0.1086	0.1064	0.1045	0.1026	0.1010	0.0994	0.0980	0.0967	0.0955
4.1	3.95	0.1537	0.1466	0.1387	0.1362	0.1336	0.1314	0.1291	0.1252	0.1218	0.1187	0.1159	0.1134	0.1112	0.1091	0.1072	0.1055	0.1039	0.1024	0.1011	0.0998
4.2	4.04	0.1602	0.1529	0.1447	0.1421	0.1393	0.1371	0.1347	0.1306	0.1271	0.1239	0.1210	0.1184	0.1160	0.1139	0.1119	0.1101	0.1085	0.1069	0.1055	0.1042
4.3	4.14	0.1669	0.1593	0.1508	0.1481	0.1452	0.1429	0.1404	0.1362	0.1325	0.1291	0.1261	0.1234	0.1210	0.1188	0.1167	0.1149	0.1131	0.1115	0.1100	0.1087
4.4	4.23		0.1659	0.1570	0.1541	0.1512	0.1487	0.1462	0.1418	0.1379	0.1345	0.1314	0.1286	0.1260	0.1237	0.1216	0.1197	0.1178	0.1162	0.1147	0.1132
4.5	4.33			0.1633	0.1603	0.1573	0.1547	0.1521	0.1475	0.1435	0.1399	0.1367	0.1338	0.1312	0.1288	0.1266	0.1246	0.1227	0.1209	0.1194	0.1179
4.6	4.43			0.1697	0.1666	0.1635	0.1608	0.1581	0.1534	0.1492	0.1455	0.1422	0.1391	0.1364	0.1339	0.1316	0.1295	0.1276	0.1258	0.1241	0.1226
4.7	4.52					0.1698	0.1670	0.1642	0.1593	0.1550	0.1511	0.1477	0.1446	0.1417	0.1391	0.1368	0.1346	0.1326	0.1307	0.1290	0.1274
4.8	4.62								0.1653	0.1609	0.1569	0.1533	0.1501	0.1471	0.1445	0.1420	0.1398	0.1376	0.1357	0.1340	0.1323
4.9	4.72									0.1668	0.1627	0.1590	0.1557	0.1526	0.1499	0.1473	0.1450	0.1428	0.1408	0.1390	0.1373
5.0	4.81										0.1686	0.1648	0.1614	0.1582	0.1554	0.1527	0.1503	0.1481	0.1460	0.1441	0.1424
5.1	4.91												0.1671	0.1639	0.1609	0.1582	0.1557	0.1534	0.1513	0.1493	0.1475
5.2	5.00													0.1697	0.1666	0.1638	0.1612	0.1588	0.1566	0.1546	0.1527
5.3	5.10															0.1695	0.1668	0.1643	0.1621	0.1600	0.1580
5.4	5.20																	0.1699	0.1676	0.1654	0.1634
5.5	5.29																				0.1689

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor MLC — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.48	0.00682	0.00651	0.00619	0.00594	0.00568	0.00547	0.00525	0.00490	0.00460	0.00435	0.00413	0.00395	0.00379	0.00364	0.00353	0.00342	0.00331	0.00323	0.00314	0.00308
0.6	0.58	0.00913	0.00873	0.00830	0.00798	0.00764	0.00736	0.00707	0.00661	0.00622	0.00589	0.00560	0.00536	0.00515	0.00495	0.00480	0.00465	0.00451	0.00440	0.00429	0.00421
0.7	0.67	0.01170	0.01120	0.01066	0.01026	0.00983	0.00948	0.00912	0.00853	0.00804	0.00762	0.00725	0.00695	0.00668	0.00643	0.00623	0.00605	0.00587	0.00573	0.00558	0.00548
0.8	0.77	0.01452	0.01391	0.01326	0.01276	0.01223	0.01181	0.01137	0.01065	0.01004	0.00953	0.00908	0.00870	0.00837	0.00807	0.00783	0.00759	0.00738	0.00720	0.00702	0.00689
0.9	0.87	0.01758	0.01685	0.01608	0.01548	0.01486	0.01435	0.01382	0.01296	0.01224	0.01162	0.01108	0.01063	0.01022	0.00986	0.00957	0.00929	0.00903	0.00881	0.00860	0.00844
1.0	0.96	0.02088	0.02002	0.01911	0.01842	0.01768	0.01709	0.01647	0.01546	0.01460	0.01387	0.01324	0.01271	0.01223	0.01180	0.01146	0.01112	0.01082	0.01056	0.01031	0.01012
1.1	1.06	0.02440	0.02341	0.02237	0.02156	0.02071	0.02003	0.01930	0.01814	0.01715	0.01630	0.01557	0.01494	0.01439	0.01389	0.01349	0.01310	0.01274	0.01245	0.01215	0.01193
1.2	1.15	0.02814	0.02702	0.02582	0.02491	0.02393	0.02315	0.02233	0.02099	0.01986	0.01889	0.01805	0.01733	0.01670	0.01612	0.01567	0.01522	0.01481	0.01447	0.01413	0.01388
1.3	1.25	0.03210	0.03083	0.02948	0.02845	0.02735	0.02646	0.02553	0.02402	0.02274	0.02164	0.02068	0.01987	0.01915	0.01850	0.01798	0.01747	0.01700	0.01661	0.01623	0.01594
1.4	1.35	0.03627	0.03485	0.03334	0.03218	0.03095	0.02996	0.02891	0.02722	0.02578	0.02454	0.02347	0.02256	0.02175	0.02101	0.02043	0.01986	0.01933	0.01889	0.01846	0.01813
1.5	1.44	0.04065	0.03907	0.03740	0.03611	0.03474	0.03364	0.03247	0.03059	0.02898	0.02760	0.02641	0.02539	0.02448	0.02366	0.02301	0.02237	0.02178	0.02129	0.02081	0.02044
1.6	1.54	0.04523	0.04349	0.04164	0.04022	0.03871	0.03749	0.03620	0.03412	0.03234	0.03081	0.02949	0.02836	0.02736	0.02645	0.02572	0.02501	0.02436	0.02382	0.02328	0.02288
1.7	1.64	0.05002	0.04811	0.04608	0.04452	0.04286	0.04152	0.04010	0.03781	0.03585	0.03418	0.03272	0.03148	0.03037	0.02937	0.02857	0.02779	0.02706	0.02646	0.02587	0.02543
1.8	1.73	0.05500	0.05292	0.05070	0.04899	0.04718	0.04572	0.04417	0.04166	0.03952	0.03769	0.03609	0.03473	0.03352	0.03242	0.03154	0.03068	0.02989	0.02923	0.02858	0.02809
1.9	1.83	0.06017	0.05791	0.05550	0.05365	0.05168	0.05009	0.04840	0.04567	0.04334	0.04134	0.03960	0.03812	0.03680	0.03560	0.03464	0.03370	0.03284	0.03212	0.03141	0.03088
2.0	1.92	0.06554	0.06309	0.06049	0.05848	0.05634	0.05462	0.05279	0.04984	0.04731	0.04514	0.04325	0.04164	0.04021	0.03890	0.03786	0.03685	0.03590	0.03512	0.03435	0.03377
2.1	2.02	0.07110	0.06846	0.06565	0.06348	0.06118	0.05932	0.05735	0.05416	0.05142	0.04908	0.04704	0.04530	0.04375	0.04234	0.04121	0.04011	0.03909	0.03825	0.03741	0.03678
2.2	2.12	0.07685	0.07401	0.07099	0.06866	0.06619	0.06418	0.06206	0.05863	0.05569	0.05316	0.05096	0.04909	0.04741	0.04589	0.04468	0.04349	0.04240	0.04148	0.04058	0.03990
2.3	2.21	0.08278	0.07974	0.07651	0.07401	0.07136	0.06921	0.06694	0.06325	0.06009	0.05738	0.05502	0.05301	0.05121	0.04958	0.04827	0.04700	0.04582	0.04484	0.04386	0.04314
2.4	2.31	0.08889	0.08565	0.08219	0.07952	0.07669	0.07439	0.07196	0.06802	0.06464	0.06174	0.05921	0.05706	0.05513	0.05338	0.05198	0.05062	0.04935	0.04830	0.04726	0.04648
2.5	2.41	0.09519	0.09173	0.08805	0.08521	0.08218	0.07974	0.07714	0.07294	0.06933	0.06624	0.06354	0.06124	0.05918	0.05731	0.05582	0.05436	0.05300	0.05188	0.05076	0.04993
2.6	2.50	0.10166	0.09799	0.09408	0.09105	0.08784	0.08524	0.08248	0.07800	0.07417	0.07087	0.06800	0.06554	0.06335	0.06136	0.05977	0.05821	0.05677	0.05557	0.05438	0.05349
2.7	2.60	0.10831	0.10442	0.10027	0.09706	0.09365	0.09089	0.08796	0.08321	0.07914	0.07564	0.07258	0.06997	0.06765	0.06553	0.06383	0.06218	0.06064	0.05937	0.05811	0.05716
2.8	2.69	0.11514	0.11102	0.10663	0.10323	0.09962	0.09670	0.09360	0.08857	0.08425	0.08054	0.07730	0.07453	0.07206	0.06981	0.06802	0.06626	0.06463	0.06328	0.06194	0.06093
2.9	2.79	0.12215	0.11780	0.11315	0.10957	0.10575	0.10266	0.09938	0.09406	0.08949	0.08557	0.08214	0.07921	0.07660	0.07422	0.07232	0.07046	0.06873	0.06730	0.06588	0.06481
3.0	2.89	0.12932	0.12474	0.11984	0.11606	0.11204	0.10878	0.10532	0.09970	0.09488	0.09073	0.08711	0.08402	0.08126	0.07874	0.07673	0.07477	0.07294	0.07143	0.06992	0.06880
3.1	2.98	0.13667	0.13185	0.12669	0.12271	0.11847	0.11504	0.11139	0.10548	0.10039	0.09603	0.09221	0.08895	0.08603	0.08338	0.08126	0.07919	0.07726	0.07567	0.07408	0.07289
3.2	3.08	0.14419	0.13912	0.13370	0.12952	0.12506	0.12145	0.11762	0.11139	0.10605	0.10145	0.09743	0.09400	0.09093	0.08814	0.08590	0.08372	0.08169	0.08001	0.07833	0.07708
3.3	3.18	0.15188	0.14656	0.14087	0.13648	0.13180	0.12801	0.12399	0.11745	0.11183	0.10700	0.10278	0.09917	0.09594	0.09301	0.09066	0.08836	0.08623	0.08446	0.08270	0.08138
3.4	3.27	0.15974	0.15416	0.14820	0.14360	0.13869	0.13472	0.13050	0.12364	0.11775	0.11268	0.10825	0.10446	0.10107	0.09799	0.09552	0.09311	0.09087	0.08901	0.08716	0.08578
3.5	3.37	0.16776	0.16192	0.15569	0.15087	0.14573	0.14157	0.13715	0.12997	0.12380	0.11849	0.11384	0.10987	0.10632	0.10309	0.10050	0.09797	0.09562	0.09367	0.09173	0.09028
3.6	3.46		0.16985	0.16333	0.15829	0.15292	0.14857	0.14395	0.13644	0.12998	0.12442	0.11956	0.11540	0.11168	0.10830	0.10559	0.10294	0.10048	0.09844	0.09640	0.09488
3.7	3.56				0.16587	0.16026	0.15571	0.15089	0.14304	0.13629	0.13047	0.12539	0.12105	0.11716	0.11362	0.11079	0.10801	0.10544	0.10331	0.10118	0.09959
3.8	3.66					0.16774	0.16300	0.15796	0.14977	0.14272	0.13666	0.13135	0.12681	0.12275	0.11905	0.11610	0.11320	0.11051	0.10828	0.10606	0.10439
3.9	3.75							0.16518	0.15664	0.14929	0.14296	0.13743	0.13269	0.12846	0.12460	0.12151	0.11849	0.11568	0.11335	0.11103	0.10930

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" **Uponor MLC** — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	3.85								0.16364	0.15598	0.14939	0.14363	0.13869	0.13428	0.13025	0.12704	0.12388	0.12096	0.11853	0.11611	0.11430
4.1	3.95									0.16280	0.15594	0.14994	0.14480	0.14021	0.13602	0.13267	0.12939	0.12634	0.12381	0.12129	0.11941
4.2	4.04									0.16975	0.16262	0.15638	0.15103	0.14625	0.14190	0.13841	0.13499	0.13182	0.12919	0.12657	0.12461
4.3	4.14										0.16941	0.16293	0.15738	0.15241	0.14788	0.14426	0.14071	0.13741	0.13467	0.13195	0.12991
4.4	4.23											0.16960	0.16383	0.15868	0.15397	0.15021	0.14652	0.14310	0.14026	0.13742	0.13530
4.5	4.33													0.16505	0.16017	0.15627	0.15244	0.14889	0.14594	0.14300	0.14080
4.6	4.43														0.16648	0.16243	0.15846	0.15478	0.15172	0.14867	0.14639
4.7	4.52															0.16870	0.16459	0.16077	0.15760	0.15444	0.15208
4.8	4.62																	0.16687	0.16358	0.16031	0.15786
4.9	4.72																		0.16966	0.16628	0.16374
5.0	4.81																				0.16972

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor MLC — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.48	0.00819	0.00773	0.00725	0.00689	0.00651	0.00623	0.00593	0.00546	0.00507	0.00475	0.00448	0.00424	0.00404	0.00387	0.00372	0.00360	0.00347	0.00363	0.00352	0.00341
0.6	0.58	0.01091	0.01031	0.00968	0.00922	0.00873	0.00836	0.00797	0.00735	0.00683	0.00641	0.00606	0.00575	0.00548	0.00525	0.00506	0.00489	0.00473	0.00493	0.00479	0.00465
0.7	0.67	0.01393	0.01318	0.01239	0.01182	0.01120	0.01074	0.01024	0.00946	0.00881	0.00828	0.00783	0.00744	0.00711	0.00681	0.00656	0.00635	0.00614	0.00640	0.00622	0.00604
0.8	0.77	0.01723	0.01633	0.01537	0.01466	0.01391	0.01335	0.01274	0.01179	0.01100	0.01035	0.00979	0.00931	0.00890	0.00854	0.00823	0.00797	0.00771	0.00803	0.00781	0.00759
0.9	0.87	0.02080	0.01973	0.01859	0.01775	0.01686	0.01618	0.01547	0.01432	0.01338	0.01260	0.01193	0.01135	0.01086	0.01042	0.01006	0.00974	0.00943	0.00982	0.00955	0.00928
1.0	0.96	0.02464	0.02339	0.02206	0.02108	0.02004	0.01924	0.01840	0.01706	0.01595	0.01503	0.01425	0.01356	0.01298	0.01247	0.01204	0.01166	0.01129	0.01175	0.01143	0.01112
1.1	1.06	0.02873	0.02729	0.02576	0.02463	0.02343	0.02251	0.02154	0.01999	0.01871	0.01764	0.01673	0.01594	0.01527	0.01467	0.01416	0.01373	0.01330	0.01384	0.01346	0.01310
1.2	1.15	0.03307	0.03144	0.02969	0.02841	0.02704	0.02599	0.02488	0.02312	0.02165	0.02043	0.01939	0.01848	0.01770	0.01702	0.01644	0.01594	0.01545	0.01606	0.01563	0.01522
1.3	1.25	0.03766	0.03582	0.03385	0.03240	0.03086	0.02968	0.02843	0.02643	0.02476	0.02338	0.02220	0.02117	0.02030	0.01951	0.01886	0.01829	0.01773	0.01843	0.01794	0.01747
1.4	1.35	0.04248	0.04043	0.03823	0.03661	0.03488	0.03356	0.03216	0.02992	0.02805	0.02650	0.02518	0.02402	0.02304	0.02216	0.02142	0.02078	0.02015	0.02094	0.02039	0.01985
1.5	1.44	0.04754	0.04527	0.04283	0.04103	0.03911	0.03764	0.03608	0.03359	0.03152	0.02979	0.02831	0.02702	0.02592	0.02494	0.02412	0.02341	0.02270	0.02358	0.02296	0.02237
1.6	1.54	0.05283	0.05033	0.04764	0.04566	0.04354	0.04192	0.04020	0.03744	0.03515	0.03324	0.03160	0.03017	0.02895	0.02787	0.02695	0.02617	0.02538	0.02635	0.02567	0.02501
1.7	1.64	0.05835	0.05560	0.05266	0.05048	0.04816	0.04638	0.04449	0.04147	0.03894	0.03684	0.03505	0.03347	0.03213	0.03093	0.02992	0.02906	0.02819	0.02926	0.02851	0.02778
1.8	1.73	0.06408	0.06109	0.05788	0.05551	0.05297	0.05103	0.04897	0.04566	0.04290	0.04060	0.03864	0.03691	0.03544	0.03413	0.03303	0.03208	0.03112	0.03230	0.03148	0.03068
1.9	1.83	0.07004	0.06679	0.06331	0.06073	0.05798	0.05587	0.05362	0.05003	0.04702	0.04452	0.04238	0.04050	0.03890	0.03747	0.03626	0.03523	0.03419	0.03547	0.03457	0.03370
2.0	1.92	0.07621	0.07270	0.06893	0.06615	0.06317	0.06088	0.05845	0.05456	0.05130	0.04859	0.04627	0.04423	0.04249	0.04094	0.03963	0.03850	0.03737	0.03877	0.03779	0.03684
2.1	2.02	0.08259	0.07881	0.07476	0.07175	0.06854	0.06608	0.06346	0.05926	0.05574	0.05281	0.05030	0.04810	0.04622	0.04454	0.04312	0.04190	0.04068	0.04219	0.04113	0.04010
2.2	2.12	0.08918	0.08513	0.08077	0.07755	0.07410	0.07145	0.06864	0.06412	0.06034	0.05718	0.05448	0.05211	0.05008	0.04827	0.04674	0.04543	0.04411	0.04574	0.04460	0.04349
2.3	2.21	0.09598	0.09165	0.08698	0.08353	0.07984	0.07700	0.07398	0.06914	0.06509	0.06170	0.05880	0.05625	0.05407	0.05213	0.05049	0.04908	0.04766	0.04941	0.04818	0.04699
2.4	2.31	0.10299	0.09836	0.09338	0.08970	0.08575	0.08273	0.07950	0.07432	0.06999	0.06637	0.06326	0.06053	0.05820	0.05612	0.05436	0.05285	0.05133	0.05320	0.05189	0.05061
2.5	2.41	0.11019	0.10527	0.09997	0.09605	0.09185	0.08862	0.08518	0.07966	0.07504	0.07118	0.06786	0.06495	0.06246	0.06023	0.05836	0.05674	0.05511	0.05712	0.05572	0.05435
2.6	2.50	0.11760	0.11238	0.10675	0.10258	0.09811	0.09469	0.09103	0.08516	0.08024	0.07613	0.07260	0.06950	0.06685	0.06447	0.06248	0.06075	0.05902	0.06115	0.05966	0.05820
2.7	2.60	0.12521	0.11967	0.11371	0.10929	0.10455	0.10092	0.09704	0.09081	0.08559	0.08122	0.07748	0.07418	0.07136	0.06884	0.06672	0.06488	0.06304	0.06531	0.06372	0.06217
2.8	2.69	0.13302	0.12716	0.12086	0.11618	0.11117	0.10732	0.10322	0.09662	0.09108	0.08646	0.08249	0.07899	0.07600	0.07333	0.07108	0.06913	0.06718	0.06958	0.06790	0.06625
2.9	2.79	0.14102	0.13484	0.12818	0.12325	0.11795	0.11389	0.10955	0.10258	0.09673	0.09184	0.08764	0.08394	0.08077	0.07794	0.07556	0.07350	0.07143	0.07398	0.07219	0.07045
3.0	2.89	0.14921	0.14270	0.13569	0.13048	0.12490	0.12062	0.11604	0.10869	0.10251	0.09735	0.09292	0.08901	0.08567	0.08268	0.08016	0.07798	0.07579	0.07849	0.07660	0.07475
3.1	2.98	0.15759	0.15075	0.14337	0.13790	0.13202	0.12751	0.12270	0.11495	0.10844	0.10300	0.09833	0.09421	0.09069	0.08753	0.08488	0.08258	0.08027	0.08311	0.08112	0.07917
3.2	3.08	0.16617	0.15898	0.15123	0.14548	0.13931	0.13457	0.12951	0.12136	0.11452	0.10879	0.10387	0.09954	0.09583	0.09251	0.08971	0.08729	0.08486	0.08785	0.08575	0.08370
3.3	3.18		0.16739	0.15927	0.15324	0.14676	0.14179	0.13647	0.12792	0.12073	0.11472	0.10955	0.10500	0.10110	0.09761	0.09466	0.09212	0.08956	0.09271	0.09050	0.08834
3.4	3.27			0.16748	0.16116	0.15437	0.14916	0.14359	0.13463	0.12709	0.12078	0.11536	0.11058	0.10649	0.10282	0.09973	0.09706	0.09437	0.09768	0.09536	0.09309
3.5	3.37				0.16925	0.16215	0.15669	0.15086	0.14148	0.13358	0.12697	0.12129	0.11628	0.11200	0.10815	0.10491	0.10211	0.09929	0.10276	0.10033	0.09795
3.6	3.46						0.16439	0.15829	0.14847	0.14022	0.13330	0.12736	0.12212	0.11763	0.11360	0.11021	0.10728	0.10433	0.10795	0.10541	0.10292
3.7	3.56							0.16587	0.15562	0.14699	0.13976	0.13355	0.12807	0.12338	0.11917	0.11562	0.11255	0.10947	0.11326	0.11060	0.10800
3.8	3.66								0.16290	0.15390	0.14636	0.13987	0.13415	0.12925	0.12485	0.12115	0.11794	0.11472	0.11868	0.11590	0.11318
3.9	3.75									0.16094	0.15308	0.14632	0.14035	0.13523	0.13065	0.12679	0.12344	0.12007	0.12421	0.12131	0.11847

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor MLC — 40% Propylene Glycol — Feet of Head per Foot of Tubing

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Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	3.85									0.16812	0.15993	0.15289	0.14667	0.14134	0.13657	0.13254	0.12905	0.12554	0.12985	0.12682	0.12386
4.1	3.95										0.16692	0.15958	0.15311	0.14757	0.14259	0.13840	0.13476	0.13111	0.13560	0.13245	0.12936
4.2	4.04											0.16641	0.15968	0.15391	0.14873	0.14437	0.14059	0.13679	0.14146	0.13818	0.13497
4.3	4.14												0.16636	0.16036	0.15499	0.15045	0.14652	0.14257	0.14742	0.14401	0.14068
4.4	4.23													0.16694	0.16136	0.15664	0.15256	0.14846	0.15350	0.14996	0.14650
4.5	4.33														0.16783	0.16295	0.15871	0.15445	0.15968	0.15601	0.15241
4.6	4.43															0.16936	0.16497	0.16055	0.16597	0.16216	0.15844
4.7	4.52																	0.16675		0.16842	0.16456

