uponor

MULTI-LAYER COMPOSITE (MLC) PIPING SYSTEMS

INSTALLATION GUIDE

Multi-layer Composite (MLC) Piping Systems Installation Guide
is published by

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Table of Contents

Section 1
Uponor MLC Tubing

Product Data

Uponor MLC tubing features aluminum pipe between inner and outer layers of crosslinked polyethylene (PEX) tubing. Layers are bonded to the aluminum by a special adhesive. MLC offers 100% oxygen diffusion which protects ferrous components from corrosion in a closed-loop, hot-water system. MLC tubing can be embedded in concrete and can be installed in walls, floors or ceilings. The flexibility of MLC tubing results in easy rollouts, and its stay-in-place rigid feature is ideal for hydronic baseboard and radiator connections.

Uponor MLC tubing uses MLC fitting assemblies to connect to Uponor's complete line of heating manifolds and compression fittings. Refer to **Section 5** for further information.

The following temperature and pressure ratings for Uponor MLC tubing are issued by the Hydrostatic Design Stress Board of the Plastics Pipe Institute (PPI). PPI is a division of the Society of Plastics Industry (SPI).

- 200°F at 100 psi
- 180°F at 125 psi
- 140°F at 160 psi
- 73°F at 200 psi

Certifications

MLC is produced to ASTM F1281 as certified by NSF International.

Listings

ICBO ER-5298; SBCCI PST; ESI 9829

Technical Data

Tubing Roughness:	2.76E-4"
Thermal Conductivity:	0.23 Btu/h/ft/°F
Thermal Expansion Coefficient:	1.38E-5/°F
Linear Expansion Rate:	0.3"/18°F (8°C)/100'
Operating Temperature (max. long term):	203°F (95°C)
Operating Temperature (max. short term):	230°F (110°C)
Operating Pressure (max. long term):	145 psi

Tubing Size	I.D.	O.D.	Weight per 100'	Volume per 100'	Min. Bend Radius by Hand	Min. Bend Radius with Bending Tool	Min. Support Vertical	Min. Support Distance Horizontal
½"	0.490"	0.636"	7.3 lbs.	0.98 gal	3.2"	-	4'	4'
⅝"	0.627"	0.793"	11.0 lbs.	1.60 gal	4"	-	4.25'	4.25'
¾"	0.792"	0.990"	17.0 lbs.	2.56 gal	5"	4"	5'	5'
1"	1.014"	1.266"	29.0 lbs.	4.19 gal	6"	5"	5.25'	5.25'

Section 2
Working with Uponor MLC Tubing

MLC tubing is ideal for radiant slab installations. Roll coils directly from the box or use an Uponor Uncoiler.

Cutting MLC

Uponor MLC tubing should be square cut perpendicular to the length of the tube with a suitable cutting tool. Be sure to remove excess material or burrs that might affect the fitting connection.

Bending

MLC tubing can be bent by hand or with an Uponor MLC Tubing Bending Tool (D6165010). Bend supports are not necessary since MLC maintains its shape. The following chart outlines the minimum bending radius for MLC tubing.

Tubing Size	Min. Bend Radius by Hand	Min. Bend Radius with Bending Tool
½"	3.2"	-
⅝"	4"	-
¾"	5"	4"
1"	6"	5"

Bending by Hand

Hold tubing with a distance of 15" to 18" from the bending point and bend to required radius.

Using an MLC Tubing Bending Tool (D6165010)

1. Chamfer the tubing end with an Uponor Chamfering Tool.
2. Insert the bending tool, leaving about 1" sticking out of the tubing.
3. Carefully bend the tubing to required radius following the minimum bending radius guidelines shown in the chart above.

IMPORTANT! Do NOT bend tubing to the point that the spring ribs become visible through the outer jacket of the tubing.

CAUTION: If the tubing is damaged or kinked during installation, use an Uponor coupling to repair. Wrap the coupling with a small piece of insulation or shrink sleeve and make a note of its location. (See instructions on **page 10**.)