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor MLC — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.48	0.00979	0.00920	0.00857	0.00811	0.00763	0.00726	0.00688	0.00627	0.00578	0.00537	0.00503	0.00473	0.00449	0.00427	0.00408	0.00392	0.00377	0.00364	0.00353	0.00343
0.6	0.58	0.01298	0.01221	0.01140	0.01081	0.01018	0.00971	0.00920	0.00842	0.00777	0.00723	0.00678	0.00640	0.00607	0.00578	0.00554	0.00532	0.00513	0.00495	0.00481	0.00467
0.7	0.67	0.01650	0.01555	0.01454	0.01380	0.01302	0.01242	0.01179	0.01081	0.00999	0.00932	0.00875	0.00826	0.00785	0.00749	0.00717	0.00690	0.00665	0.00643	0.00624	0.00606
0.8	0.77	0.02034	0.01920	0.01798	0.01708	0.01613	0.01540	0.01464	0.01343	0.01244	0.01161	0.01092	0.01032	0.00981	0.00937	0.00898	0.00865	0.00834	0.00806	0.00783	0.00761
0.9	0.87	0.02450	0.02314	0.02169	0.02063	0.01949	0.01863	0.01772	0.01629	0.01510	0.01411	0.01328	0.01257	0.01196	0.01143	0.01096	0.01056	0.01019	0.00985	0.00958	0.00931
1.0	0.96	0.02894	0.02736	0.02568	0.02444	0.02311	0.02211	0.02105	0.01937	0.01797	0.01682	0.01584	0.01500	0.01428	0.01365	0.01311	0.01263	0.01219	0.01180	0.01147	0.01116
1.1	1.06	0.03368	0.03187	0.02993	0.02850	0.02698	0.02582	0.02460	0.02266	0.02105	0.01971	0.01858	0.01761	0.01677	0.01604	0.01541	0.01486	0.01434	0.01389	0.01351	0.01314
1.2	1.15	0.03870	0.03664	0.03444	0.03282	0.03108	0.02977	0.02837	0.02616	0.02432	0.02279	0.02150	0.02039	0.01943	0.01860	0.01787	0.01724	0.01665	0.01612	0.01569	0.01527
1.3	1.25	0.04398	0.04167	0.03920	0.03737	0.03542	0.03394	0.03236	0.02987	0.02779	0.02606	0.02460	0.02334	0.02226	0.02131	0.02048	0.01976	0.01909	0.01850	0.01800	0.01752
1.4	1.35	0.04954	0.04696	0.04421	0.04216	0.03999	0.03833	0.03657	0.03378	0.03145	0.02951	0.02787	0.02646	0.02524	0.02417	0.02324	0.02244	0.02168	0.02101	0.02046	0.01992
1.5	1.44	0.05536	0.05250	0.04945	0.04719	0.04478	0.04294	0.04098	0.03788	0.03530	0.03314	0.03131	0.02974	0.02838	0.02719	0.02616	0.02525	0.02441	0.02366	0.02304	0.02244
1.6	1.54	0.06143	0.05829	0.05493	0.05245	0.04979	0.04776	0.04560	0.04218	0.03933	0.03694	0.03492	0.03318	0.03168	0.03036	0.02921	0.02821	0.02728	0.02645	0.02576	0.02509
1.7	1.64	0.06776	0.06432	0.06065	0.05792	0.05501	0.05279	0.05043	0.04668	0.04354	0.04092	0.03870	0.03678	0.03513	0.03368	0.03242	0.03131	0.03029	0.02937	0.02861	0.02787
1.8	1.73	0.07433	0.07060	0.06659	0.06362	0.06045	0.05803	0.05545	0.05135	0.04793	0.04507	0.04264	0.04054	0.03873	0.03714	0.03576	0.03455	0.03343	0.03242	0.03159	0.03078
1.9	1.83	0.08115	0.07710	0.07276	0.06954	0.06610	0.06347	0.06067	0.05622	0.05249	0.04938	0.04674	0.04445	0.04248	0.04075	0.03924	0.03793	0.03670	0.03560	0.03469	0.03381
2.0	1.92	0.08821	0.08384	0.07915	0.07567	0.07195	0.06911	0.06608	0.06127	0.05723	0.05386	0.05099	0.04852	0.04638	0.04450	0.04286	0.04143	0.04010	0.03891	0.03792	0.03696
2.1	2.02	0.09550	0.09080	0.08576	0.08202	0.07801	0.07495	0.07168	0.06649	0.06214	0.05850	0.05541	0.05274	0.05043	0.04839	0.04662	0.04508	0.04363	0.04235	0.04127	0.04023
2.2	2.12	0.10303	0.09799	0.09259	0.08857	0.08427	0.08098	0.07748	0.07190	0.06722	0.06331	0.05998	0.05710	0.05461	0.05242	0.05052	0.04885	0.04729	0.04591	0.04475	0.04363
2.3	2.21	0.11079	0.10541	0.09963	0.09533	0.09073	0.08721	0.08346	0.07748	0.07247	0.06827	0.06470	0.06161	0.05894	0.05659	0.05455	0.05276	0.05108	0.04959	0.04835	0.04714
2.4	2.31	0.11878	0.11304	0.10688	0.10229	0.09739	0.09363	0.08962	0.08324	0.07788	0.07340	0.06958	0.06627	0.06342	0.06090	0.05871	0.05679	0.05500	0.05340	0.05207	0.05077
2.5	2.41	0.12699	0.12089	0.11434	0.10946	0.10424	0.10024	0.09597	0.08917	0.08346	0.07868	0.07460	0.07108	0.06803	0.06534	0.06300	0.06095	0.05904	0.05733	0.05590	0.05452
2.6	2.50	0.13543	0.12896	0.12200	0.11683	0.11128	0.10703	0.10250	0.09527	0.08920	0.08411	0.07978	0.07602	0.07278	0.06992	0.06742	0.06524	0.06320	0.06138	0.05986	0.05839
2.7	2.60	0.14409	0.13724	0.12987	0.12439	0.11851	0.11401	0.10920	0.10154	0.09510	0.08970	0.08510	0.08111	0.07766	0.07463	0.07197	0.06966	0.06749	0.06555	0.06394	0.06237
2.8	2.69	0.15297	0.14573	0.13795	0.13215	0.12594	0.12117	0.11609	0.10798	0.10116	0.09544	0.09057	0.08635	0.08269	0.07947	0.07666	0.07420	0.07190	0.06984	0.06813	0.06647
2.9	2.79	0.16206	0.15443	0.14622	0.14011	0.13355	0.12852	0.12315	0.11459	0.10738	0.10134	0.09618	0.09172	0.08785	0.08444	0.08146	0.07886	0.07642	0.07425	0.07243	0.07067
3.0	2.89		0.16334	0.15469	0.14825	0.14134	0.13605	0.13039	0.12136	0.11376	0.10738	0.10194	0.09723	0.09314	0.08954	0.08640	0.08365	0.08107	0.07878	0.07686	0.07500
3.1	2.98			0.16336	0.15659	0.14932	0.14375	0.13780	0.12830	0.12029	0.11357	0.10784	0.10287	0.09857	0.09477	0.09146	0.08856	0.08584	0.08342	0.08139	0.07943
3.2	3.08				0.16512	0.15749	0.15163	0.14538	0.13539	0.12698	0.11991	0.11389	0.10866	0.10413	0.10013	0.09664	0.09359	0.09073	0.08818	0.08604	0.08397
3.3	3.18					0.16583	0.15969	0.15313	0.14265	0.13382	0.12640	0.12007	0.11458	0.10982	0.10562	0.10195	0.09874	0.09573	0.09305	0.09081	0.08863
3.4	3.27						0.16793	0.16105	0.15007	0.14082	0.13303	0.12639	0.12063	0.11564	0.11123	0.10738	0.10401	0.10086	0.09804	0.09568	0.09340
3.5	3.37							0.16914	0.15765	0.14796	0.13981	0.13286	0.12682	0.12159	0.11697	0.11294	0.10940	0.10609	0.10314	0.10067	0.09827
3.6	3.46								0.16539	0.15526	0.14673	0.13946	0.13315	0.12767	0.12284	0.11861	0.11491	0.11145	0.10835	0.10577	0.10325
3.7	3.56									0.16270	0.15380	0.14620	0.13960	0.13388	0.12883	0.12441	0.12054	0.11692	0.11368	0.11097	0.10835
3.8	3.66										0.16101	0.15308	0.14619	0.14021	0.13494	0.13033	0.12629	0.12250	0.11912	0.11629	0.11355
3.9	3.75										0.16836	0.16009	0.15291	0.14667	0.14117	0.13636	0.13215	0.12820	0.12467	0.12172	0.11885

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

⅝" Uponor MLC — 50% Propylene Glycol — Feet of Head per Foot of Tubing

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Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	3.85											0.16724	0.15975	0.15326	0.14753	0.14252	0.13812	0.13401	0.13033	0.12725	0.12427
4.1	3.95												0.16673	0.15998	0.15401	0.14879	0.14422	0.13993	0.13610	0.13289	0.12978
4.2	4.04													0.16681	0.16061	0.15518	0.15042	0.14596	0.14198	0.13864	0.13541
4.3	4.14														0.16733	0.16169	0.15675	0.15211	0.14797	0.14450	0.14114
4.4	4.23															0.16831	0.16318	0.15837	0.15407	0.15047	0.14697
4.5	4.33																0.16973	0.16473	0.16027	0.15654	0.15291
4.6	4.43																		0.16659	0.16271	0.15895
4.7	4.52																			0.16899	0.16509

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor MLC — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.77	0.0031	0.0030	0.0028	0.0027	0.0026	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0020	0.0020	0.0019	0.0019	0.0019	0.0018
0.6	0.92	0.0043	0.0040	0.0038	0.0037	0.0036	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0029	0.0028	0.0027	0.0027	0.0026	0.0026	0.0026	0.0025
0.7	1.08	0.0055	0.0052	0.0049	0.0048	0.0047	0.0046	0.0045	0.0043	0.0042	0.0040	0.0039	0.0038	0.0037	0.0037	0.0036	0.0035	0.0035	0.0034	0.0033	0.0033
0.8	1.23	0.0069	0.0065	0.0061	0.0060	0.0059	0.0057	0.0056	0.0054	0.0053	0.0051	0.0050	0.0048	0.0047	0.0046	0.0045	0.0044	0.0044	0.0043	0.0042	0.0042
0.9	1.38	0.0084	0.0080	0.0075	0.0073	0.0072	0.0070	0.0069	0.0066	0.0064	0.0062	0.0061	0.0059	0.0058	0.0057	0.0056	0.0054	0.0054	0.0053	0.0052	0.0051
1.0	1.54	0.0101	0.0096	0.0090	0.0088	0.0086	0.0084	0.0083	0.0080	0.0077	0.0075	0.0073	0.0071	0.0070	0.0068	0.0067	0.0065	0.0064	0.0063	0.0062	0.0061
1.1	1.69	0.0119	0.0112	0.0106	0.0103	0.0101	0.0099	0.0097	0.0094	0.0091	0.0088	0.0086	0.0084	0.0082	0.0080	0.0079	0.0077	0.0076	0.0075	0.0074	0.0073
1.2	1.84	0.0138	0.0131	0.0123	0.0120	0.0117	0.0115	0.0113	0.0109	0.0106	0.0103	0.0100	0.0098	0.0096	0.0094	0.0092	0.0090	0.0089	0.0087	0.0086	0.0085
1.3	2.00	0.0158	0.0150	0.0141	0.0138	0.0135	0.0132	0.0130	0.0125	0.0122	0.0118	0.0115	0.0112	0.0110	0.0108	0.0106	0.0104	0.0102	0.0100	0.0099	0.0097
1.4	2.15	0.0179	0.0170	0.0160	0.0157	0.0153	0.0150	0.0148	0.0143	0.0138	0.0135	0.0131	0.0128	0.0125	0.0123	0.0120	0.0118	0.0116	0.0114	0.0113	0.0111
1.5	2.30	0.0201	0.0191	0.0180	0.0176	0.0173	0.0170	0.0166	0.0161	0.0156	0.0152	0.0148	0.0144	0.0141	0.0138	0.0136	0.0133	0.0131	0.0129	0.0127	0.0125
1.6	2.46	0.0225	0.0214	0.0201	0.0197	0.0193	0.0190	0.0186	0.0180	0.0175	0.0170	0.0166	0.0162	0.0158	0.0155	0.0152	0.0149	0.0147	0.0145	0.0143	0.0141
1.7	2.61	0.0250	0.0237	0.0223	0.0219	0.0214	0.0211	0.0207	0.0200	0.0194	0.0189	0.0184	0.0180	0.0176	0.0172	0.0169	0.0166	0.0163	0.0161	0.0159	0.0157
1.8	2.76	0.0275	0.0262	0.0247	0.0242	0.0237	0.0233	0.0228	0.0221	0.0214	0.0209	0.0203	0.0199	0.0195	0.0191	0.0187	0.0184	0.0181	0.0178	0.0176	0.0173
1.9	2.92	0.0302	0.0287	0.0271	0.0266	0.0260	0.0256	0.0251	0.0243	0.0236	0.0229	0.0224	0.0219	0.0214	0.0210	0.0206	0.0202	0.0199	0.0196	0.0193	0.0191
2.0	3.07	0.0330	0.0314	0.0296	0.0290	0.0284	0.0279	0.0274	0.0266	0.0258	0.0251	0.0245	0.0239	0.0234	0.0230	0.0225	0.0222	0.0218	0.0215	0.0212	0.0209
2.1	3.23	0.0359	0.0342	0.0322	0.0316	0.0310	0.0304	0.0299	0.0289	0.0281	0.0273	0.0267	0.0261	0.0255	0.0250	0.0246	0.0241	0.0238	0.0234	0.0231	0.0228
2.2	3.38	0.0389	0.0370	0.0349	0.0343	0.0336	0.0330	0.0324	0.0314	0.0305	0.0297	0.0289	0.0283	0.0277	0.0272	0.0267	0.0262	0.0258	0.0254	0.0251	0.0247
2.3	3.53	0.0420	0.0400	0.0377	0.0370	0.0363	0.0357	0.0350	0.0339	0.0329	0.0321	0.0313	0.0306	0.0300	0.0294	0.0289	0.0284	0.0279	0.0275	0.0271	0.0268
2.4	3.69	0.0452	0.0430	0.0406	0.0399	0.0391	0.0384	0.0377	0.0365	0.0355	0.0346	0.0337	0.0330	0.0323	0.0317	0.0311	0.0306	0.0301	0.0297	0.0292	0.0289
2.5	3.84	0.0485	0.0462	0.0436	0.0428	0.0419	0.0412	0.0405	0.0392	0.0381	0.0371	0.0362	0.0354	0.0347	0.0341	0.0334	0.0329	0.0324	0.0319	0.0314	0.0310
2.6	3.99	0.0519	0.0495	0.0467	0.0458	0.0449	0.0442	0.0434	0.0420	0.0409	0.0398	0.0388	0.0380	0.0372	0.0365	0.0358	0.0353	0.0347	0.0342	0.0337	0.0333
2.7	4.15	0.0554	0.0528	0.0499	0.0490	0.0480	0.0472	0.0464	0.0449	0.0437	0.0425	0.0415	0.0406	0.0398	0.0390	0.0383	0.0377	0.0371	0.0366	0.0361	0.0356
2.8	4.30	0.0590	0.0562	0.0531	0.0522	0.0511	0.0503	0.0494	0.0479	0.0465	0.0453	0.0443	0.0433	0.0424	0.0416	0.0409	0.0402	0.0396	0.0390	0.0385	0.0380
2.9	4.45	0.0627	0.0598	0.0565	0.0555	0.0544	0.0535	0.0525	0.0509	0.0495	0.0482	0.0471	0.0461	0.0451	0.0443	0.0435	0.0428	0.0421	0.0415	0.0410	0.0404
3.0	4.61	0.0665	0.0634	0.0599	0.0588	0.0577	0.0567	0.0558	0.0541	0.0526	0.0512	0.0500	0.0489	0.0479	0.0470	0.0462	0.0455	0.0447	0.0441	0.0435	0.0430
3.1	4.76	0.0704	0.0671	0.0635	0.0623	0.0611	0.0601	0.0591	0.0573	0.0557	0.0543	0.0530	0.0518	0.0508	0.0499	0.0490	0.0482	0.0474	0.0468	0.0461	0.0455
3.2	4.91	0.0744	0.0710	0.0671	0.0659	0.0646	0.0635	0.0624	0.0606	0.0589	0.0574	0.0561	0.0548	0.0537	0.0527	0.0518	0.0510	0.0502	0.0495	0.0488	0.0482
3.3	5.07	0.0784	0.0749	0.0708	0.0695	0.0682	0.0671	0.0659	0.0639	0.0622	0.0606	0.0592	0.0579	0.0568	0.0557	0.0547	0.0539	0.0530	0.0523	0.0516	0.0509
3.4	5.22	0.0826	0.0789	0.0746	0.0733	0.0718	0.0707	0.0695	0.0674	0.0655	0.0639	0.0624	0.0611	0.0598	0.0587	0.0577	0.0568	0.0559	0.0551	0.0544	0.0537
3.5	5.38	0.0869	0.0829	0.0785	0.0771	0.0756	0.0744	0.0731	0.0709	0.0690	0.0672	0.0657	0.0643	0.0630	0.0618	0.0608	0.0598	0.0589	0.0581	0.0573	0.0566
3.6	5.53	0.0912	0.0871	0.0825	0.0810	0.0794	0.0782	0.0768	0.0745	0.0725	0.0707	0.0690	0.0676	0.0662	0.0650	0.0639	0.0629	0.0619	0.0611	0.0603	0.0595
3.7	5.68	0.0957	0.0914	0.0865	0.0850	0.0833	0.0820	0.0806	0.0782	0.0761	0.0742	0.0725	0.0709	0.0695	0.0683	0.0671	0.0660	0.0650	0.0641	0.0633	0.0625
3.8	5.84	0.1002	0.0958	0.0907	0.0890	0.0873	0.0859	0.0845	0.0820	0.0798	0.0778	0.0760	0.0744	0.0729	0.0716	0.0704	0.0693	0.0682	0.0672	0.0664	0.0655
3.9	5.99	0.1049	0.1002	0.0949	0.0932	0.0914	0.0900	0.0884	0.0858	0.0835	0.0814	0.0796	0.0779	0.0764	0.0750	0.0737	0.0725	0.0714	0.0704	0.0695	0.0687

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor MLC — 100% Water — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	6.14	0.1096	0.1047	0.0992	0.0974	0.0956	0.0941	0.0925	0.0897	0.0873	0.0852	0.0832	0.0815	0.0799	0.0784	0.0771	0.0759	0.0747	0.0737	0.0727	0.0718
4.1	6.30	0.1144	0.1094	0.1036	0.1018	0.0998	0.0982	0.0966	0.0937	0.0912	0.0890	0.0870	0.0851	0.0835	0.0820	0.0806	0.0793	0.0781	0.0770	0.0760	0.0751
4.2	6.45	0.1194	0.1141	0.1081	0.1062	0.1042	0.1025	0.1008	0.0978	0.0952	0.0929	0.0908	0.0889	0.0871	0.0856	0.0841	0.0828	0.0816	0.0804	0.0794	0.0784
4.3	6.60	0.1244	0.1189	0.1126	0.1106	0.1086	0.1069	0.1051	0.1020	0.0993	0.0968	0.0946	0.0927	0.0909	0.0892	0.0877	0.0864	0.0851	0.0839	0.0828	0.0818
4.4	6.76	0.1294	0.1237	0.1173	0.1152	0.1130	0.1113	0.1094	0.1062	0.1034	0.1008	0.0986	0.0965	0.0947	0.0930	0.0914	0.0900	0.0886	0.0874	0.0863	0.0852
4.5	6.91	0.1346	0.1287	0.1220	0.1199	0.1176	0.1158	0.1138	0.1105	0.1076	0.1049	0.1026	0.1005	0.0985	0.0968	0.0951	0.0937	0.0923	0.0910	0.0898	0.0887
4.6	7.06	0.1399	0.1338	0.1268	0.1246	0.1223	0.1203	0.1183	0.1149	0.1119	0.1091	0.1067	0.1045	0.1025	0.1006	0.0990	0.0974	0.0960	0.0947	0.0934	0.0923
4.7	7.22	0.1453	0.1389	0.1317	0.1294	0.1270	0.1250	0.1229	0.1194	0.1162	0.1134	0.1108	0.1085	0.1065	0.1046	0.1028	0.1012	0.0997	0.0984	0.0971	0.0959
4.8	7.37	0.1507	0.1441	0.1367	0.1343	0.1318	0.1297	0.1276	0.1239	0.1206	0.1177	0.1151	0.1127	0.1105	0.1086	0.1068	0.1051	0.1036	0.1022	0.1009	0.0996
4.9	7.53	0.1562	0.1494	0.1417	0.1392	0.1367	0.1345	0.1323	0.1285	0.1251	0.1221	0.1194	0.1169	0.1147	0.1127	0.1108	0.1091	0.1075	0.1060	0.1047	0.1034
5.0	7.68	0.1619	0.1548	0.1468	0.1443	0.1416	0.1394	0.1371	0.1332	0.1297	0.1265	0.1237	0.1212	0.1189	0.1168	0.1149	0.1131	0.1114	0.1099	0.1085	0.1072
5.1	7.83	0.1676	0.1603	0.1520	0.1494	0.1467	0.1444	0.1420	0.1379	0.1343	0.1311	0.1282	0.1256	0.1232	0.1210	0.1190	0.1172	0.1155	0.1139	0.1125	0.1111
5.2	7.99		0.1659	0.1573	0.1546	0.1518	0.1494	0.1470	0.1428	0.1390	0.1357	0.1327	0.1300	0.1275	0.1253	0.1232	0.1213	0.1195	0.1179	0.1165	0.1151
5.3	8.14			0.1627	0.1599	0.1570	0.1546	0.1520	0.1477	0.1438	0.1404	0.1373	0.1345	0.1319	0.1296	0.1275	0.1255	0.1237	0.1220	0.1205	0.1191
5.4	8.29			0.1682	0.1653	0.1623	0.1598	0.1571	0.1526	0.1487	0.1451	0.1419	0.1390	0.1364	0.1340	0.1318	0.1298	0.1279	0.1262	0.1246	0.1231
5.5	8.45					0.1676	0.1650	0.1623	0.1577	0.1536	0.1499	0.1466	0.1437	0.1410	0.1385	0.1362	0.1342	0.1322	0.1304	0.1288	0.1273
5.6	8.60							0.1676	0.1628	0.1586	0.1548	0.1514	0.1484	0.1456	0.1430	0.1407	0.1386	0.1365	0.1347	0.1330	0.1315
5.7	8.75								0.1680	0.1637	0.1598	0.1563	0.1531	0.1503	0.1476	0.1452	0.1430	0.1410	0.1391	0.1373	0.1357
5.8	8.91									0.1688	0.1648	0.1612	0.1580	0.1550	0.1523	0.1498	0.1476	0.1454	0.1435	0.1417	0.1400
5.9	9.06										0.1699	0.1662	0.1629	0.1598	0.1570	0.1545	0.1522	0.1500	0.1480	0.1461	0.1444
6.0	9.21												0.1678	0.1647	0.1618	0.1592	0.1568	0.1546	0.1525	0.1506	0.1489
6.1	9.37													0.1696	0.1667	0.1640	0.1615	0.1592	0.1571	0.1552	0.1534
6.2	9.52															0.1689	0.1663	0.1639	0.1618	0.1598	0.1579
6.3	9.68																	0.1687	0.1665	0.1645	0.1625
6.4	9.83																			0.1692	0.1672

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor MLC — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.77	0.00507	0.00485	0.00461	0.00443	0.00424	0.00409	0.00393	0.00367	0.00345	0.00327	0.00311	0.00297	0.00285	0.00275	0.00266	0.00258	0.00250	0.00244	0.00238	0.00233
0.6	0.92	0.00680	0.00651	0.00620	0.00596	0.00571	0.00551	0.00530	0.00496	0.00467	0.00443	0.00422	0.00404	0.00388	0.00374	0.00362	0.00351	0.00341	0.00333	0.00325	0.00318
0.7	1.08	0.00873	0.00836	0.00797	0.00767	0.00736	0.00710	0.00684	0.00641	0.00604	0.00573	0.00547	0.00524	0.00504	0.00486	0.00471	0.00457	0.00444	0.00433	0.00423	0.00415
0.8	1.23	0.01084	0.01039	0.00992	0.00955	0.00917	0.00886	0.00853	0.00801	0.00756	0.00718	0.00685	0.00657	0.00632	0.00610	0.00592	0.00574	0.00558	0.00545	0.00532	0.00522
0.9	1.38	0.01314	0.01261	0.01204	0.01160	0.01114	0.01077	0.01038	0.00975	0.00921	0.00876	0.00836	0.00802	0.00773	0.00745	0.00724	0.00703	0.00684	0.00668	0.00652	0.00640
1.0	1.54	0.01562	0.01499	0.01433	0.01381	0.01327	0.01284	0.01238	0.01164	0.01101	0.01047	0.01000	0.00960	0.00925	0.00893	0.00867	0.00843	0.00820	0.00801	0.00782	0.00768
1.1	1.69	0.01826	0.01754	0.01677	0.01618	0.01556	0.01505	0.01452	0.01366	0.01293	0.01230	0.01176	0.01130	0.01089	0.01052	0.01022	0.00993	0.00966	0.00944	0.00922	0.00906
1.2	1.84	0.02108	0.02026	0.01938	0.01870	0.01799	0.01741	0.01680	0.01582	0.01498	0.01426	0.01364	0.01311	0.01264	0.01221	0.01187	0.01154	0.01123	0.01098	0.01073	0.01054
1.3	2.00	0.02406	0.02313	0.02214	0.02138	0.02057	0.01992	0.01923	0.01811	0.01716	0.01635	0.01564	0.01504	0.01450	0.01402	0.01363	0.01325	0.01290	0.01261	0.01233	0.01211
1.4	2.15	0.02720	0.02616	0.02505	0.02420	0.02329	0.02256	0.02179	0.02053	0.01947	0.01855	0.01776	0.01708	0.01648	0.01593	0.01549	0.01507	0.01467	0.01435	0.01402	0.01378
1.5	2.30	0.03050	0.02934	0.02811	0.02716	0.02615	0.02534	0.02448	0.02308	0.02189	0.02087	0.01998	0.01923	0.01856	0.01794	0.01746	0.01698	0.01654	0.01618	0.01581	0.01554
1.6	2.46	0.03396	0.03268	0.03132	0.03027	0.02915	0.02825	0.02730	0.02576	0.02444	0.02331	0.02233	0.02149	0.02074	0.02006	0.01952	0.01899	0.01850	0.01810	0.01770	0.01740
1.7	2.61	0.03757	0.03616	0.03467	0.03351	0.03229	0.03130	0.03025	0.02856	0.02711	0.02586	0.02478	0.02385	0.02303	0.02228	0.02169	0.02110	0.02056	0.02012	0.01967	0.01934
1.8	2.76	0.04132	0.03979	0.03816	0.03690	0.03556	0.03448	0.03333	0.03148	0.02989	0.02853	0.02734	0.02633	0.02542	0.02460	0.02395	0.02331	0.02272	0.02223	0.02174	0.02137
1.9	2.92	0.04523	0.04356	0.04179	0.04042	0.03896	0.03778	0.03654	0.03452	0.03279	0.03130	0.03001	0.02890	0.02792	0.02702	0.02631	0.02561	0.02496	0.02443	0.02390	0.02350
2.0	3.07	0.04928	0.04748	0.04556	0.04407	0.04249	0.04122	0.03987	0.03768	0.03580	0.03419	0.03278	0.03158	0.03051	0.02954	0.02877	0.02801	0.02730	0.02672	0.02614	0.02571
2.1	3.23	0.05348	0.05153	0.04946	0.04786	0.04616	0.04478	0.04332	0.04095	0.03892	0.03718	0.03566	0.03437	0.03321	0.03216	0.03132	0.03049	0.02973	0.02910	0.02847	0.02800
2.2	3.38	0.05782	0.05573	0.05350	0.05178	0.04995	0.04846	0.04689	0.04435	0.04216	0.04028	0.03865	0.03725	0.03600	0.03487	0.03396	0.03307	0.03225	0.03157	0.03089	0.03039
2.3	3.53	0.06230	0.06006	0.05767	0.05582	0.05386	0.05227	0.05059	0.04785	0.04551	0.04349	0.04173	0.04023	0.03889	0.03767	0.03670	0.03574	0.03486	0.03413	0.03340	0.03285
2.4	3.69	0.06692	0.06453	0.06197	0.06000	0.05790	0.05620	0.05440	0.05147	0.04896	0.04681	0.04492	0.04332	0.04188	0.04057	0.03953	0.03851	0.03756	0.03677	0.03599	0.03541
2.5	3.84	0.07168	0.06913	0.06641	0.06430	0.06207	0.06025	0.05833	0.05521	0.05253	0.05023	0.04821	0.04650	0.04496	0.04357	0.04245	0.04136	0.04034	0.03950	0.03867	0.03804
2.6	3.99	0.07658	0.07386	0.07097	0.06873	0.06635	0.06442	0.06238	0.05906	0.05620	0.05375	0.05161	0.04978	0.04814	0.04665	0.04546	0.04430	0.04322	0.04232	0.04143	0.04076
2.7	4.15	0.08161	0.07873	0.07566	0.07329	0.07076	0.06871	0.06654	0.06301	0.05998	0.05738	0.05510	0.05315	0.05141	0.04983	0.04856	0.04732	0.04618	0.04522	0.04427	0.04356
2.8	4.30	0.08677	0.08373	0.08048	0.07796	0.07529	0.07312	0.07082	0.06708	0.06387	0.06110	0.05869	0.05662	0.05478	0.05310	0.05175	0.05044	0.04922	0.04821	0.04720	0.04645
2.9	4.45	0.09207	0.08886	0.08542	0.08276	0.07994	0.07764	0.07521	0.07125	0.06786	0.06493	0.06237	0.06019	0.05824	0.05646	0.05503	0.05364	0.05235	0.05128	0.05021	0.04941
3.0	4.61	0.09750	0.09411	0.09049	0.08769	0.08470	0.08228	0.07971	0.07554	0.07195	0.06886	0.06616	0.06385	0.06179	0.05991	0.05840	0.05693	0.05556	0.05443	0.05330	0.05246
3.1	4.76	0.10306	0.09949	0.09568	0.09273	0.08958	0.08704	0.08433	0.07993	0.07615	0.07289	0.07004	0.06761	0.06543	0.06344	0.06186	0.06030	0.05886	0.05766	0.05647	0.05558
3.2	4.91	0.10876	0.10500	0.10099	0.09789	0.09458	0.09190	0.08906	0.08443	0.08045	0.07702	0.07402	0.07145	0.06916	0.06707	0.06540	0.06376	0.06224	0.06098	0.05973	0.05879
3.3	5.07	0.11458	0.11064	0.10643	0.10317	0.09970	0.09688	0.09389	0.08903	0.08485	0.08124	0.07809	0.07540	0.07298	0.07079	0.06903	0.06731	0.06571	0.06438	0.06306	0.06207
3.4	5.22	0.12053	0.11640	0.11199	0.10857	0.10493	0.10198	0.09884	0.09374	0.08935	0.08557	0.08226	0.07943	0.07690	0.07459	0.07274	0.07093	0.06926	0.06786	0.06647	0.06543
3.5	5.38	0.12660	0.12228	0.11766	0.11409	0.11027	0.10718	0.10390	0.09855	0.09395	0.08999	0.08652	0.08355	0.08090	0.07848	0.07654	0.07465	0.07288	0.07142	0.06997	0.06888
3.6	5.53	0.13281	0.12829	0.12346	0.11972	0.11573	0.11250	0.10906	0.10347	0.09865	0.09451	0.09088	0.08777	0.08499	0.08245	0.08043	0.07844	0.07660	0.07506	0.07354	0.07240
3.7	5.68	0.13913	0.13442	0.12937	0.12547	0.12130	0.11792	0.11433	0.10849	0.10346	0.09912	0.09533	0.09208	0.08917	0.08652	0.08440	0.08232	0.08039	0.07878	0.07719	0.07599
3.8	5.84	0.14559	0.14067	0.13540	0.13133	0.12699	0.12346	0.11971	0.11361	0.10836	0.10383	0.09987	0.09647	0.09344	0.09067	0.08845	0.08628	0.08426	0.08258	0.08092	0.07967
3.9	5.99	0.15216	0.14704	0.14155	0.13731	0.13278	0.12911	0.12520	0.11884	0.11336	0.10864	0.10450	0.10096	0.09779	0.09490	0.09259	0.09032	0.08821	0.08646	0.08472	0.08342

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor MLC — 30% Propylene Glycol — Feet of Head per Foot of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	6.14	0.15886	0.15353	0.14782	0.14340	0.13869	0.13486	0.13079	0.12416	0.11845	0.11353	0.10922	0.10553	0.10223	0.09922	0.09680	0.09444	0.09225	0.09042	0.08860	0.08724
4.1	6.30	0.16568	0.16014	0.15420	0.14960	0.14470	0.14072	0.13648	0.12959	0.12365	0.11853	0.11404	0.11020	0.10676	0.10362	0.10111	0.09864	0.09636	0.09446	0.09256	0.09115
4.2	6.45		0.16687	0.16070	0.15592	0.15082	0.14669	0.14229	0.13512	0.12894	0.12361	0.11895	0.11495	0.11137	0.10811	0.10549	0.10293	0.10055	0.09857	0.09660	0.09513
4.3	6.60			0.16731	0.16235	0.15706	0.15276	0.14819	0.14074	0.13433	0.12879	0.12394	0.11979	0.11607	0.11267	0.10996	0.10729	0.10482	0.10276	0.10071	0.09918
4.4	6.76				0.16889	0.16340	0.15894	0.15420	0.14647	0.13981	0.13406	0.12903	0.12472	0.12085	0.11733	0.11451	0.11174	0.10917	0.10703	0.10490	0.10331
4.5	6.91					0.16985	0.16523	0.16031	0.15230	0.14539	0.13943	0.13421	0.12973	0.12572	0.12206	0.11913	0.11626	0.11360	0.11138	0.10917	0.10751
4.6	7.06							0.16652	0.15822	0.15106	0.14488	0.13947	0.13483	0.13067	0.12688	0.12385	0.12087	0.11810	0.11580	0.11351	0.11179
4.7	7.22								0.16424	0.15683	0.15043	0.14482	0.14002	0.13571	0.13178	0.12864	0.12555	0.12268	0.12030	0.11792	0.11615
4.8	7.37									0.16269	0.15607	0.15027	0.14529	0.14083	0.13676	0.13351	0.13031	0.12734	0.12487	0.12241	0.12057
4.9	7.53									0.16865	0.16180	0.15580	0.15065	0.14604	0.14183	0.13846	0.13515	0.13208	0.12953	0.12698	0.12507
5.0	7.68										0.16762	0.16141	0.15609	0.15132	0.14697	0.14349	0.14007	0.13689	0.13425	0.13162	0.12965
5.1	7.83											0.16712	0.16162	0.15669	0.15220	0.14860	0.14506	0.14178	0.13905	0.13633	0.13429
5.2	7.99												0.16723	0.16215	0.15750	0.15379	0.15014	0.14675	0.14393	0.14112	0.13901
5.3	8.14													0.16768	0.16289	0.15905	0.15529	0.15179	0.14888	0.14598	0.14381
5.4	8.29														0.16836	0.16440	0.16051	0.15690	0.15390	0.15091	0.14867
5.5	8.45															0.16982	0.16582	0.16210	0.15900	0.15592	0.15361
5.6	8.60																	0.16736	0.16418	0.16100	0.15861
5.7	8.75																		0.16942	0.16615	0.16369
5.8	8.91																				0.16885

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor MLC — 40% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.77	0.00587	0.00555	0.00521	0.00497	0.00471	0.00451	0.00430	0.00396	0.00369	0.00346	0.00327	0.00311	0.00297	0.00284	0.00274	0.00265	0.00256	0.00267	0.00259	0.00252
0.6	0.92	0.00784	0.00743	0.00699	0.00667	0.00632	0.00606	0.00579	0.00535	0.00499	0.00469	0.00444	0.00422	0.00403	0.00386	0.00373	0.00361	0.00349	0.00364	0.00353	0.00343
0.7	1.08	0.01003	0.00951	0.00896	0.00856	0.00813	0.00780	0.00745	0.00690	0.00644	0.00607	0.00575	0.00547	0.00523	0.00502	0.00484	0.00469	0.00454	0.00473	0.00459	0.00447
0.8	1.23	0.01243	0.01180	0.01113	0.01064	0.01011	0.00971	0.00929	0.00861	0.00805	0.00759	0.00719	0.00685	0.00656	0.00630	0.00608	0.00589	0.00570	0.00594	0.00577	0.00562
0.9	1.38	0.01503	0.01429	0.01349	0.01290	0.01227	0.01179	0.01129	0.01048	0.00981	0.00925	0.00878	0.00836	0.00801	0.00770	0.00743	0.00721	0.00698	0.00726	0.00707	0.00688
1.0	1.54	0.01783	0.01696	0.01602	0.01533	0.01460	0.01404	0.01344	0.01249	0.01170	0.01105	0.01049	0.01000	0.00959	0.00922	0.00890	0.00864	0.00837	0.00870	0.00847	0.00825
1.1	1.69	0.02082	0.01981	0.01874	0.01794	0.01709	0.01644	0.01576	0.01466	0.01374	0.01298	0.01233	0.01176	0.01128	0.01085	0.01049	0.01018	0.00986	0.01025	0.00998	0.00972
1.2	1.84	0.02399	0.02285	0.02162	0.02071	0.01974	0.01900	0.01822	0.01696	0.01591	0.01504	0.01430	0.01365	0.01309	0.01260	0.01218	0.01182	0.01146	0.01191	0.01160	0.01130
1.3	2.00	0.02735	0.02606	0.02467	0.02365	0.02255	0.02172	0.02083	0.01941	0.01822	0.01723	0.01639	0.01565	0.01502	0.01445	0.01398	0.01357	0.01317	0.01367	0.01332	0.01298
1.4	2.15	0.03088	0.02944	0.02789	0.02674	0.02552	0.02458	0.02358	0.02199	0.02065	0.01955	0.01860	0.01776	0.01705	0.01642	0.01589	0.01543	0.01497	0.01554	0.01514	0.01475
1.5	2.30	0.03459	0.03299	0.03126	0.02999	0.02863	0.02759	0.02648	0.02470	0.02322	0.02198	0.02092	0.02000	0.01920	0.01850	0.01790	0.01739	0.01687	0.01751	0.01707	0.01663
1.6	2.46	0.03847	0.03670	0.03480	0.03339	0.03189	0.03074	0.02951	0.02755	0.02591	0.02454	0.02337	0.02234	0.02146	0.02068	0.02002	0.01945	0.01888	0.01958	0.01909	0.01861
1.7	2.61	0.04251	0.04057	0.03849	0.03695	0.03530	0.03403	0.03269	0.03053	0.02872	0.02722	0.02593	0.02479	0.02382	0.02296	0.02223	0.02160	0.02097	0.02175	0.02121	0.02068
1.8	2.76	0.04672	0.04461	0.04233	0.04065	0.03885	0.03747	0.03600	0.03364	0.03166	0.03001	0.02860	0.02736	0.02629	0.02535	0.02455	0.02386	0.02317	0.02402	0.02342	0.02284
1.9	2.92	0.05109	0.04880	0.04633	0.04450	0.04254	0.04104	0.03944	0.03687	0.03472	0.03292	0.03138	0.03003	0.02887	0.02783	0.02696	0.02621	0.02546	0.02639	0.02574	0.02510
2.0	3.07	0.05563	0.05315	0.05047	0.04850	0.04637	0.04475	0.04301	0.04023	0.03790	0.03595	0.03427	0.03280	0.03155	0.03042	0.02948	0.02866	0.02784	0.02885	0.02814	0.02745
2.1	3.23	0.06032	0.05765	0.05477	0.05263	0.05035	0.04859	0.04672	0.04371	0.04119	0.03908	0.03728	0.03569	0.03433	0.03311	0.03209	0.03120	0.03031	0.03141	0.03064	0.02989
2.2	3.38	0.06517	0.06230	0.05920	0.05691	0.05445	0.05257	0.05055	0.04732	0.04460	0.04234	0.04039	0.03867	0.03721	0.03590	0.03479	0.03384	0.03288	0.03406	0.03323	0.03242
2.3	3.53	0.07017	0.06710	0.06379	0.06133	0.05869	0.05667	0.05451	0.05104	0.04813	0.04570	0.04361	0.04176	0.04019	0.03878	0.03759	0.03657	0.03553	0.03680	0.03591	0.03505
2.4	3.69	0.07533	0.07205	0.06851	0.06589	0.06307	0.06091	0.05860	0.05489	0.05177	0.04917	0.04693	0.04496	0.04327	0.04176	0.04049	0.03939	0.03828	0.03964	0.03869	0.03776
2.5	3.84	0.08064	0.07714	0.07337	0.07058	0.06758	0.06527	0.06281	0.05886	0.05553	0.05275	0.05036	0.04825	0.04645	0.04484	0.04348	0.04230	0.04112	0.04257	0.04155	0.04056
2.6	3.99	0.08609	0.08238	0.07838	0.07541	0.07222	0.06977	0.06715	0.06294	0.05940	0.05644	0.05389	0.05165	0.04973	0.04801	0.04656	0.04530	0.04404	0.04559	0.04450	0.04344
2.7	4.15	0.09170	0.08776	0.08352	0.08037	0.07699	0.07439	0.07161	0.06714	0.06338	0.06023	0.05753	0.05514	0.05310	0.05127	0.04973	0.04839	0.04705	0.04870	0.04755	0.04641
2.8	4.30	0.09745	0.09329	0.08880	0.08546	0.08188	0.07913	0.07619	0.07145	0.06747	0.06413	0.06126	0.05873	0.05657	0.05463	0.05299	0.05157	0.05015	0.05190	0.05067	0.04947
2.9	4.45	0.10335	0.09896	0.09421	0.09069	0.08691	0.08400	0.08089	0.07588	0.07167	0.06814	0.06510	0.06243	0.06013	0.05808	0.05634	0.05484	0.05334	0.05519	0.05389	0.05262
3.0	4.61	0.10939	0.10476	0.09976	0.09605	0.09206	0.08899	0.08571	0.08042	0.07597	0.07225	0.06904	0.06621	0.06379	0.06162	0.05979	0.05820	0.05661	0.05857	0.05719	0.05585
3.1	4.76	0.11558	0.11071	0.10545	0.10154	0.09733	0.09410	0.09065	0.08508	0.08039	0.07646	0.07308	0.07010	0.06754	0.06525	0.06332	0.06165	0.05996	0.06203	0.06058	0.05916
3.2	4.91	0.12191	0.11679	0.11126	0.10715	0.10273	0.09934	0.09570	0.08985	0.08491	0.08078	0.07722	0.07408	0.07139	0.06898	0.06694	0.06518	0.06341	0.06558	0.06405	0.06256
3.3	5.07	0.12838	0.12301	0.11721	0.11290	0.10826	0.10469	0.10088	0.09473	0.08954	0.08520	0.08146	0.07816	0.07533	0.07279	0.07065	0.06880	0.06693	0.06922	0.06761	0.06604
3.4	5.22	0.13499	0.12936	0.12329	0.11877	0.11391	0.11017	0.10617	0.09972	0.09428	0.08972	0.08580	0.08233	0.07936	0.07670	0.07445	0.07250	0.07054	0.07295	0.07126	0.06960
3.5	5.38	0.14174	0.13585	0.12949	0.12476	0.11968	0.11576	0.11157	0.10481	0.09912	0.09434	0.09023	0.08660	0.08348	0.08069	0.07833	0.07629	0.07423	0.07676	0.07498	0.07325
3.6	5.53	0.14862	0.14247	0.13583	0.13088	0.12557	0.12147	0.11709	0.11002	0.10406	0.09907	0.09476	0.09096	0.08770	0.08477	0.08230	0.08016	0.07801	0.08065	0.07879	0.07698
3.7	5.68	0.15565	0.14923	0.14229	0.13713	0.13158	0.12730	0.12272	0.11534	0.10911	0.10389	0.09939	0.09541	0.09200	0.08894	0.08636	0.08412	0.08186	0.08463	0.08269	0.08079
3.8	5.84	0.16281	0.15612	0.14888	0.14350	0.13771	0.13325	0.12847	0.12076	0.11426	0.10881	0.10411	0.09996	0.09639	0.09320	0.09050	0.08816	0.08580	0.08869	0.08666	0.08468
3.9	5.99		0.16313	0.15560	0.14999	0.14395	0.13931	0.13433	0.12630	0.11952	0.11383	0.10893	0.10459	0.10088	0.09754	0.09472	0.09228	0.08982	0.09284	0.09072	0.08865

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor MLC — 40% Propylene Glycol — Feet of Head per Foot of Tubing

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Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	6.14			0.16244	0.15660	0.15032	0.14548	0.14030	0.13193	0.12487	0.11895	0.11384	0.10932	0.10545	0.10197	0.09903	0.09649	0.09393	0.09707	0.09486	0.09270
4.1	6.30			0.16941	0.16334	0.15681	0.15177	0.14638	0.13768	0.13033	0.12416	0.11884	0.11414	0.11011	0.10649	0.10343	0.10078	0.09811	0.10138	0.09908	0.09683
4.2	6.45					0.16341	0.15818	0.15257	0.14353	0.13589	0.12948	0.12394	0.11906	0.11486	0.11109	0.10791	0.10515	0.10237	0.10578	0.10338	0.10104
4.3	6.60						0.16470	0.15888	0.14948	0.14155	0.13489	0.12914	0.12406	0.11970	0.11578	0.11247	0.10960	0.10672	0.11026	0.10776	0.10533
4.4	6.76							0.16529	0.15554	0.14731	0.14039	0.13442	0.12915	0.12462	0.12055	0.11712	0.11414	0.11114	0.11482	0.11223	0.10970
4.5	6.91								0.16171	0.15317	0.14599	0.13980	0.13433	0.12963	0.12541	0.12184	0.11875	0.11564	0.11946	0.11677	0.11414
4.6	7.06								0.16797	0.15912	0.15169	0.14527	0.13960	0.13473	0.13035	0.12666	0.12345	0.12022	0.12418	0.12139	0.11867
4.7	7.22									0.16518	0.15748	0.15084	0.14496	0.13991	0.13538	0.13155	0.12823	0.12488	0.12898	0.12609	0.12327
4.8	7.37										0.16337	0.15649	0.15041	0.14518	0.14049	0.13652	0.13308	0.12962	0.13386	0.13087	0.12795
4.9	7.53										0.16935	0.16223	0.15594	0.15054	0.14568	0.14158	0.13802	0.13443	0.13883	0.13573	0.13270
5.0	7.68											0.16807	0.16157	0.15598	0.15096	0.14671	0.14303	0.13933	0.14387	0.14067	0.13754
5.1	7.83												0.16728	0.16150	0.15632	0.15193	0.14813	0.14430	0.14899	0.14568	0.14245
5.2	7.99													0.16711	0.16176	0.15723	0.15330	0.14934	0.15419	0.15078	0.14743
5.3	8.14														0.16728	0.16261	0.15855	0.15447	0.15947	0.15595	0.15250
5.4	8.29															0.16807	0.16388	0.15967	0.16483	0.16119	0.15764
5.5	8.45																0.16929	0.16495		0.16652	0.16285
5.6	8.60																				0.16814