Storing and Handling

Store Uponor MLC in its original packaging under cover to avoid dirt accumulation and extended exposure to direct sunlight. **Never install tubing that has been exposed to direct sunlight for more than 30 days.**

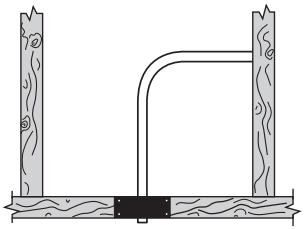
Other Handling Precautions

- **DO NOT** use Uponor tubing where temperatures and pressures exceed product ratings.
- **DO NOT** apply an open flame to Uponor tubing.
- **DO NOT** solder within 18" of Uponor tubing in the same water line.
- **DO NOT** install Uponor tubing where it will come in direct contact with high concentrations of low molecular weight petroleum products, such as fuels or solvents.
- **DO NOT** install Uponor tubing in direct contact with sharp fill.
- **DO NOT** weld or glue Uponor tubing.
- **DO NOT** install Uponor tubing within 6" of any gas appliance vents or within 12" of any uninsulated recessed light fixtures.
- **DO NOT** use Uponor tubing to convey natural gas.
- **DO NOT** use Uponor tubing for an electrical ground.
- **DO NOT** run heavy machinery over MLC tubing as it may crush the tubing wall.

Section 3
Installing in Wood Framed Construction

Protecting Exposed Tubing

Protect installed tubing from possible damage (e.g., being pierced by drywall, paneling, trim screws or nails, etc.) during construction with suitable steel plate protectors.



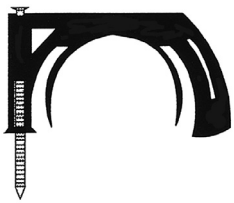
Note: Protect MLC tubing passing through hollow masonry walls or metal studs with suitable sleeves or grommets.

Tubing Runs

1. Leave extra tubing at the beginning and end of runs to simplify connection to manifolds and fittings. Immediate connection to the manifold and fittings simplifies installation.
2. Clearly mark each run with permanent marker to identify it as supply or return.
3. Install tubing within or under concrete slabs in continuous lengths (do not splice).
4. Consult local building codes for information on where and how to drill through load-bearing construction.

Tubing Supports

1. Uponor recommends using supports made specifically for plastic tubing products. Refer to the Uponor Product Catalog for a complete listing of tubing support products.



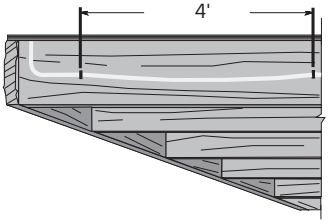
2. Do not use supports that will damage the tubing. Inspect metal supports for sharp edges.
3. The linear expansion rate for MLC is approximately 0.3" per 18°F (8°C) temperature change for every 100 feet of tubing.
4. Do not rigidly anchor MLC tubing with supports. The tubing should have freedom of movement to expand and contract.
5. Allow adequate clearance between MLC tubing and the structure (bored holes or sleeves) for freedom of movement due to thermal expansion and contraction.

Tubing Support Spacing

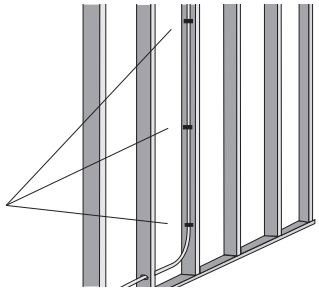
Anchor MLC securely enough to support the tubing, yet relaxed enough to allow the tubing to expand and contract.

1. For spacing recommendations, use the following chart as a guide.
2. Along vertical runs, install supports every 4' to 5' at each floor and mid-story guide.

Tubing Size	Min. Support Distance Vertical	Min. Support Distance Horizontal
½"	4'	4'
⅝"	4.25'	4.25'
¾"	5'	5'
1"	5.25'	5.25'



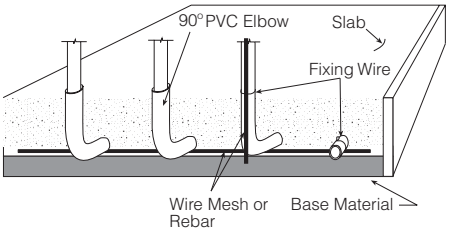
Pipe Support(s) 4' to 5'



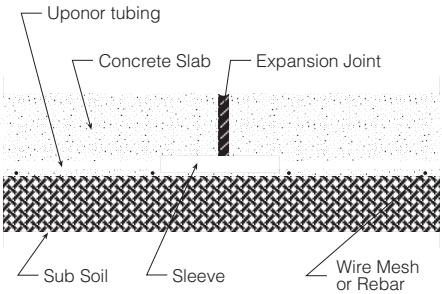
Section 4

Installing MLC In or Below the Slab

1. Secure tubing using Uponor Fixing Wire (A7031000) at intervals necessary to keep the tubing from excessive movement during the pour.
2. When entering or exiting the slab, PVC elbows may be helpful (but are not required) to ensure tubing placement when it exits the slab. In a 4" pour, the elbows will also protect the tubing from abrasion.



3. Maintain pressure on tubing installed in slab during the pour to facilitate leak detection.
4. Tubing that will be exposed to ultraviolet light for more than 30 days must be sleeved to protect against UV damage.