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor MLC — 50% Propylene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
0.5	0.77	0.00697	0.00657	0.00613	0.00582	0.00548	0.00523	0.00496	0.00454	0.00419	0.00390	0.00366	0.00346	0.00328	0.00313	0.00299	0.00288	0.00277	0.00268	0.00260	0.00252
0.6	0.92	0.00927	0.00875	0.00819	0.00777	0.00734	0.00700	0.00665	0.00610	0.00565	0.00527	0.00495	0.00468	0.00445	0.00424	0.00407	0.00392	0.00377	0.00365	0.00354	0.00344
0.7	1.08	0.01182	0.01116	0.01046	0.00995	0.00940	0.00898	0.00854	0.00785	0.00728	0.00680	0.00640	0.00605	0.00576	0.00550	0.00528	0.00508	0.00490	0.00474	0.00461	0.00448
0.8	1.23	0.01460	0.01381	0.01296	0.01233	0.01166	0.01116	0.01062	0.00978	0.00907	0.00849	0.00800	0.00757	0.00721	0.00689	0.00662	0.00638	0.00616	0.00596	0.00579	0.00563
0.9	1.38	0.01761	0.01667	0.01566	0.01492	0.01412	0.01352	0.01288	0.01187	0.01103	0.01033	0.00974	0.00923	0.00880	0.00842	0.00808	0.00780	0.00753	0.00729	0.00709	0.00690
1.0	1.54	0.02084	0.01974	0.01856	0.01769	0.01677	0.01606	0.01531	0.01413	0.01314	0.01232	0.01163	0.01103	0.01052	0.01007	0.00967	0.00933	0.00902	0.00873	0.00850	0.00827
1.1	1.69	0.02428	0.02302	0.02166	0.02066	0.01960	0.01878	0.01792	0.01655	0.01541	0.01446	0.01365	0.01296	0.01236	0.01184	0.01138	0.01099	0.01062	0.01029	0.01002	0.00975
1.2	1.84	0.02793	0.02649	0.02496	0.02382	0.02260	0.02167	0.02069	0.01913	0.01782	0.01673	0.01581	0.01502	0.01433	0.01373	0.01321	0.01275	0.01233	0.01195	0.01164	0.01133
1.3	2.00	0.03179	0.03017	0.02844	0.02715	0.02578	0.02473	0.02362	0.02185	0.02038	0.01915	0.01810	0.01720	0.01643	0.01575	0.01515	0.01463	0.01415	0.01372	0.01336	0.01302
1.4	2.15	0.03584	0.03403	0.03210	0.03066	0.02913	0.02796	0.02671	0.02473	0.02308	0.02170	0.02053	0.01951	0.01864	0.01787	0.01721	0.01662	0.01608	0.01560	0.01519	0.01480
1.5	2.30	0.04008	0.03808	0.03594	0.03434	0.03264	0.03134	0.02996	0.02776	0.02592	0.02438	0.02308	0.02195	0.02097	0.02012	0.01937	0.01872	0.01812	0.01757	0.01712	0.01669
1.6	2.46	0.04451	0.04231	0.03995	0.03820	0.03632	0.03489	0.03336	0.03093	0.02890	0.02720	0.02575	0.02450	0.02342	0.02248	0.02165	0.02093	0.02025	0.01965	0.01915	0.01867
1.7	2.61	0.04914	0.04673	0.04414	0.04222	0.04016	0.03859	0.03691	0.03425	0.03201	0.03014	0.02855	0.02718	0.02599	0.02494	0.02403	0.02324	0.02249	0.02183	0.02128	0.02074
1.8	2.76	0.05394	0.05132	0.04850	0.04640	0.04416	0.04244	0.04061	0.03770	0.03526	0.03321	0.03147	0.02997	0.02867	0.02752	0.02652	0.02565	0.02484	0.02411	0.02350	0.02292
1.9	2.92	0.05893	0.05608	0.05303	0.05075	0.04831	0.04645	0.04446	0.04130	0.03864	0.03641	0.03451	0.03288	0.03146	0.03021	0.02912	0.02817	0.02728	0.02648	0.02582	0.02518
2.0	3.07	0.06410	0.06102	0.05772	0.05526	0.05262	0.05061	0.04845	0.04503	0.04215	0.03973	0.03768	0.03590	0.03436	0.03300	0.03182	0.03079	0.02982	0.02896	0.02824	0.02754
2.1	3.23	0.06944	0.06613	0.06257	0.05992	0.05708	0.05491	0.05259	0.04889	0.04578	0.04317	0.04095	0.03903	0.03737	0.03590	0.03462	0.03350	0.03246	0.03152	0.03074	0.02999
2.2	3.38	0.07496	0.07140	0.06759	0.06474	0.06170	0.05936	0.05687	0.05289	0.04955	0.04674	0.04435	0.04228	0.04049	0.03891	0.03753	0.03632	0.03519	0.03419	0.03334	0.03253
2.3	3.53	0.08064	0.07685	0.07276	0.06972	0.06646	0.06395	0.06128	0.05702	0.05344	0.05043	0.04786	0.04564	0.04371	0.04201	0.04053	0.03924	0.03802	0.03694	0.03604	0.03516
2.4	3.69	0.08650	0.08245	0.07809	0.07485	0.07136	0.06869	0.06584	0.06128	0.05745	0.05423	0.05148	0.04910	0.04704	0.04523	0.04364	0.04225	0.04095	0.03979	0.03882	0.03788
2.5	3.84	0.09253	0.08822	0.08358	0.08013	0.07641	0.07357	0.07053	0.06567	0.06159	0.05815	0.05522	0.05268	0.05048	0.04854	0.04684	0.04536	0.04397	0.04273	0.04169	0.04069
2.6	3.99	0.09872	0.09415	0.08923	0.08555	0.08161	0.07859	0.07535	0.07019	0.06584	0.06219	0.05907	0.05637	0.05402	0.05195	0.05015	0.04856	0.04708	0.04576	0.04466	0.04358
2.7	4.15	0.10508	0.10024	0.09502	0.09113	0.08695	0.08374	0.08031	0.07484	0.07022	0.06634	0.06303	0.06016	0.05767	0.05547	0.05355	0.05186	0.05029	0.04888	0.04771	0.04657
2.8	4.30	0.11160	0.10648	0.10097	0.09685	0.09243	0.08904	0.08541	0.07961	0.07472	0.07061	0.06710	0.06405	0.06141	0.05908	0.05704	0.05526	0.05359	0.05209	0.05085	0.04963
2.9	4.45	0.11828	0.11288	0.10706	0.10272	0.09805	0.09447	0.09063	0.08451	0.07934	0.07499	0.07128	0.06806	0.06526	0.06279	0.06064	0.05875	0.05698	0.05539	0.05407	0.05279
3.0	4.61	0.12512	0.11944	0.11331	0.10873	0.10381	0.10003	0.09599	0.08953	0.08408	0.07949	0.07557	0.07216	0.06921	0.06660	0.06432	0.06233	0.06046	0.05878	0.05739	0.05603
3.1	4.76	0.13213	0.12615	0.11970	0.11488	0.10971	0.10573	0.10148	0.09467	0.08893	0.08409	0.07996	0.07638	0.07326	0.07051	0.06811	0.06600	0.06403	0.06226	0.06079	0.05935
3.2	4.91	0.13928	0.13301	0.12624	0.12118	0.11574	0.11156	0.10709	0.09994	0.09390	0.08881	0.08447	0.08069	0.07741	0.07452	0.07198	0.06976	0.06768	0.06583	0.06427	0.06276
3.3	5.07	0.14660	0.14002	0.13292	0.12761	0.12191	0.11753	0.11283	0.10533	0.09898	0.09364	0.08907	0.08510	0.08166	0.07862	0.07595	0.07362	0.07143	0.06948	0.06784	0.06625
3.4	5.22	0.15407	0.14718	0.13974	0.13419	0.12821	0.12362	0.11870	0.11083	0.10418	0.09858	0.09379	0.08962	0.08601	0.08281	0.08002	0.07757	0.07527	0.07322	0.07150	0.06983
3.5	5.38	0.16169	0.15449	0.14671	0.14090	0.13465	0.12985	0.12470	0.11646	0.10949	0.10362	0.09860	0.09424	0.09045	0.08710	0.08417	0.08160	0.07919	0.07704	0.07524	0.07349
3.6	5.53	0.16947	0.16194	0.15382	0.14775	0.14122	0.13620	0.13082	0.12220	0.11492	0.10878	0.10353	0.09896	0.09499	0.09149	0.08842	0.08573	0.08320	0.08095	0.07906	0.07723
3.7	5.68		0.16955	0.16108	0.15474	0.14792	0.14268	0.13706	0.12807	0.12046	0.11404	0.10855	0.10378	0.09963	0.09596	0.09276	0.08994	0.08730	0.08494	0.08297	0.08105
3.8	5.84			0.16847	0.16186	0.15476	0.14929	0.14343	0.13405	0.12611	0.11941	0.11368	0.10870	0.10436	0.10054	0.09718	0.09424	0.09149	0.08902	0.08696	0.08495
3.9	5.99				0.16912	0.16172	0.15603	0.14992	0.14014	0.13187	0.12489	0.11891	0.11371	0.10919	0.10520	0.10170	0.09863	0.09576	0.09318	0.09103	0.08893

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Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

¾" Uponor MLC — 50% Propylene Glycol — Feet of Head per Foot of Tubing

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Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
4.0	6.14					0.16881	0.16289	0.15653	0.14635	0.13774	0.13047	0.12424	0.11883	0.11412	0.10996	0.10631	0.10311	0.10011	0.09743	0.09518	0.09300
4.1	6.30						0.16987	0.16327	0.15268	0.14372	0.13615	0.12968	0.12404	0.11914	0.11480	0.11101	0.10768	0.10455	0.10176	0.09942	0.09714
4.2	6.45								0.15912	0.14981	0.14194	0.13521	0.12935	0.12425	0.11974	0.11579	0.11233	0.10908	0.10617	0.10373	0.10137
4.3	6.60								0.16568	0.15601	0.14784	0.14084	0.13475	0.12946	0.12477	0.12067	0.11707	0.11369	0.11066	0.10813	0.10567
4.4	6.76									0.16231	0.15384	0.14658	0.14026	0.13476	0.12989	0.12563	0.12189	0.11838	0.11524	0.11261	0.11005
4.5	6.91									0.16873	0.15994	0.15241	0.14585	0.14015	0.13510	0.13068	0.12680	0.12316	0.11990	0.11717	0.11451
4.6	7.06										0.16614	0.15834	0.15155	0.14563	0.14040	0.13582	0.13180	0.12802	0.12464	0.12180	0.11905
4.7	7.22											0.16437	0.15733	0.15121	0.14579	0.14104	0.13687	0.13296	0.12946	0.12652	0.12367
4.8	7.37												0.16321	0.15688	0.15127	0.14635	0.14204	0.13798	0.13436	0.13132	0.12836
4.9	7.53												0.16919	0.16264	0.15683	0.15175	0.14728	0.14309	0.13934	0.13619	0.13314
5.0	7.68													0.16849	0.16249	0.15723	0.15262	0.14828	0.14440	0.14115	0.13798
5.1	7.83														0.16823	0.16280	0.15803	0.15355	0.14954	0.14618	0.14291
5.2	7.99															0.16845	0.16353	0.15890	0.15476	0.15129	0.14791
5.3	8.14																0.16911	0.16433	0.16006	0.15647	0.15299
5.4	8.29																	0.16984	0.16544	0.16174	0.15815
5.5	8.45																			0.16708	0.16338
5.6	8.60																				0.16868

Recommended Head Loss Design Range for Radiant Loops

For radiant loops, sizing in this region will lead to excessive head loss conditions.

1" Uponor MLC — 100% Water — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	3.78	1.47	1.39	1.31	1.29	1.26	1.24	1.22	1.18	1.14	1.11	1.09	1.06	1.04	1.02	1.00	0.98	0.97	0.95	0.94	0.92
1.6	4.03	1.64	1.56	1.47	1.44	1.41	1.39	1.36	1.32	1.28	1.25	1.22	1.19	1.16	1.14	1.12	1.10	1.08	1.07	1.05	1.04
1.7	4.28	1.82	1.73	1.63	1.60	1.57	1.54	1.51	1.47	1.42	1.39	1.35	1.32	1.29	1.27	1.25	1.22	1.21	1.19	1.17	1.15
1.8	4.53	2.01	1.91	1.80	1.77	1.73	1.70	1.67	1.62	1.57	1.53	1.50	1.46	1.43	1.40	1.38	1.36	1.33	1.31	1.30	1.28
1.9	4.78	2.20	2.10	1.98	1.94	1.91	1.87	1.84	1.78	1.73	1.69	1.65	1.61	1.58	1.54	1.52	1.49	1.47	1.45	1.43	1.41
2.0	5.03	2.41	2.29	2.17	2.13	2.08	2.05	2.01	1.95	1.89	1.84	1.80	1.76	1.72	1.69	1.66	1.63	1.61	1.58	1.56	1.54
2.1	5.29	2.62	2.50	2.36	2.31	2.27	2.23	2.19	2.12	2.06	2.01	1.96	1.92	1.88	1.84	1.81	1.78	1.75	1.73	1.70	1.68
2.2	5.54	2.84	2.71	2.56	2.51	2.46	2.42	2.38	2.30	2.24	2.18	2.13	2.08	2.04	2.00	1.97	1.93	1.90	1.88	1.85	1.83
2.3	5.79	3.07	2.92	2.76	2.71	2.66	2.62	2.57	2.49	2.42	2.36	2.30	2.25	2.21	2.17	2.13	2.09	2.06	2.03	2.00	1.98
2.4	6.04	3.30	3.15	2.98	2.92	2.87	2.82	2.77	2.68	2.61	2.54	2.48	2.43	2.38	2.34	2.30	2.26	2.22	2.19	2.16	2.13
2.5	6.29	3.54	3.38	3.20	3.14	3.08	3.03	2.98	2.88	2.81	2.73	2.67	2.61	2.56	2.51	2.47	2.43	2.39	2.36	2.32	2.29
2.6	6.55	3.79	3.62	3.42	3.36	3.30	3.24	3.19	3.09	3.01	2.93	2.86	2.80	2.74	2.69	2.65	2.60	2.56	2.53	2.49	2.46
2.7	6.80	4.05	3.87	3.66	3.59	3.52	3.47	3.41	3.30	3.21	3.13	3.06	2.99	2.93	2.88	2.83	2.78	2.74	2.70	2.67	2.63
2.8	7.05	4.31	4.12	3.90	3.83	3.76	3.69	3.63	3.52	3.43	3.34	3.26	3.19	3.13	3.07	3.02	2.97	2.93	2.88	2.85	2.81
2.9	7.30	4.59	4.38	4.15	4.07	3.99	3.93	3.86	3.75	3.65	3.55	3.47	3.40	3.33	3.27	3.21	3.16	3.11	3.07	3.03	2.99
3.0	7.55	4.87	4.65	4.40	4.32	4.24	4.17	4.10	3.98	3.87	3.77	3.69	3.61	3.54	3.47	3.41	3.36	3.31	3.26	3.22	3.18
3.1	7.80	5.15	4.92	4.66	4.58	4.49	4.42	4.34	4.21	4.10	4.00	3.91	3.83	3.75	3.68	3.62	3.56	3.51	3.46	3.41	3.37
3.2	8.06	5.44	5.20	4.93	4.84	4.75	4.67	4.59	4.46	4.34	4.23	4.13	4.05	3.97	3.90	3.83	3.77	3.71	3.66	3.61	3.57
3.3	8.31	5.74	5.49	5.20	5.11	5.01	4.93	4.85	4.71	4.58	4.47	4.37	4.27	4.19	4.12	4.05	3.98	3.92	3.87	3.82	3.77
3.4	8.56	6.05	5.78	5.48	5.38	5.28	5.20	5.11	4.96	4.83	4.71	4.60	4.51	4.42	4.34	4.27	4.20	4.14	4.08	4.03	3.98
3.5	8.81	6.37	6.09	5.77	5.67	5.56	5.47	5.38	5.22	5.08	4.96	4.85	4.75	4.65	4.57	4.49	4.42	4.36	4.30	4.24	4.19
3.6	9.06	6.69	6.39	6.06	5.95	5.84	5.75	5.65	5.49	5.34	5.21	5.10	4.99	4.89	4.81	4.73	4.65	4.58	4.52	4.46	4.41
3.7	9.31	7.01	6.71	6.36	6.25	6.13	6.04	5.94	5.76	5.61	5.47	5.35	5.24	5.14	5.05	4.96	4.89	4.81	4.75	4.69	4.63
3.8	9.57	7.35	7.03	6.66	6.55	6.43	6.33	6.22	6.04	5.88	5.74	5.61	5.49	5.39	5.29	5.21	5.12	5.05	4.98	4.92	4.86
3.9	9.82	7.69	7.36	6.98	6.86	6.73	6.62	6.51	6.33	6.16	6.01	5.88	5.75	5.65	5.55	5.45	5.37	5.29	5.22	5.15	5.09
4.0	10.07	8.04	7.69	7.29	7.17	7.04	6.93	6.81	6.62	6.44	6.29	6.15	6.02	5.91	5.80	5.71	5.62	5.53	5.46	5.39	5.32
4.1	10.32	8.39	8.03	7.62	7.49	7.35	7.24	7.12	6.91	6.73	6.57	6.42	6.29	6.17	6.06	5.96	5.87	5.78	5.71	5.63	5.57
4.2	10.57	8.76	8.38	7.95	7.81	7.67	7.55	7.43	7.21	7.03	6.86	6.71	6.57	6.44	6.33	6.23	6.13	6.04	5.96	5.88	5.81
4.3	10.82	9.12	8.73	8.29	8.14	7.99	7.87	7.74	7.52	7.32	7.15	6.99	6.85	6.72	6.60	6.49	6.39	6.30	6.22	6.14	6.06
4.4	11.08	9.50	9.09	8.63	8.48	8.33	8.20	8.06	7.83	7.63	7.45	7.28	7.14	7.00	6.88	6.77	6.66	6.57	6.48	6.40	6.32
4.5	11.33	9.88	9.46	8.98	8.82	8.66	8.53	8.39	8.15	7.94	7.75	7.58	7.43	7.29	7.16	7.04	6.94	6.84	6.74	6.66	6.58
4.6	11.58	10.27	9.83	9.33	9.17	9.01	8.87	8.72	8.48	8.26	8.06	7.89	7.73	7.58	7.45	7.33	7.22	7.11	7.02	6.93	6.85
4.7	11.83	10.66	10.21	9.69	9.53	9.36	9.21	9.06	8.81	8.58	8.38	8.19	8.03	7.88	7.74	7.61	7.50	7.39	7.29	7.20	7.12
4.8	12.08	11.07	10.60	10.06	9.89	9.71	9.56	9.41	9.14	8.91	8.70	8.51	8.34	8.18	8.04	7.91	7.79	7.68	7.57	7.48	7.39
4.9	12.33	11.47	10.99	10.43	10.26	10.07	9.92	9.76	9.48	9.24	9.02	8.83	8.65	8.49	8.34	8.21	8.08	7.97	7.86	7.76	7.67

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor MLC — 100% Water — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	12.59	11.89	11.38	10.81	10.63	10.44	10.28	10.12	9.83	9.58	9.35	9.15	8.97	8.80	8.65	8.51	8.38	8.26	8.15	8.05	7.95
5.1	12.84	12.31	11.79	11.20	11.01	10.81	10.65	10.48	10.18	9.92	9.69	9.48	9.29	9.12	8.96	8.82	8.68	8.56	8.45	8.34	8.24
5.2	13.09	12.74	12.20	11.59	11.39	11.19	11.02	10.84	10.54	10.27	10.03	9.81	9.62	9.44	9.28	9.13	8.99	8.86	8.75	8.64	8.54
5.3	13.34	13.17	12.62	11.99	11.78	11.57	11.40	11.22	10.90	10.63	10.38	10.15	9.95	9.77	9.60	9.45	9.31	9.17	9.05	8.94	8.84
5.4	13.59	13.61	13.04	12.39	12.18	11.96	11.78	11.60	11.27	10.99	10.73	10.50	10.29	10.10	9.93	9.77	9.62	9.49	9.36	9.25	9.14
5.5	13.85	14.06	13.47	12.80	12.58	12.36	12.17	11.98	11.65	11.35	11.09	10.85	10.63	10.44	10.26	10.10	9.95	9.80	9.68	9.56	9.45
5.6	14.10	14.51	13.90	13.21	12.99	12.76	12.57	12.37	12.03	11.72	11.45	11.20	10.98	10.78	10.60	10.43	10.27	10.13	10.00	9.87	9.76
5.7	14.35	14.97	14.34	13.63	13.41	13.17	12.97	12.77	12.41	12.10	11.82	11.56	11.34	11.13	10.94	10.76	10.61	10.45	10.32	10.19	10.07
5.8	14.60	15.43	14.79	14.06	13.83	13.58	13.38	13.17	12.80	12.48	12.19	11.93	11.69	11.48	11.29	11.11	10.94	10.79	10.65	10.52	10.40
5.9	14.85	15.91	15.24	14.49	14.25	14.00	13.79	13.57	13.20	12.87	12.57	12.30	12.06	11.84	11.64	11.45	11.28	11.12	10.98	10.85	10.72
6.0	15.10	16.38	15.70	14.93	14.68	14.42	14.21	13.98	13.60	13.26	12.95	12.68	12.43	12.20	11.99	11.80	11.63	11.47	11.32	11.18	11.05
6.1	15.36	16.87	16.17	15.37	15.12	14.85	14.63	14.40	14.01	13.65	13.34	13.06	12.80	12.57	12.36	12.16	11.98	11.81	11.66	11.52	11.39
6.2	15.61	17.36	16.64	15.82	15.56	15.29	15.06	14.82	14.42	14.06	13.73	13.44	13.18	12.94	12.72	12.52	12.34	12.16	12.01	11.86	11.73
6.3	15.86	17.85	17.12	16.28	16.01	15.73	15.50	15.25	14.83	14.46	14.13	13.83	13.56	13.32	13.09	12.89	12.70	12.52	12.36	12.21	12.07
6.4	16.11	18.36	17.60	16.74	16.46	16.17	15.94	15.69	15.26	14.88	14.53	14.23	13.95	13.70	13.47	13.26	13.06	12.88	12.72	12.56	12.42
6.5	16.36	18.86	18.09	17.20	16.92	16.63	16.38	16.13	15.68	15.29	14.94	14.63	14.34	14.09	13.85	13.63	13.43	13.25	13.08	12.92	12.77
6.6	16.61	19.38	18.58	17.68	17.39	17.08	16.83	16.57	16.12	15.72	15.36	15.04	14.74	14.48	14.24	14.01	13.81	13.62	13.44	13.28	13.13
6.7	16.87	19.90	19.08	18.15	17.86	17.55	17.29	17.02	16.56	16.15	15.78	15.45	15.15	14.87	14.63	14.40	14.19	13.99	13.81	13.65	13.49
6.8	17.12	20.43	19.59	18.64	18.33	18.02	17.75	17.48	17.00	16.58	16.20	15.86	15.55	15.28	15.02	14.79	14.57	14.37	14.19	14.02	13.86
6.9	17.37	20.96	20.10	19.13	18.82	18.49	18.22	17.94	17.45	17.02	16.63	16.28	15.97	15.68	15.42	15.18	14.96	14.75	14.57	14.39	14.23
7.0	17.62	21.50	20.62	19.62	19.30	18.97	18.69	18.40	17.90	17.46	17.06	16.71	16.39	16.09	15.83	15.58	15.35	15.14	14.95	14.77	14.60
7.1	17.87	22.05	21.15	20.12	19.80	19.45	19.17	18.87	18.36	17.91	17.50	17.14	16.81	16.51	16.23	15.98	15.75	15.53	15.34	15.15	14.98
7.2	18.12	22.60	21.68	20.63	20.29	19.94	19.65	19.35	18.83	18.36	17.95	17.57	17.24	16.93	16.65	16.39	16.15	15.93	15.73	15.54	15.37
7.3	18.38	23.15	22.21	21.14	20.80	20.44	20.14	19.83	19.30	18.82	18.40	18.02	17.67	17.35	17.07	16.80	16.56	16.33	16.13	15.94	15.76
7.4	18.63	23.72	22.75	21.66	21.31	20.94	20.64	20.32	19.77	19.29	18.85	18.46	18.11	17.78	17.49	17.22	16.97	16.74	16.53	16.33	16.15
7.5	18.88	24.29	23.30	22.18	21.82	21.45	21.14	20.81	20.25	19.76	19.31	18.91	18.55	18.22	17.92	17.64	17.39	17.15	16.93	16.73	16.55
7.6	19.13	24.86	23.86	22.71	22.34	21.96	21.64	21.31	20.74	20.23	19.77	19.37	18.99	18.66	18.35	18.07	17.81	17.56	17.34	17.14	16.95
7.7	19.38	25.44	24.41	23.24	22.87	22.48	22.15	21.81	21.23	20.71	20.24	19.83	19.45	19.10	18.79	18.50	18.23	17.98	17.76	17.55	17.35
7.8	19.64	26.03	24.98	23.78	23.40	23.00	22.67	22.32	21.72	21.19	20.72	20.29	19.90	19.55	19.23	18.93	18.66	18.41	18.18	17.96	17.76
7.9	19.89	26.62	25.55	24.33	23.94	23.53	23.19	22.83	22.22	21.68	21.20	20.76	20.36	20.00	19.68	19.37	19.10	18.84	18.60	18.38	18.18
8.0	20.14	27.22	26.13	24.88	24.48	24.06	23.72	23.35	22.73	22.18	21.68	21.23	20.83	20.46	20.13	19.82	19.54	19.27	19.03	18.81	18.60

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor MLC — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	3.78	2.38	2.29	2.20	2.12	2.04	1.98	1.91	1.80	1.71	1.63	1.56	1.50	1.45	1.40	1.36	1.33	1.29	1.26	1.24	1.21
1.6	4.03	2.65	2.55	2.45	2.36	2.28	2.21	2.13	2.01	1.91	1.82	1.74	1.68	1.62	1.57	1.52	1.48	1.45	1.41	1.38	1.36
1.7	4.28	2.93	2.82	2.71	2.62	2.52	2.44	2.36	2.23	2.12	2.02	1.94	1.86	1.80	1.74	1.69	1.65	1.61	1.57	1.54	1.51
1.8	4.53	3.23	3.11	2.98	2.88	2.78	2.69	2.60	2.46	2.33	2.23	2.14	2.06	1.99	1.92	1.87	1.82	1.77	1.74	1.70	1.67
1.9	4.78	3.53	3.40	3.26	3.16	3.04	2.95	2.85	2.70	2.56	2.44	2.34	2.26	2.18	2.11	2.05	2.00	1.95	1.91	1.87	1.84
2.0	5.03	3.85	3.71	3.56	3.44	3.32	3.22	3.11	2.94	2.80	2.67	2.56	2.47	2.38	2.31	2.25	2.19	2.13	2.09	2.04	2.01
2.1	5.29	4.18	4.03	3.86	3.74	3.61	3.50	3.38	3.20	3.04	2.90	2.79	2.68	2.59	2.51	2.45	2.38	2.32	2.27	2.22	2.19
2.2	5.54	4.52	4.35	4.18	4.04	3.90	3.79	3.66	3.46	3.29	3.15	3.02	2.91	2.81	2.72	2.65	2.58	2.52	2.47	2.41	2.37
2.3	5.79	4.87	4.69	4.50	4.36	4.21	4.08	3.95	3.74	3.55	3.40	3.26	3.14	3.04	2.94	2.87	2.79	2.72	2.67	2.61	2.57
2.4	6.04	5.23	5.04	4.84	4.69	4.52	4.39	4.25	4.02	3.82	3.66	3.51	3.38	3.27	3.17	3.09	3.01	2.93	2.87	2.81	2.77
2.5	6.29	5.60	5.40	5.19	5.02	4.85	4.71	4.56	4.31	4.10	3.92	3.77	3.63	3.51	3.40	3.32	3.23	3.15	3.09	3.02	2.97
2.6	6.55	5.98	5.77	5.54	5.37	5.18	5.03	4.87	4.61	4.39	4.20	4.03	3.89	3.76	3.64	3.55	3.46	3.38	3.31	3.24	3.18
2.7	6.80	6.37	6.15	5.91	5.72	5.53	5.37	5.20	4.92	4.68	4.48	4.30	4.15	4.02	3.89	3.79	3.70	3.61	3.53	3.46	3.40
2.8	7.05	6.78	6.54	6.29	6.09	5.88	5.71	5.53	5.24	4.99	4.77	4.58	4.42	4.28	4.15	4.04	3.94	3.84	3.77	3.69	3.63
2.9	7.30	7.19	6.94	6.67	6.46	6.24	6.06	5.87	5.57	5.30	5.07	4.87	4.70	4.55	4.41	4.30	4.19	4.09	4.01	3.92	3.86
3.0	7.55	7.62	7.35	7.07	6.85	6.62	6.43	6.23	5.90	5.62	5.38	5.17	4.99	4.83	4.68	4.56	4.45	4.34	4.25	4.16	4.10
3.1	7.80	8.05	7.77	7.47	7.24	7.00	6.80	6.59	6.24	5.95	5.69	5.47	5.28	5.11	4.96	4.83	4.71	4.60	4.50	4.41	4.34
3.2	8.06	8.49	8.20	7.89	7.65	7.39	7.18	6.96	6.59	6.28	6.02	5.78	5.58	5.40	5.24	5.11	4.98	4.86	4.76	4.66	4.59
3.3	8.31	8.95	8.64	8.31	8.06	7.79	7.57	7.33	6.95	6.63	6.35	6.10	5.89	5.70	5.53	5.39	5.26	5.13	5.03	4.93	4.85
3.4	8.56	9.41	9.09	8.75	8.48	8.20	7.97	7.72	7.32	6.98	6.68	6.43	6.20	6.01	5.83	5.68	5.54	5.41	5.30	5.19	5.11
3.5	8.81	9.89	9.55	9.19	8.91	8.61	8.37	8.12	7.70	7.34	7.03	6.76	6.53	6.32	6.13	5.98	5.83	5.69	5.58	5.46	5.38
3.6	9.06	10.37	10.02	9.64	9.35	9.04	8.79	8.52	8.08	7.71	7.38	7.10	6.86	6.64	6.44	6.28	6.13	5.98	5.86	5.74	5.65
3.7	9.31	10.87	10.50	10.10	9.80	9.47	9.21	8.93	8.47	8.08	7.74	7.45	7.19	6.96	6.76	6.59	6.43	6.28	6.15	6.03	5.94
3.8	9.57	11.37	10.99	10.58	10.26	9.92	9.64	9.35	8.87	8.46	8.11	7.80	7.54	7.30	7.08	6.91	6.74	6.58	6.45	6.32	6.22
3.9	9.82	11.88	11.48	11.06	10.72	10.37	10.08	9.78	9.28	8.85	8.49	8.16	7.89	7.64	7.41	7.23	7.05	6.89	6.75	6.62	6.52
4.0	10.07	12.41	11.99	11.55	11.20	10.83	10.53	10.22	9.70	9.25	8.87	8.53	8.24	7.98	7.75	7.56	7.38	7.20	7.06	6.92	6.81
4.1	10.32	12.94	12.51	12.04	11.69	11.30	10.99	10.66	10.12	9.66	9.26	8.91	8.61	8.34	8.09	7.90	7.70	7.53	7.38	7.23	7.12
4.2	10.57	13.48	13.03	12.55	12.18	11.78	11.46	11.11	10.55	10.07	9.66	9.29	8.98	8.70	8.44	8.24	8.04	7.85	7.70	7.55	7.43
4.3	10.82	14.04	13.57	13.07	12.68	12.27	11.93	11.57	10.99	10.49	10.06	9.68	9.36	9.07	8.80	8.59	8.38	8.19	8.03	7.87	7.75
4.4	11.08	14.60	14.11	13.59	13.19	12.76	12.41	12.04	11.44	10.92	10.47	10.08	9.74	9.44	9.16	8.94	8.73	8.53	8.36	8.19	8.07
4.5	11.33	15.17	14.67	14.13	13.71	13.27	12.91	12.52	11.90	11.36	10.89	10.48	10.13	9.82	9.53	9.31	9.08	8.87	8.70	8.53	8.40
4.6	11.58	15.75	15.23	14.67	14.24	13.78	13.40	13.01	12.36	11.80	11.32	10.89	10.53	10.21	9.91	9.67	9.44	9.22	9.04	8.87	8.73
4.7	11.83	16.34	15.80	15.22	14.78	14.30	13.91	13.50	12.83	12.25	11.75	11.31	10.94	10.60	10.29	10.05	9.81	9.58	9.40	9.21	9.07
4.8	12.08	16.93	16.38	15.78	15.32	14.83	14.43	14.00	13.31	12.71	12.19	11.74	11.35	11.00	10.68	10.43	10.18	9.95	9.75	9.56	9.42
4.9	12.33	17.54	16.97	16.35	15.87	15.36	14.95	14.51	13.79	13.17	12.64	12.17	11.77	11.41	11.08	10.81	10.56	10.32	10.12	9.92	9.77

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor MLC — 30% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	12.59	18.16	17.57	16.93	16.44	15.91	15.48	15.03	14.29	13.64	13.09	12.61	12.19	11.82	11.48	11.21	10.94	10.69	10.49	10.28	10.13
5.1	12.84	18.78	18.17	17.52	17.01	16.46	16.02	15.55	14.79	14.12	13.55	13.05	12.62	12.24	11.89	11.61	11.33	11.07	10.86	10.65	10.49
5.2	13.09	19.42	18.79	18.11	17.59	17.03	16.57	16.08	15.29	14.61	14.02	13.51	13.06	12.66	12.30	12.01	11.73	11.46	11.24	11.02	10.86
5.3	13.34	20.06	19.41	18.71	18.17	17.60	17.13	16.63	15.81	15.11	14.50	13.96	13.51	13.10	12.72	12.42	12.13	11.86	11.63	11.40	11.23
5.4	13.59	20.72	20.05	19.33	18.77	18.17	17.69	17.17	16.33	15.61	14.98	14.43	13.96	13.54	13.15	12.84	12.54	12.26	12.02	11.79	11.61
5.5	13.85	21.38	20.69	19.95	19.37	18.76	18.26	17.73	16.86	16.12	15.47	14.90	14.42	13.98	13.58	13.26	12.95	12.66	12.42	12.18	12.00
5.6	14.10	22.05	21.34	20.58	19.98	19.35	18.84	18.29	17.40	16.63	15.97	15.38	14.88	14.43	14.02	13.69	13.37	13.07	12.82	12.57	12.39
5.7	14.35	22.73	22.00	21.21	20.60	19.95	19.43	18.86	17.95	17.15	16.47	15.87	15.35	14.89	14.47	14.13	13.80	13.49	13.23	12.98	12.79
5.8	14.60	23.42	22.66	21.86	21.23	20.56	20.02	19.44	18.50	17.68	16.98	16.36	15.83	15.35	14.92	14.57	14.23	13.91	13.65	13.39	13.19
5.9	14.85	24.11	23.34	22.51	21.87	21.18	20.62	20.03	19.06	18.22	17.49	16.86	16.31	15.82	15.38	15.02	14.67	14.34	14.07	13.80	13.60
6.0	15.10	24.82	24.03	23.17	22.51	21.81	21.23	20.62	19.63	18.76	18.02	17.36	16.80	16.30	15.84	15.47	15.11	14.78	14.50	14.22	14.01
6.1	15.36	25.54	24.72	23.85	23.17	22.44	21.85	21.22	20.20	19.31	18.55	17.88	17.30	16.78	16.31	15.93	15.56	15.22	14.93	14.64	14.43
6.2	15.61	26.26	25.42	24.52	23.83	23.08	22.48	21.83	20.78	19.87	19.09	18.40	17.80	17.27	16.79	16.40	16.02	15.66	15.37	15.07	14.85
6.3	15.86	26.99	26.13	25.21	24.50	23.73	23.11	22.45	21.37	20.44	19.63	18.92	18.31	17.77	17.27	16.87	16.48	16.11	15.81	15.51	15.28
6.4	16.11	27.73	26.85	25.91	25.17	24.39	23.75	23.07	21.97	21.01	20.18	19.45	18.83	18.27	17.76	17.35	16.95	16.57	16.26	15.95	15.72
6.5	16.36	28.48	27.58	26.61	25.86	25.06	24.40	23.71	22.57	21.59	20.74	19.99	19.35	18.78	18.25	17.83	17.42	17.04	16.72	16.40	16.16
6.6	16.61	29.24	28.31	27.32	26.55	25.73	25.06	24.34	23.18	22.17	21.30	20.54	19.88	19.29	18.75	18.32	17.90	17.50	17.18	16.85	16.61
6.7	16.87	30.00	29.06	28.04	27.25	26.41	25.72	24.99	23.80	22.76	21.87	21.09	20.41	19.81	19.26	18.82	18.38	17.98	17.64	17.31	17.06
6.8	17.12	30.78	29.81	28.77	27.96	27.10	26.39	25.64	24.42	23.36	22.45	21.64	20.96	20.34	19.77	19.32	18.87	18.46	18.12	17.77	17.51
6.9	17.37	31.56	30.57	29.50	28.68	27.79	27.07	26.30	25.05	23.97	23.03	22.21	21.50	20.87	20.29	19.83	19.37	18.95	18.59	18.24	17.98
7.0	17.62	32.36	31.34	30.25	29.40	28.50	27.76	26.97	25.69	24.58	23.62	22.78	22.06	21.41	20.81	20.34	19.87	19.44	19.08	18.72	18.45
7.1	17.87	33.16	32.12	31.00	30.13	29.21	28.45	27.65	26.34	25.20	24.22	23.36	22.62	21.95	21.34	20.86	20.38	19.93	19.56	19.20	18.92
7.2	18.12	33.96	32.90	31.76	30.87	29.93	29.15	28.33	26.99	25.83	24.82	23.94	23.18	22.50	21.88	21.38	20.89	20.44	20.06	19.68	19.40
7.3	18.38	34.78	33.69	32.53	31.62	30.65	29.86	29.02	27.65	26.46	25.43	24.53	23.75	23.06	22.42	21.91	21.41	20.95	20.56	20.17	19.88
7.4	18.63	35.61	34.50	33.30	32.38	31.39	30.58	29.72	28.31	27.10	26.05	25.12	24.33	23.62	22.97	22.45	21.94	21.46	21.06	20.67	20.37
7.5	18.88	36.44	35.31	34.09	33.14	32.13	31.30	30.42	28.99	27.75	26.67	25.73	24.92	24.19	23.52	22.99	22.47	21.98	21.57	21.17	20.87
7.6	19.13	37.28	36.12	34.88	33.91	32.88	32.03	31.14	29.67	28.40	27.30	26.34	25.51	24.76	24.08	23.54	23.00	22.50	22.09	21.68	21.37
7.7	19.38	38.13	36.95	35.68	34.69	33.63	32.77	31.85	30.35	29.06	27.94	26.95	26.10	25.34	24.65	24.09	23.54	23.04	22.61	22.19	21.87
7.8	19.64	38.99	37.78	36.48	35.47	34.40	33.52	32.58	31.05	29.72	28.58	27.57	26.71	25.93	25.22	24.65	24.09	23.57	23.14	22.71	22.38
7.9	19.89	39.86	38.62	37.30	36.27	35.17	34.27	33.31	31.75	30.40	29.23	28.20	27.31	26.52	25.80	25.22	24.64	24.11	23.67	23.23	22.90
8.0	20.14	40.73	39.47	38.12	37.07	35.95	35.03	34.05	32.46	31.08	29.88	28.83	27.93	27.12	26.38	25.79	25.20	24.66	24.21	23.76	23.42

Recommended Head Loss Design Range for Distribution Piping

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1" Uponor MLC — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	3.78	2.37	2.27	2.16	2.07	1.98	1.91	1.84	1.72	1.63	1.54	1.47	1.41	1.36	1.31	1.27	1.24	1.20	1.18	1.15	1.13
1.6	4.03	2.64	2.53	2.40	2.31	2.21	2.13	2.05	1.92	1.82	1.72	1.65	1.58	1.52	1.47	1.42	1.38	1.34	1.32	1.28	1.26
1.7	4.28	2.92	2.79	2.66	2.56	2.45	2.37	2.28	2.13	2.01	1.91	1.83	1.75	1.69	1.63	1.58	1.54	1.50	1.46	1.43	1.40
1.8	4.53	3.21	3.07	2.92	2.81	2.70	2.61	2.51	2.35	2.22	2.11	2.02	1.93	1.86	1.80	1.74	1.70	1.65	1.62	1.58	1.55
1.9	4.78	3.51	3.36	3.20	3.08	2.95	2.86	2.75	2.58	2.44	2.32	2.21	2.12	2.04	1.98	1.92	1.87	1.82	1.78	1.74	1.71
2.0	5.03	3.83	3.67	3.49	3.36	3.22	3.11	3.00	2.82	2.66	2.53	2.42	2.32	2.24	2.16	2.10	2.04	1.99	1.95	1.90	1.87
2.1	5.29	4.15	3.98	3.79	3.65	3.50	3.38	3.26	3.06	2.89	2.75	2.63	2.52	2.43	2.35	2.28	2.22	2.16	2.12	2.07	2.03
2.2	5.54	4.49	4.30	4.10	3.95	3.79	3.66	3.53	3.31	3.13	2.98	2.85	2.74	2.64	2.55	2.48	2.41	2.35	2.30	2.25	2.21
2.3	5.79	4.84	4.64	4.42	4.26	4.08	3.95	3.81	3.58	3.38	3.22	3.08	2.96	2.85	2.76	2.68	2.61	2.54	2.49	2.43	2.39
2.4	6.04	5.19	4.98	4.75	4.58	4.39	4.25	4.09	3.85	3.64	3.47	3.32	3.18	3.07	2.97	2.88	2.81	2.74	2.68	2.62	2.57
2.5	6.29	5.56	5.33	5.09	4.90	4.70	4.55	4.39	4.13	3.91	3.72	3.56	3.42	3.30	3.19	3.10	3.02	2.94	2.88	2.81	2.77
2.6	6.55	5.94	5.70	5.44	5.24	5.03	4.87	4.69	4.42	4.18	3.98	3.81	3.66	3.53	3.41	3.32	3.23	3.15	3.09	3.02	2.96
2.7	6.80	6.33	6.07	5.80	5.59	5.36	5.19	5.01	4.71	4.46	4.25	4.07	3.91	3.77	3.65	3.54	3.45	3.36	3.30	3.22	3.17
2.8	7.05	6.73	6.46	6.16	5.94	5.71	5.53	5.33	5.02	4.75	4.53	4.33	4.16	4.02	3.89	3.78	3.68	3.59	3.52	3.44	3.38
2.9	7.30	7.14	6.85	6.54	6.31	6.06	5.87	5.66	5.33	5.05	4.81	4.61	4.43	4.27	4.13	4.02	3.92	3.82	3.74	3.66	3.59
3.0	7.55	7.56	7.26	6.93	6.68	6.42	6.22	6.00	5.65	5.35	5.10	4.89	4.70	4.53	4.39	4.26	4.16	4.05	3.97	3.88	3.82
3.1	7.80	7.99	7.67	7.33	7.07	6.79	6.58	6.35	5.98	5.66	5.40	5.17	4.97	4.80	4.65	4.52	4.40	4.29	4.21	4.11	4.04
3.2	8.06	8.43	8.10	7.73	7.46	7.17	6.94	6.70	6.31	5.98	5.71	5.47	5.26	5.08	4.91	4.78	4.66	4.54	4.45	4.35	4.28
3.3	8.31	8.88	8.53	8.15	7.86	7.56	7.32	7.07	6.66	6.31	6.02	5.77	5.55	5.36	5.19	5.04	4.92	4.79	4.70	4.59	4.52
3.4	8.56	9.34	8.97	8.57	8.28	7.95	7.71	7.44	7.01	6.65	6.34	6.08	5.84	5.64	5.47	5.31	5.18	5.05	4.95	4.84	4.76
3.5	8.81	9.81	9.43	9.01	8.70	8.36	8.10	7.82	7.37	6.99	6.67	6.39	6.15	5.94	5.75	5.59	5.45	5.32	5.21	5.10	5.01
3.6	9.06	10.29	9.89	9.45	9.12	8.77	8.50	8.21	7.74	7.34	7.01	6.72	6.46	6.24	6.04	5.88	5.73	5.59	5.48	5.36	5.27
3.7	9.31	10.78	10.36	9.90	9.56	9.19	8.91	8.61	8.12	7.70	7.35	7.05	6.78	6.55	6.34	6.17	6.02	5.87	5.75	5.63	5.53
3.8	9.57	11.28	10.84	10.36	10.01	9.62	9.33	9.01	8.50	8.06	7.70	7.38	7.10	6.86	6.65	6.46	6.31	6.15	6.03	5.90	5.80
3.9	9.82	11.79	11.33	10.83	10.46	10.06	9.76	9.42	8.89	8.44	8.06	7.73	7.43	7.18	6.96	6.77	6.60	6.44	6.32	6.18	6.08
4.0	10.07	12.30	11.83	11.31	10.93	10.51	10.19	9.85	9.29	8.82	8.42	8.07	7.77	7.51	7.27	7.08	6.90	6.73	6.60	6.46	6.36
4.1	10.32	12.83	12.34	11.80	11.40	10.97	10.63	10.27	9.69	9.20	8.79	8.43	8.11	7.84	7.60	7.39	7.21	7.03	6.90	6.75	6.64
4.2	10.57	13.37	12.86	12.30	11.88	11.43	11.08	10.71	10.11	9.60	9.17	8.79	8.46	8.18	7.93	7.71	7.53	7.34	7.20	7.05	6.93
4.3	10.82	13.91	13.38	12.80	12.37	11.90	11.54	11.16	10.53	10.00	9.55	9.16	8.82	8.53	8.26	8.04	7.85	7.65	7.51	7.35	7.23
4.4	11.08	14.47	13.92	13.32	12.87	12.38	12.01	11.61	10.96	10.41	9.94	9.54	9.18	8.88	8.61	8.37	8.17	7.97	7.82	7.65	7.53
4.5	11.33	15.03	14.46	13.84	13.37	12.87	12.48	12.07	11.39	10.82	10.34	9.92	9.55	9.24	8.95	8.71	8.50	8.30	8.14	7.96	7.84
4.6	11.58	15.61	15.02	14.37	13.89	13.37	12.97	12.54	11.84	11.25	10.75	10.31	9.93	9.60	9.31	9.06	8.84	8.62	8.46	8.28	8.15
4.7	11.83	16.19	15.58	14.91	14.41	13.87	13.46	13.01	12.29	11.68	11.16	10.71	10.31	9.97	9.67	9.41	9.18	8.96	8.79	8.60	8.47
4.8	12.08	16.78	16.15	15.46	14.94	14.39	13.96	13.49	12.75	12.11	11.58	11.11	10.70	10.35	10.03	9.77	9.53	9.30	9.13	8.93	8.79
4.9	12.33	17.38	16.73	16.02	15.48	14.91	14.46	13.99	13.21	12.56	12.00	11.52	11.10	10.73	10.41	10.13	9.89	9.65	9.47	9.27	9.12

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1" Uponor MLC — 40% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	12.59	17.99	17.32	16.58	16.03	15.44	14.98	14.48	13.69	13.01	12.44	11.94	11.50	11.12	10.78	10.50	10.25	10.00	9.81	9.61	9.45
5.1	12.84	18.61	17.91	17.16	16.59	15.97	15.50	14.99	14.17	13.46	12.87	12.36	11.91	11.52	11.17	10.87	10.62	10.36	10.17	9.95	9.79
5.2	13.09	19.24	18.52	17.74	17.15	16.52	16.03	15.50	14.65	13.93	13.32	12.79	12.32	11.92	11.56	11.25	10.99	10.72	10.52	10.30	10.14
5.3	13.34	19.88	19.14	18.33	17.72	17.07	16.57	16.02	15.15	14.40	13.77	13.23	12.74	12.33	11.95	11.64	11.37	11.09	10.89	10.66	10.49
5.4	13.59	20.52	19.76	18.93	18.30	17.63	17.11	16.55	15.65	14.88	14.23	13.67	13.17	12.74	12.36	12.03	11.75	11.47	11.25	11.02	10.84
5.5	13.85	21.18	20.39	19.53	18.89	18.20	17.66	17.09	16.16	15.36	14.70	14.12	13.60	13.16	12.76	12.43	12.14	11.85	11.63	11.38	11.20
5.6	14.10	21.84	21.03	20.15	19.49	18.77	18.22	17.63	16.67	15.86	15.17	14.57	14.04	13.59	13.18	12.83	12.53	12.23	12.01	11.75	11.57
5.7	14.35	22.51	21.68	20.77	20.09	19.36	18.79	18.18	17.19	16.36	15.65	15.03	14.49	14.02	13.60	13.24	12.93	12.62	12.39	12.13	11.94
5.8	14.60	23.19	22.34	21.40	20.71	19.95	19.37	18.74	17.72	16.86	16.13	15.50	14.94	14.46	14.02	13.66	13.34	13.02	12.78	12.51	12.32
5.9	14.85	23.88	23.00	22.04	21.33	20.55	19.95	19.31	18.26	17.37	16.62	15.97	15.39	14.90	14.45	14.08	13.75	13.42	13.18	12.90	12.70
6.0	15.10	24.58	23.68	22.69	21.95	21.16	20.54	19.88	18.80	17.89	17.12	16.45	15.86	15.35	14.89	14.50	14.17	13.83	13.58	13.29	13.09
6.1	15.36	25.28	24.36	23.35	22.59	21.77	21.14	20.46	19.35	18.42	17.63	16.94	16.33	15.80	15.33	14.93	14.59	14.24	13.98	13.69	13.48
6.2	15.61	26.00	25.05	24.01	23.23	22.39	21.74	21.05	19.91	18.95	18.14	17.43	16.80	16.27	15.78	15.37	15.02	14.66	14.39	14.09	13.88
6.3	15.86	26.72	25.75	24.68	23.89	23.02	22.36	21.64	20.48	19.49	18.65	17.93	17.28	16.73	16.24	15.81	15.45	15.08	14.81	14.50	14.28
6.4	16.11	27.45	26.45	25.36	24.55	23.66	22.98	22.24	21.05	20.03	19.18	18.43	17.77	17.21	16.70	16.26	15.89	15.51	15.23	14.92	14.69
6.5	16.36	28.19	27.17	26.05	25.21	24.30	23.60	22.85	21.63	20.59	19.71	18.94	18.27	17.68	17.16	16.72	16.33	15.95	15.66	15.34	15.10
6.6	16.61	28.94	27.89	26.75	25.89	24.96	24.24	23.47	22.21	21.14	20.24	19.46	18.76	18.17	17.63	17.18	16.78	16.39	16.09	15.76	15.52
6.7	16.87	29.70	28.62	27.45	26.57	25.62	24.88	24.09	22.80	21.71	20.79	19.98	19.27	18.66	18.11	17.64	17.24	16.83	16.53	16.19	15.94
6.8	17.12	30.47	29.36	28.16	27.26	26.28	25.53	24.72	23.40	22.28	21.33	20.51	19.78	19.16	18.59	18.11	17.70	17.28	16.97	16.62	16.37
6.9	17.37	31.24	30.11	28.88	27.96	26.96	26.19	25.36	24.01	22.86	21.89	21.05	20.30	19.66	19.08	18.59	18.17	17.74	17.42	17.06	16.80
7.0	17.62	32.02	30.87	29.61	28.66	27.64	26.85	26.00	24.62	23.44	22.45	21.59	20.82	20.16	19.57	19.07	18.64	18.20	17.88	17.51	17.24
7.1	17.87	32.81	31.63	30.34	29.38	28.33	27.52	26.65	25.24	24.04	23.02	22.14	21.35	20.68	20.07	19.56	19.11	18.67	18.33	17.96	17.68
7.2	18.12	33.61	32.40	31.09	30.10	29.03	28.20	27.31	25.86	24.63	23.59	22.69	21.89	21.20	20.58	20.05	19.60	19.14	18.80	18.41	18.13
7.3	18.38	34.42	33.18	31.84	30.83	29.73	28.89	27.97	26.50	25.24	24.17	23.25	22.43	21.72	21.09	20.55	20.08	19.62	19.27	18.87	18.58
7.4	18.63	35.23	33.97	32.59	31.56	30.44	29.58	28.65	27.14	25.85	24.76	23.82	22.97	22.25	21.60	21.05	20.58	20.10	19.74	19.34	19.04
7.5	18.88	36.06	34.77	33.36	32.31	31.16	30.28	29.33	27.78	26.47	25.35	24.39	23.53	22.79	22.13	21.56	21.08	20.59	20.22	19.81	19.51
7.6	19.13	36.89	35.57	34.13	33.06	31.89	30.98	30.01	28.43	27.09	25.95	24.96	24.08	23.33	22.65	22.08	21.58	21.08	20.70	20.28	19.97
7.7	19.38	37.73	36.38	34.92	33.81	32.62	31.70	30.71	29.09	27.72	26.56	25.55	24.65	23.88	23.19	22.60	22.09	21.58	21.19	20.76	20.45
7.8	19.64	38.58	37.20	35.70	34.58	33.36	32.42	31.41	29.76	28.35	27.17	26.14	25.22	24.43	23.72	23.12	22.60	22.08	21.69	21.25	20.93
7.9	19.89	39.43	38.03	36.50	35.35	34.11	33.15	32.11	30.43	29.00	27.78	26.73	25.79	24.99	24.27	23.65	23.12	22.59	22.19	21.74	21.41
8.0	20.14	40.30	38.87	37.31	36.13	34.86	33.88	32.83	31.11	29.65	28.41	27.33	26.38	25.56	24.82	24.19	23.65	23.10	22.69	22.23	21.90

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor MLC — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
1.5	3.78	2.86	2.72	2.57	2.46	2.34	2.25	2.16	2.00	1.87	1.77	1.67	1.60	1.53	1.47	1.41	1.37	1.32	1.29	1.25	1.22
1.6	4.03	3.18	3.02	2.86	2.74	2.61	2.51	2.40	2.23	2.09	1.97	1.87	1.78	1.71	1.64	1.58	1.53	1.48	1.44	1.40	1.37
1.7	4.28	3.51	3.34	3.16	3.03	2.89	2.78	2.66	2.47	2.32	2.19	2.07	1.98	1.89	1.82	1.75	1.70	1.65	1.60	1.56	1.52
1.8	4.53	3.85	3.67	3.48	3.33	3.18	3.06	2.93	2.73	2.55	2.41	2.29	2.18	2.09	2.01	1.94	1.88	1.82	1.77	1.72	1.68
1.9	4.78	4.21	4.02	3.81	3.65	3.48	3.35	3.21	2.99	2.80	2.64	2.51	2.39	2.29	2.21	2.13	2.06	2.00	1.94	1.89	1.85
2.0	5.03	4.59	4.37	4.14	3.97	3.79	3.65	3.50	3.26	3.06	2.89	2.74	2.62	2.51	2.41	2.33	2.25	2.18	2.12	2.07	2.02
2.1	5.29	4.97	4.74	4.50	4.31	4.11	3.96	3.80	3.54	3.32	3.14	2.98	2.85	2.73	2.62	2.53	2.45	2.38	2.31	2.26	2.20
2.2	5.54	5.37	5.12	4.86	4.66	4.45	4.28	4.11	3.83	3.60	3.40	3.23	3.08	2.96	2.84	2.75	2.66	2.58	2.51	2.45	2.39
2.3	5.79	5.78	5.52	5.23	5.02	4.79	4.62	4.43	4.13	3.88	3.67	3.49	3.33	3.19	3.07	2.97	2.87	2.79	2.71	2.65	2.58
2.4	6.04	6.20	5.92	5.62	5.39	5.15	4.96	4.76	4.44	4.17	3.95	3.75	3.58	3.44	3.31	3.19	3.10	3.00	2.92	2.85	2.78
2.5	6.29	6.64	6.34	6.02	5.78	5.52	5.32	5.10	4.76	4.48	4.23	4.03	3.85	3.69	3.55	3.43	3.32	3.23	3.14	3.06	2.99
2.6	6.55	7.09	6.77	6.43	6.17	5.89	5.68	5.46	5.09	4.79	4.53	4.31	4.12	3.95	3.80	3.67	3.56	3.45	3.36	3.28	3.20
2.7	6.80	7.55	7.21	6.85	6.57	6.28	6.06	5.82	5.43	5.11	4.83	4.60	4.39	4.22	4.06	3.92	3.80	3.69	3.59	3.51	3.42
2.8	7.05	8.02	7.66	7.28	6.99	6.68	6.44	6.19	5.78	5.44	5.14	4.90	4.68	4.49	4.33	4.18	4.05	3.93	3.83	3.74	3.65
2.9	7.30	8.50	8.13	7.72	7.42	7.09	6.84	6.57	6.14	5.77	5.47	5.20	4.97	4.77	4.60	4.44	4.31	4.18	4.07	3.98	3.88
3.0	7.55	9.00	8.60	8.17	7.85	7.51	7.24	6.96	6.50	6.12	5.79	5.52	5.27	5.06	4.88	4.72	4.57	4.44	4.32	4.22	4.12
3.1	7.80	9.50	9.09	8.64	8.30	7.94	7.66	7.36	6.88	6.47	6.13	5.84	5.58	5.36	5.17	4.99	4.84	4.70	4.58	4.47	4.37
3.2	8.06	10.02	9.58	9.11	8.76	8.38	8.08	7.77	7.26	6.84	6.48	6.17	5.90	5.67	5.46	5.28	5.12	4.97	4.84	4.73	4.62
3.3	8.31	10.55	10.09	9.60	9.23	8.83	8.52	8.19	7.66	7.21	6.83	6.51	6.23	5.98	5.76	5.57	5.41	5.25	5.11	4.99	4.88
3.4	8.56	11.09	10.61	10.09	9.70	9.28	8.96	8.62	8.06	7.59	7.19	6.85	6.56	6.30	6.07	5.87	5.70	5.53	5.39	5.26	5.14
3.5	8.81	11.65	11.14	10.60	10.19	9.75	9.42	9.05	8.47	7.98	7.56	7.21	6.90	6.63	6.39	6.18	5.99	5.82	5.67	5.54	5.41
3.6	9.06	12.21	11.68	11.12	10.69	10.23	9.88	9.50	8.89	8.38	7.94	7.57	7.24	6.96	6.71	6.49	6.30	6.12	5.96	5.82	5.69
3.7	9.31	12.78	12.24	11.64	11.20	10.72	10.35	9.96	9.32	8.78	8.33	7.94	7.60	7.30	7.04	6.81	6.61	6.42	6.25	6.11	5.97
3.8	9.57	13.37	12.80	12.18	11.72	11.22	10.83	10.42	9.76	9.20	8.72	8.31	7.96	7.65	7.38	7.14	6.93	6.73	6.55	6.40	6.26
3.9	9.82	13.97	13.37	12.73	12.25	11.73	11.33	10.90	10.20	9.62	9.12	8.70	8.33	8.01	7.72	7.47	7.25	7.04	6.86	6.70	6.55
4.0	10.07	14.58	13.96	13.29	12.78	12.24	11.83	11.38	10.66	10.05	9.53	9.09	8.70	8.37	8.07	7.81	7.58	7.37	7.17	7.01	6.85
4.1	10.32	15.19	14.55	13.85	13.33	12.77	12.34	11.87	11.12	10.49	9.95	9.49	9.09	8.74	8.43	8.16	7.92	7.69	7.49	7.32	7.16
4.2	10.57	15.82	15.16	14.43	13.89	13.31	12.86	12.37	11.59	10.93	10.38	9.90	9.48	9.11	8.79	8.51	8.26	8.03	7.82	7.64	7.47
4.3	10.82	16.46	15.77	15.02	14.46	13.85	13.38	12.88	12.07	11.39	10.81	10.31	9.88	9.50	9.16	8.87	8.61	8.37	8.15	7.97	7.79
4.4	11.08	17.12	16.40	15.62	15.04	14.41	13.92	13.40	12.56	11.85	11.25	10.73	10.28	9.89	9.54	9.24	8.97	8.71	8.49	8.30	8.12
4.5	11.33	17.78	17.03	16.23	15.62	14.97	14.47	13.93	13.06	12.32	11.70	11.16	10.69	10.29	9.92	9.61	9.33	9.07	8.83	8.64	8.45
4.6	11.58	18.45	17.68	16.85	16.22	15.54	15.02	14.46	13.56	12.80	12.15	11.60	11.11	10.69	10.32	9.99	9.70	9.43	9.18	8.98	8.78
4.7	11.83	19.13	18.34	17.47	16.83	16.13	15.59	15.01	14.08	13.29	12.62	12.04	11.54	11.10	10.71	10.37	10.07	9.79	9.54	9.33	9.12
4.8	12.08	19.82	19.00	18.11	17.44	16.72	16.16	15.56	14.60	13.78	13.09	12.49	11.97	11.52	11.12	10.76	10.45	10.16	9.90	9.68	9.47
4.9	12.33	20.53	19.68	18.76	18.07	17.32	16.74	16.12	15.13	14.28	13.56	12.95	12.41	11.94	11.53	11.16	10.84	10.54	10.27	10.04	9.82

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Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

1" Uponor MLC — 50% Propylene Glycol — Feet of Head per 100 Feet of Tubing

Continued from previous page

Velocity (ft./sec.)	GPM	40°F 4°C	45°F 7°C	50°F 10°C	55°F 13°C	60°F 16°C	65°F 18°C	70°F 21°C	80°F 27°C	90°F 32°C	100°F 38°C	110°F 43°C	120°F 49°C	130°F 54°C	140°F 60°C	150°F 66°C	160°F 71°C	170°F 77°C	180°F 82°C	190°F 88°C	200°F 93°C
5.0	12.59	21.24	20.36	19.41	18.70	17.93	17.33	16.69	15.67	14.79	14.05	13.41	12.86	12.37	11.94	11.57	11.24	10.92	10.65	10.41	10.18
5.1	12.84	21.97	21.06	20.08	19.34	18.55	17.93	17.27	16.21	15.31	14.54	13.89	13.31	12.81	12.37	11.98	11.64	11.31	11.03	10.78	10.55
5.2	13.09	22.70	21.77	20.76	20.00	19.18	18.54	17.86	16.77	15.83	15.04	14.37	13.77	13.26	12.80	12.40	12.04	11.71	11.41	11.16	10.92
5.3	13.34	23.45	22.48	21.44	20.66	19.81	19.16	18.46	17.33	16.37	15.55	14.85	14.24	13.71	13.23	12.82	12.45	12.11	11.80	11.55	11.29
5.4	13.59	24.20	23.21	22.14	21.33	20.46	19.79	19.06	17.90	16.91	16.07	15.35	14.72	14.17	13.68	13.25	12.87	12.52	12.20	11.94	11.68
5.5	13.85	24.96	23.95	22.84	22.01	21.11	20.42	19.68	18.48	17.46	16.59	15.85	15.20	14.63	14.13	13.69	13.30	12.93	12.61	12.33	12.06
5.6	14.10	25.74	24.69	23.55	22.70	21.78	21.06	20.30	19.06	18.01	17.12	16.35	15.68	15.10	14.58	14.13	13.73	13.35	13.02	12.73	12.46
5.7	14.35	26.52	25.45	24.28	23.40	22.45	21.72	20.93	19.66	18.57	17.66	16.87	16.18	15.58	15.05	14.58	14.17	13.78	13.43	13.14	12.86
5.8	14.60	27.32	26.21	25.01	24.11	23.13	22.38	21.56	20.26	19.14	18.20	17.39	16.68	16.06	15.51	15.03	14.61	14.21	13.85	13.55	13.26
5.9	14.85	28.12	26.99	25.75	24.82	23.82	23.04	22.21	20.87	19.72	18.75	17.92	17.19	16.55	15.99	15.49	15.06	14.65	14.28	13.97	13.67
6.0	15.10	28.94	27.77	26.50	25.55	24.52	23.72	22.86	21.48	20.31	19.31	18.45	17.70	17.05	16.47	15.96	15.51	15.09	14.71	14.39	14.09
6.1	15.36	29.76	28.56	27.26	26.28	25.23	24.41	23.53	22.11	20.90	19.88	19.00	18.23	17.55	16.96	16.43	15.97	15.54	15.15	14.82	14.51
6.2	15.61	30.60	29.37	28.03	27.03	25.94	25.10	24.20	22.74	21.50	20.45	19.55	18.75	18.06	17.45	16.91	16.44	15.99	15.59	15.26	14.93
6.3	15.86	31.44	30.18	28.81	27.78	26.67	25.80	24.88	23.38	22.11	21.03	20.10	19.29	18.58	17.95	17.40	16.91	16.45	16.04	15.70	15.36
6.4	16.11	32.30	31.00	29.60	28.54	27.40	26.51	25.56	24.03	22.73	21.62	20.66	19.83	19.10	18.46	17.89	17.39	16.92	16.50	16.15	15.80
6.5	16.36	33.16	31.83	30.39	29.31	28.14	27.23	26.26	24.69	23.35	22.21	21.23	20.38	19.63	18.97	18.39	17.88	17.39	16.96	16.60	16.24
6.6	16.61	34.03	32.68	31.20	30.09	28.89	27.96	26.96	25.35	23.98	22.81	21.81	20.93	20.17	19.49	18.89	18.37	17.87	17.43	17.06	16.69
6.7	16.87	34.92	33.53	32.01	30.88	29.65	28.70	27.67	26.02	24.62	23.42	22.39	21.50	20.71	20.01	19.40	18.86	18.36	17.90	17.52	17.15
6.8	17.12	35.81	34.39	32.84	31.67	30.41	29.44	28.39	26.70	25.26	24.04	22.98	22.06	21.26	20.55	19.92	19.37	18.85	18.38	17.99	17.61
6.9	17.37	36.71	35.25	33.67	32.48	31.19	30.19	29.12	27.39	25.91	24.66	23.58	22.64	21.81	21.08	20.44	19.87	19.34	18.86	18.46	18.07
7.0	17.62	37.62	36.13	34.51	33.29	31.97	30.95	29.85	28.08	26.57	25.29	24.18	23.22	22.37	21.63	20.97	20.39	19.84	19.35	18.94	18.54
7.1	17.87	38.55	37.02	35.36	34.12	32.77	31.72	30.60	28.79	27.24	25.93	24.80	23.81	22.94	22.18	21.50	20.91	20.35	19.85	19.43	19.02
7.2	18.12	39.48	37.92	36.22	34.95	33.57	32.50	31.35	29.49	27.91	26.57	25.41	24.40	23.52	22.73	22.04	21.43	20.86	20.35	19.92	19.50
7.3	18.38	40.42	38.82	37.09	35.79	34.38	33.28	32.11	30.21	28.59	27.22	26.04	25.00	24.10	23.29	22.59	21.96	21.38	20.85	20.41	19.98
7.4	18.63	41.37	39.74	37.97	36.63	35.19	34.08	32.87	30.94	29.28	27.88	26.67	25.61	24.68	23.86	23.14	22.50	21.90	21.37	20.91	20.47
7.5	18.88	42.33	40.66	38.85	37.49	36.02	34.88	33.65	31.67	29.98	28.54	27.30	26.22	25.27	24.43	23.69	23.04	22.43	21.88	21.42	20.97
7.6	19.13	43.29	41.59	39.75	38.36	36.85	35.69	34.43	32.41	30.68	29.21	27.95	26.84	25.87	25.01	24.26	23.59	22.97	22.41	21.93	21.47
7.7	19.38	44.27	42.54	40.65	39.23	37.69	36.50	35.22	33.15	31.39	29.89	28.60	27.46	26.48	25.60	24.83	24.15	23.51	22.93	22.45	21.98
7.8	19.64	45.26	43.49	41.56	40.11	38.54	37.33	36.02	33.91	32.10	30.57	29.25	28.10	27.09	26.19	25.40	24.71	24.05	23.47	22.97	22.49
7.9	19.89	46.26	44.45	42.48	41.00	39.40	38.16	36.82	34.67	32.83	31.26	29.92	28.74	27.70	26.79	25.98	25.27	24.61	24.01	23.50	23.01
8.0	20.14	47.26	45.42	43.41	41.90	40.27	39.00	37.64	35.44	33.56	31.96	30.59	29.38	28.33	27.39	26.57	25.85	25.16	24.55	24.04	23.54

Recommended Head Loss Design Range for Distribution Piping

For distribution piping, 5.5 ft./sec. is an industry standard for velocity limit.

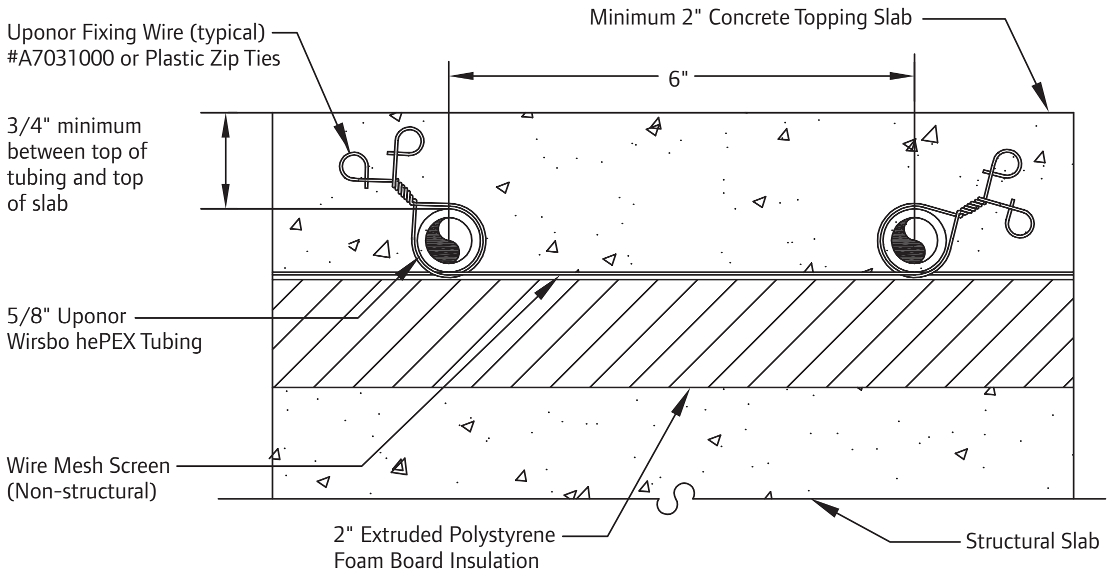
For distribution piping, velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

Appendix H

Typical Detail Drawings for Embedded Radiant Systems

Additional detail drawings can be found on the Uponor Engineering Resource Center at **www.uponorengineering.com.**

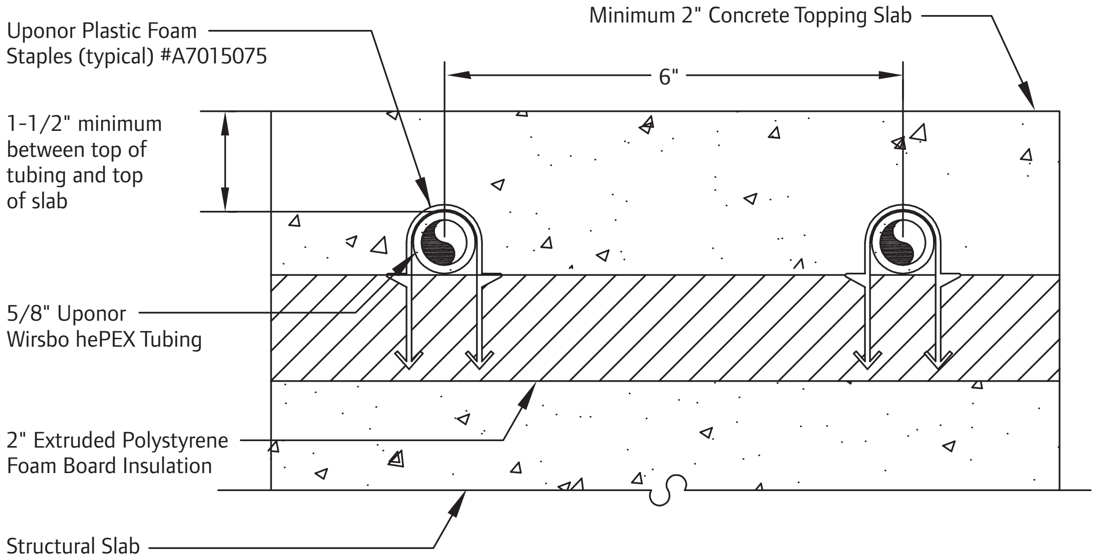
Radiant Topping Slab with Fixing Wire



Note:

1. Design and installation of the structural slab shall be per structural engineer's specifications.
2. Radiant topping slab detail with 5/8" tubing at 6" centers secured to a non-structural wire mesh using fixing wire on top of 2" rigid insulation.

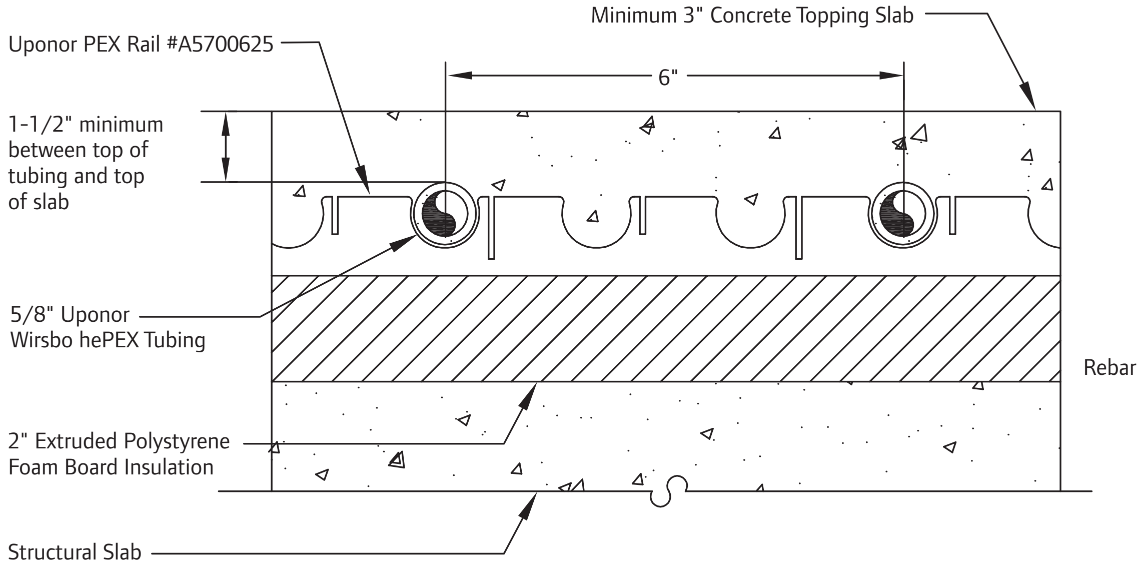
Radiant Topping Slab with Plastic Staples



Note:

1. Design and installation of the structural slab shall be per structural engineer's specifications.
2. Radiant topping slab detail with 5/8" tubing at 6" centers secured on 2" rigid insulation with plastic foam staples. If insulation is changed to 1", use A7015050 Plastic Foam Staples.

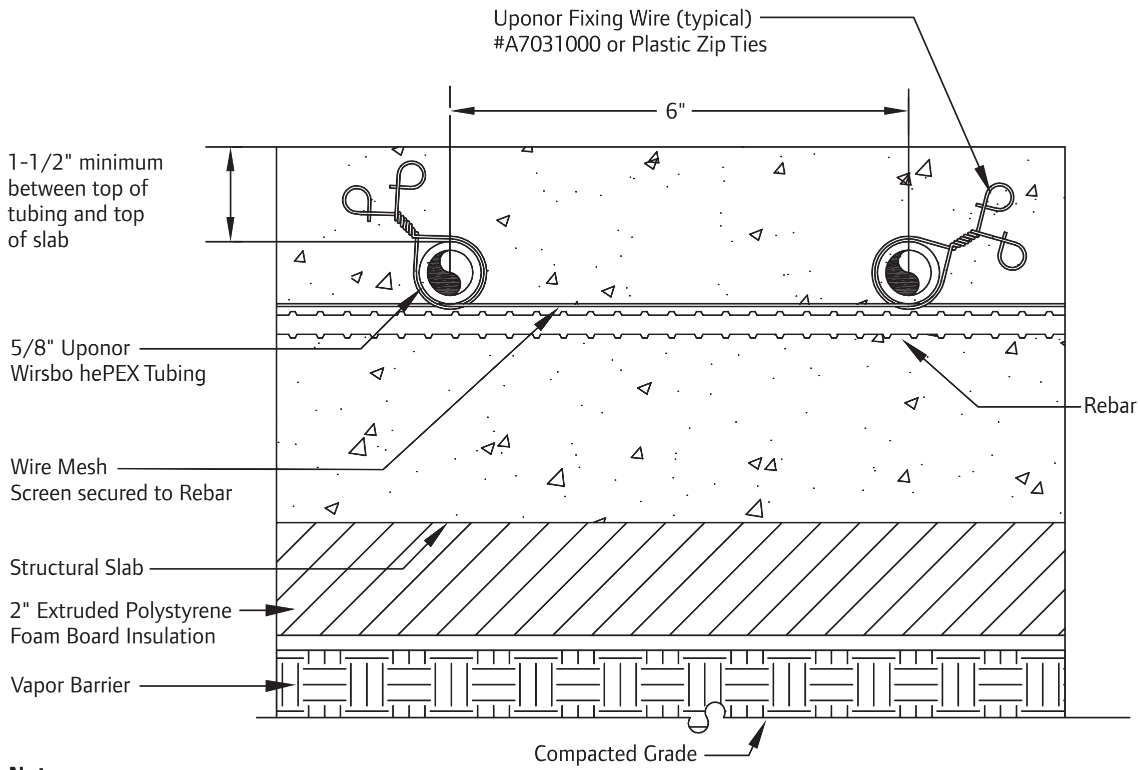
Radiant Topping Slab with PEX Rails



Note:

1. Design and installation of the structural slab shall be per structural engineer's specifications.
2. Secure Pex Rails to insulation with liquid nails or silicone.
3. Radiant topping slab detail with 5/8" tubing at 6" centers on PEX Rails. If tubing size changed to 1/2", use #A5700500. For 3/4" #A570075.

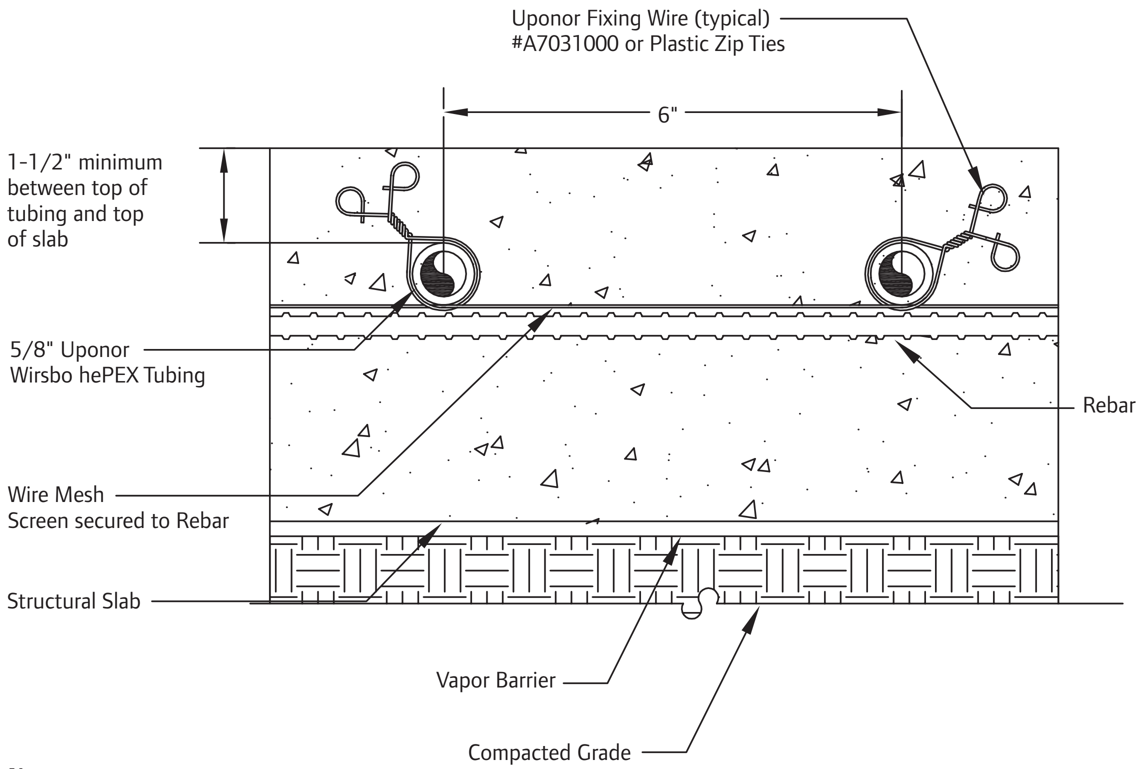
Radiant Slab on Grade with Insulation



Note:

1. Design and installation of the structural slab shall be per structural engineer's specifications.
2. Coordinate exact placement of tubing within structural slab in field, with respect to rebar, electrical conduit, piping, post-tension tendons, etc.
3. Structural slab on grade detail with 5/8" tubing at 6" centers secured to wire screen with 2" insulation.

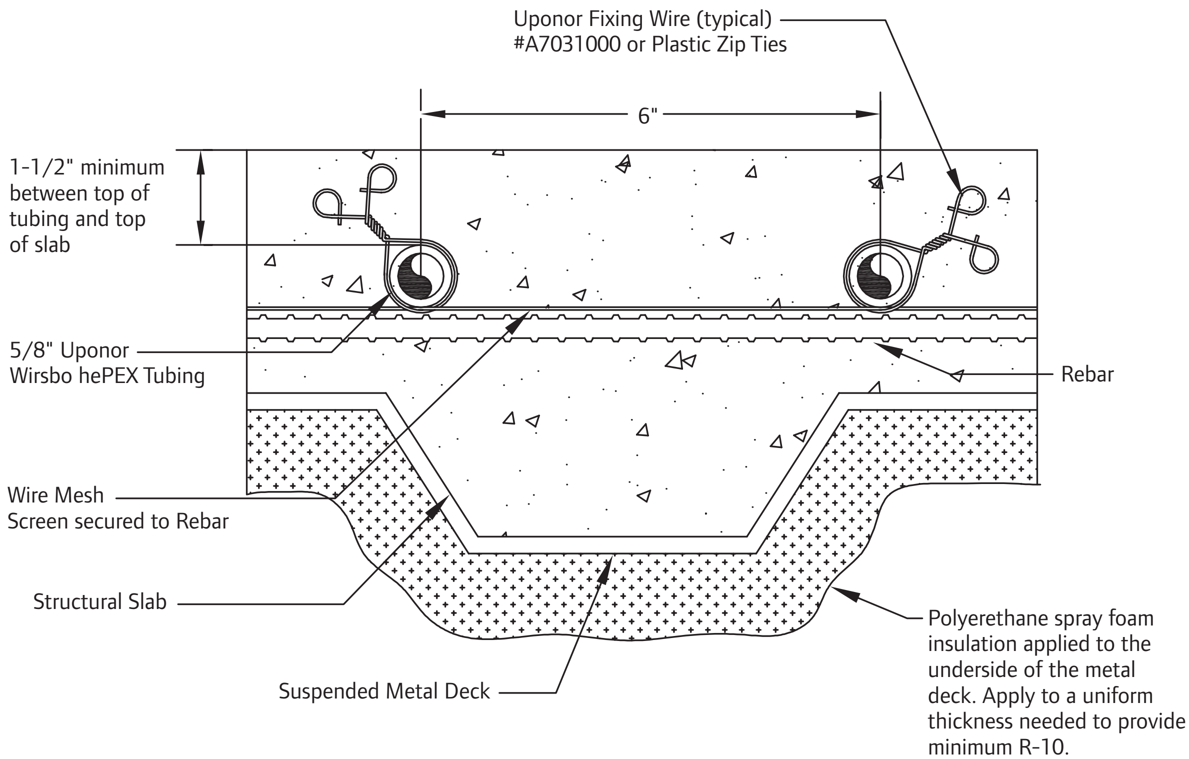
Radiant Slab on Grade without Insulation



Note:

1. Design and installation of the structural slab shall be per structural engineer's specifications.
2. Coordinate exact placement of tubing within structural slab in field, with respect to rebar, electrical conduit, piping, post-tension tendons, etc.
3. Structural slab on grade detail with 5/8" tubing at 6" centers secured to wire screen without insulation.

Radiant Slab on Suspended Deck Detail



Note:

1. Design and installation of the structural slab shall be per structural engineer's specifications.
2. Coordinate exact placement of tubing within structural slab in field with respect to rebar, electrical conduit, piping, post-tension tendons, etc.
3. Structural slab on suspended metal deck detail with 5/8" tubing at 6" centers secured to wire screen with underside insulation. Adjust insulation as needed based on flooring R-value.

Appendix I
Case Studies

Pier 15 Exploratorium
San Francisco, Calif.
LEED Gold

The Exploratorium project at Pier 15 has become a model on innovative sustainable design with the goal of becoming the largest net-zero energy museum in the United States. The 800-foot-long pier, erected nearly a century ago and vacant for a number of years, has undergone a gut renovation, including major structural repairs to its pilings to make it earthquake-safe for the next 100 plus years. The massive construction project yields approximately 330,000 square feet of indoor and outdoor space, and the finishing touch is an all-glass observatory that anchors the back of the new complex at the end of the pier's 800-foot projection into the bay.

Targeting LEED® Gold certification, the new Exploratorium will have many notable green features when it becomes fully operational in the spring of 2013, including offsetting the annual electrical consumption with photovoltaic (PV) solar panels and an innovative radiant cooling system that uses water from the San Francisco Bay to meet comfort demands. Even without the PVs, the renovated facility is projected

Project Highlights

- 330,000-square-foot renovation
- Strict historical-preservation guidelines
- Largest net-zero energy museum in the U.S.
- Targeting LEED Gold certification
- 57% more efficient than ASHRAE 90.1 standard

Project Data

- Engineering and Systems Design: Integral Group, Oakland, CA
- Uponor Radiant Heating and Cooling System
- Uponor's Radiant Rollout™ Mats
- ⅝" Wirsbo hePEX™ tubing
- ¾" Wirsbo hePEX tubing
- 82 heating and cooling zones

to be 57 percent more efficient than the ASHRAE 90.1 baseline standard for a typical U.S. museum, thanks in part to its innovative use of water from the bay. Depending on the season, the latter will function as either a heat sink or a heat source for a radiant heating and cooling system that covers approximately 90 percent of the floor space.

The job of raising or lowering the temperature of the bay water is handled by eight, 50-ton, water-to-water heat pumps. These electric-chilled heaters feed a four-pipe system that carries either hot or chilled water to a 200,000-foot network of crosslinked polyethylene (PEX) tubing made by Uponor. The tubing is embedded in concrete slabs on two levels and spanning 82 different heating/cooling zones. Each zone has a control valve and a thermostat to switch between heating and cooling, whatever the need. The use of bay water for the heating and cooling system should save about two million gallons of water annually by eliminating the need for conventional cooling towers to absorb heat during the cooling process. Cooling towers inevitably lose large quantities of potable water through evaporation.

No other type of water-heating is used in the building, nor is there any use of fossil fuels except for highly limited cooking purposes in a small restaurant – thus, the net-zero carbon designation. "We did not wish to sacrifice comfort for energy savings on this project, and radiant is a premium comfort system," says Joseph Wenisch, project manager for Integral Group, the engineering and systems design company used in this project.

The Exploratorium aims to achieve substantial energy savings over the AHSRAE 90.1 baseline in several areas. But heating and cooling, along with lighting and pumps, are expected to make the biggest contributions: a 55 percent savings in yearly electrical consumption for heating; and 94 percent for cooling. All of which is why the use of radiant slab heating and cooling was an integral part of the Exploratorium plan from the outset, according to Wenisch.

Water, Exchange Heaters and Uponor's Radiant Rollout™ Mat

Water from the bay is continuously pumped in and out of the building to a pair of titanium heat exchangers. The bay water never moves beyond the heat exchangers because the salt water would quickly corrode the heat pumps and other mechanical components. Once the heat exchange process is complete, the bay water returns to its source – completely unchanged and with no chemical treatment. In the colder months, when space heating is needed, the bay functions as a heat source and in the warmer months, heat pumps lower the temperature of the bay water before it circulates to the 82 cooling zones.

Because of the need for earthquake protection, the specification on the first level of the building was more complex, consisting of two layers of rebar with the PEX loops positioned in between and fastened to the lower stratum. The tubing was specified to sit three to three and a half inches beneath the surface to avoid being punctured by anchors securing the museum's floor-mounted exhibits. "We couldn't insulate the first floor in the dowel areas, so we ended up with this checkerboard of two-inch, rigid insulation covering roughly half to 60% of the area. This checkerboard wasn't particularly easy for the installers to walk on — let alone work on — and that added to the installation time," Wenisch said. But the use of Uponor's Radiant Rollout Mats on approximately 80 percent of the floor surface helped make up for these construction obstacles.

Custom-designed and prefabricated to project specifications by Uponor, the Radiant Rollout Mats are pre-pressurized rolls of PEX-a tubing loops fitted with Uponor ProPEX® engineered plastic (EP) fittings. Once on the job site, the mats roll out like carpeting over the floor space, while requiring fewer ties to secure their position. As a result, the Radiant Rollout Mats can install approximately 85 percent faster than conventional radiant tubing methods.

When the Exploratorium becomes fully functioning in the spring of 2013, they invite visitors to become active and creative explorers – much like the engineers, architects and contractors in this renovation who had to create long-lasting and innovative green designs.

David Brower Center
Berkeley, Calif.
LEED Platinum

Utilizing the latest in energy-saving technologies and recycled building materials, the David Brower Center is designed to make as light a footprint on the Earth as possible, taking into account the true life-cycle cost of building construction, operation, and maintenance.

The building is located on a one-acre lot in downtown Berkeley, one block from the Bay Area Rapid Transit (BART) station and across the street from the University of California at Berkeley campus. Previously a surface parking lot, the mixed-use development includes a below-grade public parking garage, 97 units of affordable rental apartments, 40 residential parking spaces and bike storage, retail space, a restaurant, conference center, and rental office space.

Uponor provided a low-energy mechanical system using radiant heating and cooling within the building's concrete structural slabs. The radiant cooling application provided several advantages including its ability to deal with high direct solar gains, reduced drafts and noise and superior human comfort. And in addition, a radiant cooling system, in conjunction with a dedicated outside air system (DOAS) can save as much as 53% over the baseline HVAC system.

The building's in-slab radiant heating and cooling system can be 'turned down' at night by pre-cooling during periods of warmer weather to store cooling for the next day. The ground floor of the building is served by a high-efficiency water source heat pump system. Overall, the building uses over 60% less energy than the average U.S. building of similar use, without taking credit for the energy produced by the photovoltaic system.

The David Brower Center promises to be an invaluable asset for the region and a landmark for anyone committed to the planet and its inhabitants.

Project Highlights

- Square feet: 45,000
- Architects: Solomon E.T.C.
- Energy Efficiency: 54% better than standard U.S. Energy Star office building rating
- LEED® Platinum certification

Project Data

- Uponor Radiant Heating and Cooling System
- ⅝" Wirsbo hePEX™ tubing
- 6" to 9" on-center tubing spacing
- Maximum tubing length per loop: 350'

Project Highlights

- Square feet: 169,000
- Cost: $29.7 million
- Architects: Busby Perkins+Will, Beauchamp et Bourbeau Canada, ABCP Architecture & Urbanisme
- Engineers: Pageau Morel et Associes
- Plumbing Contractor: Plomberie Charbonneau

Project Data

- Uponor Radiant Heating and Cooling System
- Wirsbo hePEX™ Tubing
- Uponor Snow and Ice Melting System
- Multi-layer Composite (MLC) Tubing

Normand Maurice Building
Montreal, QC.
LEED Gold

With an emphasis on sustainable building practices, Public Works Governmental Services Canada (PWGSC) required solutions adhering to LEED® Gold certification under the U.S. Green Building Council's ratings based on green design and construction. From architect to engineer to contractor, the direction was clear: build a state-of-the-art structure that features innovative sustainable solutions that provide energy savings without compromising the comfort and aesthetics of the building.

Located in Montreal's historic St. Henri district, the 112,000-square-foot site of the Normand Maurice building already contained storage facilities that government agencies had been using for the previous 15 years. Prior to that, the complex of buildings, constructed between 1851 and 1950 and originally a munitions foundry, required the PWGSC and the design team to undertake remediation of the site, which included carting away several feet of soil.

Site environmental remediation and the reuse of building components combined to form a facility that sits comfortably alongside the old industrial buildings and apartment conversions of St. Henri. Measuring a full city block in length, the main axis of the Normand Maurice Building runs from northwest to southeast. The steel-frame structure comprises a brick base that almost covers the building lot from sidewalk to sidewalk with a separate building that sits close to the northeast edge, and reaches an additional three stories higher.

Uponor provided the radiant heating and cooling system to the Normand Maurice building, reducing energy consumption while providing optimal efficiency and comfort. In fact, the building consumes 54 percent less energy than code, exceeding expectations by almost 10 percent. The radiant heating component takes advantage of the energy storage capacity of concrete floors for heating a commercial structure. In radiant heating, energy moves away from the heated surface, surrounding people with warmth. And Uponor's radiant systems offer the ability to work with existing HVAC systems to conserve energy during peak operating hours.

Uponor's radiant cooling system is a quiet and energy-efficient alternative to traditional air conditioning in commercial buildings. A passive system, it uses off-peak electric power at night, reducing the need for energy-intensive HVAC air conditioning during the day and providing the opportunity for downsized chillers and the elimination of individual air conditioning units.

During the winter months, a snow melt system from Uponor provides safe sidewalks and passage ways for the outside of the building. Durable Uponor PEX-a tubing buried in the concrete circulates a warm water-glycol solution to heat the surface and melt ice and snow, eliminating the need for shoveling, salting and sanding. And it offers safety and convenience to the hundreds of workers using the Normand Maurice building every day.

Maurice J. Gallagher Jr. Hall
Davis, Calif.
LEED Platinum

When UC Davis sought to double the space for its business school and build an environmentally sustainable home for its Masters of Business Administration program, it turned the search into a competition about who could integrate green concepts for maximum gain and minimum cost.

The team of Sasaki Associates, San Francisco, and Sundt Construction, Sacramento, was chosen to build the structure partly due to an innovative integrated design approach to the ceilings and floors. "They function as a structural membrane, an architectural array of ceiling, lighting and cooling systems," says Ray Keane, principal design engineer with Timmons Design Engineers in San Francisco. "The slab is more expensive than a typical slab, but when you consider all the functions it provides, it's much more cost effective."

The collaborative process also led to many design decisions that built on one another. For example, because the soil in the area is of poor quality and a deep excavation was required, Keane suggested installing a ground-source loop so the building could benefit from ground-source heating and cooling. Tim Stevens, architect, LEED AP, and principal with Sasaki Associates, says the decision to go with geothermal technology influenced every system of the building. "It reduces our mechanical load to next to nothing," he notes. "Instead of moving huge volumes of air to cool the building, we're just pumping water cooled by the ground and utilizing the buildings' mass and slabs to radiate the coolness through the building."

Uponor provided the hydronic radiant heating and cooling system to the project, and water flows through PEX-a tubing inside the building's floors and ceilings. As the water moves back and forth between the building and ground, constantly exchanging heat, it regulates the building's indoor climate. If there's a need for more heating or cooling, an electric-powered chiller helps support the system.

Project Highlights

- LEED® Platinum Building
- Owner: University of California at Davis
- Architect: Sasaki Associates, Inc., San Francisco
- Engineers: Rutherford and Chekene, San Francisco
- General Contractor: Sundt Construction Inc., Sacramento

Project Data

- Uponor Radiant Heating and Cooling
- Wirsbo hePEX™ tubing

Keane also recommends another technique to further minimize the cooling load. "Our strategy is to pre-cool the slab and ceilings at night as much as we can without using mechanical compressors," he explains. "This uses less energy to cool the thermal mass and will eliminate four to five hours of chiller run time during the heat of the day when it costs the most."

Project Highlights

- LEED® Silver
- Uponor radiant heating and cooling system
- Geothermal system
- 150 wells, each 500 feet deep
- Heating and cooling controlled from remote location
- Every classroom features radiant floors from Uponor

Project Data

- Amount of pipe: 75,000 feet
- Project cost: $58 million
- Architect: Drummey Rosane Anderson, Newton, MA
- General Contractor: Gilbane, Inc., Providence, RI
- Radiant contractor: Action Air, Manchester, CT

West Bristol School
Bristol, Conn.
LEED® Silver

All new schools in Connecticut are mandated by the state to be built to LEED® Silver, according to the Capital Region Education Council which works with schools to reduce energy costs. LEED (Leadership in Energy and Environmental Design) is an internationally recognized green building certification system, and Silver is the third highest of its four designations. There are several methods that can be used to reach the LEED Silver rating, and points are accumulated based on the complexity of the technology used. Using geothermal technology is a rarity, especially in the public school system, partly due to the amount of land needed to drill wells.

"We are cutting edge. The long-term energy savings will be tremendous, that was why we made the decision to install the geothermal system in the first place," Bristol Deputy Superintendent, Susan Moreau, said.

Each of the 150 wells is about 500 feet deep, explained Tim Callahan, the district's projects manager for the school. West Bristol's geothermal system required more than 75,000 feet of pipe, and water is pumped through Wirsbo hePEX pipes from deep in the earth, where the ambient temperature is always 52 degrees, Callahan said. During warm weather the water will be cooled down and in the winter it will warm up. There are no boilers and the water is heated through heat transfer pumps and then circulated through the buildings.

The classroom floors have radiant heat that brings warmth to the students' feet, and cool air is brought in through vents near the ceilings. By bringing the warmer temperatures in from the floor and the cooler from the ceiling the system works at its optimum and most efficient design. Heating and cooling are controlled remotely by a computer, Callahan said. "The system is able to simultaneously cool some portions of the building and heat other portions depending on where the sun is shining."

Representatives from CES of Middletown, the engineering company installing the schools' geothermal system, said the wells in the bore field are not visible above ground. "You don't see it, you don't hear it, you don't feel vibrations, it's just underground," said Jim Kowalski, a CES associate. The system is accessed through a "collector box" that is similar in size to a manhole cover.

The project, completed in time for the 2012 school year, received great support from the field, especially through Uponor's rep firm Shelton Winnelson's Gary Maturo, sales and training manager, who spent hours in the field supporting contractors with training and installation assistance. "We provided in-depth engineering design and assistance," Maturo said. "And when it came time to install the systems, we provided on-site training and support. I think we provided more than just a great product. We provided peace of mind that the tubing was installed and connected correctly and professionally."

Hall Winery
St. Helena, Calif.
LEED® Gold

When hydronics contractor Robert Reid saw the radiant flooring plan for a commercial winery, he questioned whether the system would work as designed. The plans for one of Napa Valley's most prestigious wineries, called for an in-floor Uponor radiant heating and cooling system to precisely control temperatures in two vital production areas: a state-of-the-art, 20,000 square-foot winery and a 26,931-square-foot barrel cellar. Reid's concern was that plans specified the radiant tubing be installed at the bottom of the 20-inch-thick concrete slab, instead of sandwiched in-between.

"For most commercial applications, we position the tubing in the top third or middle to ensure a comfortable heat transfer," says the 33-year plumbing industry veteran and owner of San Rafael, Calif.-based Reid Heating & Energy, Inc. "Initially, I was leery about placing the tubing on the bottom of the slab, but I discovered that this lower position made the slab more efficient for this particular application."

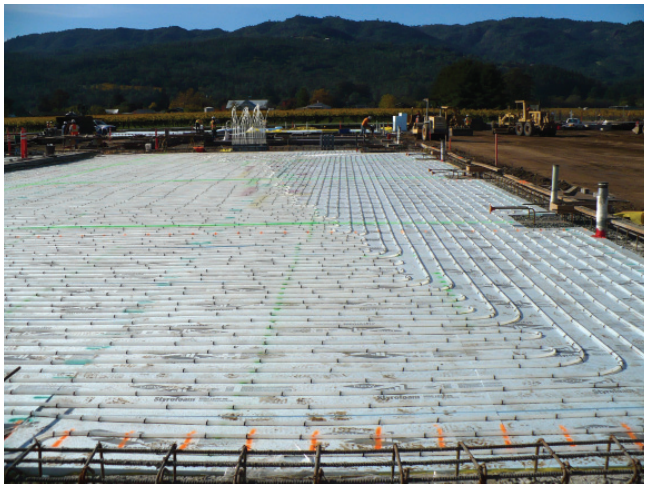
Indeed, the radiant system did perform as planned, and the project's environmentally friendly construction received LEED® Gold certification, making Hall St. Helena the first winery in California to achieve this level of certification from the U.S. Green Building Council.

Project Highlights

- First winery in CA to receive LEED® Gold
- Features Uponor radiant heating and cooling

Project Data

- 20,000-square-foot winery
- 26,931-square-foot barrel cellar
- 83,000 feet of 5/8" Wirsbo hePEX™
- 200 loops at an average of 490 feet
- 6" on-center spacing
- 14 manifolds



Attractiveness of Radiant Cooling

Radiant heating and cooling is a fairly new trend in wineries acknowledges project engineer Peter Simmonds, Ph.D. with Los Angeles-based IBE Consulting Engineers, who adds that the efficient technology helped achieve the Gold LEED status.

"We explored a range of conventional systems to newer technologies, such as chilled structural beams, but radiant was the only option to deliver the consistent and precise temperature control we required," says Simmonds. "Because temperature and humidity have the biggest impact on winemaking, it was vital to design a system that could maintain a consistent 55ºF operating temperature."

Implementing the Plan

Reid used roughly 83,000 feet of Uponor's 5/8" Wirsbo hePEX™ tubing for the two buildings. "Luckily, there were a lot of straight runs without many bends in this project," recalls Reid, who likens the large warehouse spaces to a football gridiron. "We chose the 5/8-inch hePEX because we could sustain runs up to 500 feet per loop with the larger diameter. With 1/2-inch tube, we couldn't really exceed 320 feet per run."

Reid and his crew began the installation process by stapling the Wirsbo hePEX tubing to sheets of 2-inch, rigid insulation at roughly six-inches on center. "Obviously, with spacing so tight, we had to stagger turns and flair out the tubing before making a turn," he says.

With nearly 200 loops at an average of 490 feet, Reid's football field analogy wasn't far off the mark. The Wirsbo hePEX tubing was routed to 14 manifolds that provide control for the two buildings. Once a section was stapled, a rebar mesh was laid on top of the tubing to provide support for the substantial slab floor.

"We left the tubing under about 100-pounds of water pressure during the rebar installation and concrete pour, so we could immediately identify and replace any portion that was inadvertently punctured," explains Reid.

All in all, he says, the project was very unique and memorable. "Although we do hundreds of commercial radiant installations a year, only one or two involve cooling — and nothing on the scale of this project," concludes Reid. "Hall St. Helena was unique for its unconventional 'cool' temperature, thick foundation and the sheer size of the warehouse buildings."

According to the project's owners, the radiant system has exceeded expectations. "Green building technologies such as radiant, have always been an important part of who we are and what we do," says Kathryn Hall. "Aside from achieving energy efficiency, the radiant system allows our winemaking team to maintain precise control of the temperature inside our new buildings, which is vital to ensuring the quality of our award-winning wines."

Project Highlights

- Quarter-mile racetrack in Morrison, Colo.
- Features an Uponor radiant cooling system
- System offers 30-degree difference in track surface temp.
- Cooler track offers drivers greater control, faster times

Project Data

- Quarter-mile racetrack
- 15,000 feet of ¾" Uponor AquaPEX® tubing
- 30 loops
- 6" on-center spacing

Bandimere Speedway
Arvada, Colo.

To mark the 50th anniversary of their racetrack, the Bandimere family sought engineering and professional installation help to create the nation's first substantial radiant track cooling system. Tony Vecchiarelli, owner of Arvada, CO-based Tony V Plumbing & Heating, came on board to do the installation.

"We were thrilled to be involved in a radiant cooling project this substantial," says Vecchiarelli. "We helped with the layout of the system along with fabrication and setting of the manifolds."

The track cooling system acts like a radiant heat system in reverse. Rather than supplying heat, it sends chilled water into an immense network of embedded tubing to draw heat out of the high-mass concrete slab, wicking away heat faster than the sun supplies it.

Cooler Track, Faster Times

Just three inches below the track's surface lies 15,000 feet of ¾" Uponor AquaPEX® tubing for serious cooling of the surface above. The cooling system circulates 110 gallons per minute, removing just over one million BTUs of heat per hour.

"Another challenge we're solving is the inconsistencies caused by solar gain on the track," says system design engineer Brandon Thompson, PE, president of Thompson Engineering in Littleton, Colo.

"The purpose of the system's design — in addition to cooling the starting lanes of the race track — was to evenout the temperatures for both east and west lanes," he says. "Bandimere is built next to a hill and as the sun goes down, the west lane is shaded sooner than the east lane, so it cools faster."

Thompson worked closely with Him Ly, commercial sales engineer for Uponor. According to Thompson, their initial design calculations determined track temperatures could be lowered by 20 degrees. They actually learned that an 18-degree difference was achieved without a chiller and cooling tower, so they knew it would be possible to improve track temperatures even more dramatically by circulating chilled water.

National Renewable Energy Lab (NREL)
Golden, Colo.
LEED Platinum

The National Renewable Energy Laboratory (NREL) in Golden, Colo., is the nation's only federal laboratory dedicated to the research, development, commercialization and deployment of renewable energy and energy-efficient technologies. When it came time to build a $64 million, 220,000-square-foot Research Support Facility on the campus, NREL engineers looked to Uponor radiant heating and cooling to help meet their energy-neutral goals.

"In designing and building the new facility, our aim was to move the needle in how America uses energy to heat and cool buildings," NREL Senior Engineer Paul Torcellini says. "It isn't enough to be energy-efficient when commercially viable technology exists to make buildings energy-neutral."

Among the many groundbreaking innovations that made the facility possible was a new method for installing radiant heating and cooling systems: the Uponor Radiant Rollout™ Mat, which enabled mechanical contractor Trautman & Shreve to dramatically slash labor time and costs. These savings, in turn, helped NREL meet its budgetary goals and tight construction schedule.

High-performance Design

Centennial, Colo.-based Haselden Construction was the builder of the facility. Haselden Design-Build Project Manager Philip Macey, AIA, LEED AP, helped the project

Project Highlights

- $64 million research support facility
- Features Uponor radiant heating and cooling
- Largest net-zero energy building in the U.S.
- Increased campus square footage by 60%
- Only increased campus energy use by 6%
- LEED Platinum

Project Data

- 220,000 square feet of office space
- 42 miles of Wirsbo hePEX tubing
- Zones from 48 to 250 ft. long, up to 24 ft. wide
- Loops with 6- to 10-inch on-center spacing

team through critical design decisions based on information in the contractor's cost model and the design team's energy, daylighting, natural-ventilation and thermal-mass models.

"Our goal was to maximize the passive performance of this facility," says David Okada of Stantec in San Francisco. "Then we focused on making the engineered systems as efficient as possible. Thermal and energy modeling provided the information the design-build team needed to keep the design true to the project's aggressive goals."

In recognition of Stantec's engineering consulting work on RSF, the company received the prestigious Engineering Excellence Grand Award from the American Council of Engineering Companies in April.

Unique Radiant Installation

Tony Barela, project manager for mechanical contractor Trautman & Shreve, needed an ultra-efficient tool to meet the twin performance criteria of energy efficiency and cost control. "The job schedule was critical on this project," Barela says. "Working with Haselden Construction, we knew that the five days allocated to us were not enough time to build all the radiant heating and cooling zones. It was critical we find another way."

Working with local sales agents Tom Meek and Tobi Gibson from TM Sales in Arvada, Colo., Barela and superintendent Don Martinez devised a pre-fab plan for the radiant zones. After mapping out all zones, Trautman & Shreve purchased Wirsbo hePEX tubing in standard 1,000- and 500-foot rolls, then using 3-foot plastic rails (with loops in 6- to 10-inch spacings to hold the pipe together in an even width), they prefabricated their own radiant mats.

"Zones on this project ranged anywhere from 48 to 250 feet long and up to 24 feet wide," Barela explains. "We customized each mat in whatever dimensions were needed." For example, on the widest zone, four 6-foot mats were connected to complete that zone.

"Overall, we saved 28 days in the construction schedule," Barela says, estimating the true day-savings was much more like 60 versus the time required in a conventional radiant installation.

CityCenter™ Crystals
Las Vegas, Nev.
LEED Gold

Spanning 18 million square feet under roof and a total of 67 acres, the $8.5 billion MGM Mirage CityCenter™ in downtown Las Vegas is currently the largest privately funded construction project in the United States.

Crystals, the retail and entertainment district at CityCenter, is the world's largest retail district to receive LEED Gold Core & Shell certification. The building features 700,000 square feet over three levels filled with high-end retail stores, gourmet restaurants, art galleries and nightclubs.

The Uponor radiant floor cooling system installed on all three levels of Crystals is designed to use less energy for air conditioning and also improve occupant comfort. The radiant heating and cooling system in the exterior zones of Crystals is designed to provide subtle heat in the cooler months and a cooling system in the warmer months.

Crystals Project Data

- 98,199 feet of ⅝" Wirsbo hePEX tubing
- 6 inches on-center tube spacing for exterior zones
- 9 inches on-center tube spacing for interior zones
- Cooling only for interior zones
- Heating and cooling for exterior zones
- 25 total zones on three levels
- TruFLOW Manifolds
- LEED Gold

Manitoba Hydro Place
Winnipeg, Manitoba
LEED Platinum

Manitoba Hydro Place, the fourth-largest government-owned electric and natural gas utility in Canada, is located in one of the most challenging cities for extreme weather. Temperatures typically reach well below 0°F (-18°C) during the winter months. Yet the entire 18-floor building is being effectively and efficiently heated by renewable sources — the sun and geothermal wells, supplemented by hydroelectric power — all distributed throughout the facility by several different application methods, including an Uponor radiant heating and cooling system.

65% Less Energy Consumption

The building, which was completed in September 2009, is expected to use 65% less energy compared to similar buildings in the area. Based on simulation, the annual energy use of the building is predicted to be around 29 $kBTU/ft^2$ ($330MJ/m^2$), which is a 65% reduction from the base case. Additionally, the annual carbon footprint is predicted to be 1.1 lbs. CO^2/ft^2 (5.4 kg CO^2/m^2).

Project Data

- 695,742 square feet (64,634 square meters)
- Predicted energy use: 29 $kBTU/ft^2$ ($330MJ/m^2$)
- Predicted annual carbon footprint: 1.1 lbs. CO^2/ft^2 (5.4 kg CO^2/m^2)
- Completed September 2009
- Awarded AIA's 2010 COTE Top Ten Green Project
- LEED Platinum

Hunter Museum of American Art
Chattanooga, Tenn.

As part of the city of Chattanooga's 21st Century Waterfront Plan, the Hunter Museum of American Art received a $19.5 million expansion which included a new, 5,000-square-foot lobby complete with soaring, 30-foot glass windows. John Giles, president of ACS Services, Inc., was the installing contractor for the Hunter Museum lobby.

Since the project required especially stringent temperature constraints, Giles recommended radiant cooling in addition to radiant heating to maintain optimum comfort levels. Radiant would also meet the museum's need for an open-air design with no unsightly ductwork that would hinder the modern décor.

Scott McKenzie, project engineer for March Adams & Associates, the engineering firm hired to facilitate the Hunter Museum addition, explains how the issue of condensation was addressed when designing the cooling portion of the system. "By maintaining the floor at five degrees above the outside air dew point, it prevents condensation on the floor while providing radiant cooling and immediate absorption of heat due to direct sunlight" says McKenzie.

Another challenge the Hunter Museum posed was how to control the dramatic temperature changes that can occur when a large influx of patrons enter and exit the lobby. According to McKenzie, radiant was the most economical way to maintain a comfortable, consistent environment. "The museum has an extensive outreach program and lots of schoolchildren enter the building," says McKenzie. "Your occupancy load can go from zero to 200 in a matter of 20 minutes. But radiant gives a nice, stable mass while providing comfort at floor level where visitors are located."

Project Data

- 5,000 square-foot museum lobby
- 6,000 feet of ½" Wirsbo hePEX tubing
- 18 loops, average length 330 feet
- 3 manifolds
- 11 heating and cooling zones

Retail Supercentre, Burlington, Ontario

Installation Efficiency

In January 2009, a supercentre retail chain opened its first environmental demonstration store. The new concept store uses about 60% less energy than the company's typical supercentre store and reduces carbon emissions by an estimated 141 metric tons.

One of the key components to the supercentre's sustainable building practices is the Uponor

Radiant Rollout Mat, which allows fast, efficient installation of crosslinked polyethylene (PEX) tubing for radiant floor heating and cooling systems, and offers several benefits over standard high-density polyethylene (HDPE) mat systems and other installation methods.

With the Radiant Rollout Mats, six contractors installed about 35,000 square feet (16 to 19 mats) per day, as opposed to only 4,500 square feet per day using conventional installation methods. Installing the mats covered 7.7 times more square footage when compared to conventional installation methods for a store this size, reducing installation time to two days instead of two weeks.

Meets Tight Schedules

"The rollout mat does a great job; really speeds up the install," says Michael Hobson, section chief - mechanical at Nelco Mechanical Ltd., the mechanical contractor on the project. "This is going to open up whole new commercial markets for us to compete in. Normally, the commercial timeline is very tight, but the mat allows us to work within that aggressive schedule."

One large advantage of the Radiant Rollout Mat over HDPE mat systems is the ability to perform onsite customizations. The design of the Radiant Rollout Mat allows quick and efficient modifications simply by using Uponor's ½" engineered polymer (EP) couplings.

"The rollout mat is flexible and easy to repair or make length changes onsite," says Scott MacDonald, foreman at Nelco Mechanical Ltd. "Using HD PE would have been much more difficult."

Also, durable EP fittings can be buried in the slab; something other manufacturers' fittings simply cannot do. And unlike HDPE fusion-weld fittings, Uponor ProPEX® connections are made quickly, safely and efficiently without the need for heat, torches, solvent, glues or gauges. The ProPEX method simply requires one tool, which is available in a manual, air, battery or corded configuration to meet any application need.

Consistent Results

When the radiant heating and cooling system was ready to start up, the Radiant Rollout Mat gave consistent performance results. "The performance of the Radiant Rollout Mat system was right on target," says Nuno Duarte, P. Eng., project engineer at Stantec, the engineering firm on the project. "After commissioning, the system's flow rates, pressures and heat exchange were performing to specs."

Additionally, the installers appreciated how easy, comfortable and pain-free the Radiant Rollout Mat was to install. With HDPE, heavy equipment can become cumbersome. "With HDPE, the equipment has to be lugged around, and working in the trench was difficult due to issues with power to the equipment," says MacDonald. "Also, no one had to get on their hands and knees, so there were no issues with back pain and no one was injured."

Project Highlights

- Retail Supercentre in Burlington, Ontario
- Uponor Radiant Heating and Cooling
- Uponor Radiant Rollout Mats increase installation efficiency 7.7 times over conventional installation methods
- Reduced installation time from two weeks to two days

Project Data

- Total Area Heated and Cooled: 79,895 square feet
- Number of Radiant Rollout Mats: 73
- Tubing: 159,790 ft. of Uponor AquaPEX
- Tubing Spacing: 6" on center
- Cooling Load: 974,000 BTU/h
- Heating Load: 1,689,000 BTU/h
- Total Flow Rate: 389 gpm cooling; 371 gpm heating

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