Notes:

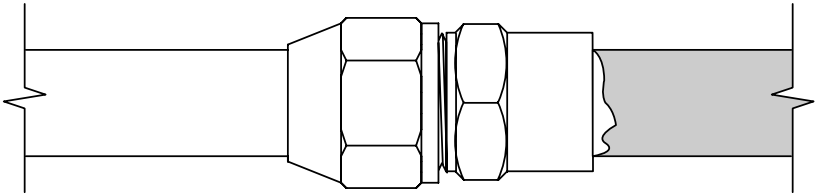
- At the entry and exit points of the slab, Uponor recommends covering 2' to 3' of the tubing with a suitable poly sleeve to prevent dirt and debris from entering the system.
- Tubing must be sleeved or dipped below the joint running through an expansion joint.

Caution: If the tubing is damaged or kinked during installation, use an Uponor coupling to repair. Wrap the coupling with a small piece of insulation or shrink sleeve and make a note of its location. (See instructions on **page 10**.)

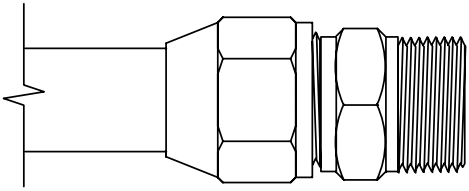
Section 5

Connecting MLC Tubing to QS-style Fittings and Brass Manifolds

The Uponor MLC compression fitting assembly is designed specifically for use with Uponor MLC tubing. The ½", ⅝" and ¾" MLC fitting assemblies adapt to any Uponor QS-style fittings, R20 (for ½" and ⅝" tubing) or R25 (for ¾" tubing). For 1" MLC tubing, a 1" large-dimension fitting assembly can be used to transition from 1" MLC to 1" MNPT. Refer to the Uponor Product Catalog for a detailed list of heating system components.

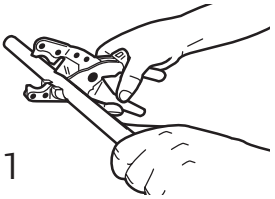


MLC Fitting Assembly Connected to a QS-style Copper Adapter



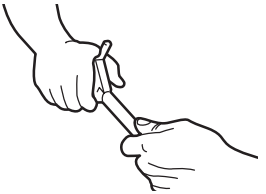
MLC Fitting Assembly Connected to a QS-style Threaded Adapter

Making a Connection



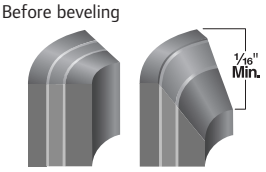
1

Cut the MLC tubing at a right angle with a tubing cutter.



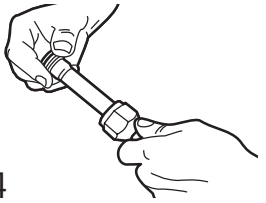
2

Bevel the MLC tubing with the chamfering tool. The depth of the bevel should be at least 1/16" to ensure a permanent and tight connection. (See **Figure 3**.)



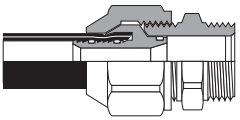
3

Visually check the tubing for an even bevel. After completing Step 2, the end of the tubing should look similar to the second illustration above.



4

Place the nut onto the tubing. Slide the insert into the end of the tubing making sure it is fully seated.



5

Tighten the thread connection. Wait 30 minutes and retighten. Pressurize the system to test.

Section 6
MLC System Sizing

MLC Tubing can be used in lieu of copper or steel piping in traditional hydronic heating systems. When combined with Uponor's complete line of heating components, MLC is ideal for the following applications:

- Radiant floor heating
- Baseboard and radiator connections
- Manifold supply piping
- Fan coils, chillers and other terminal units
- Snow and ice melting systems
- Solar systems

Baseboard System Sizing Charts

The chart on the following page will help in choosing the proper tubing size and circulator size. Uponor recommends ½" or ⅝" tubing for an efficient system design and installation. For designs requiring higher flow rates, ¾" tubing calculations are also listed.

Column A: Total Btu/h load of zone or loop

Column B: Required flow in gallons per minute (gpm) through zone or loop

Column C: Pressure drop through baseboard element (¾" copper) needed to deliver required Btus

Column D: Pressure drop through tubing (max. length recommended) and elements

Column E: Feet of baseboard required based on 550 Btu/h per foot

Maximum Length of MLC Tubing Using a Typical Small Residential Circulator

(1/25 HP Circulator)

180F Supply Water Temperature with 20F Differential

Heat Load Btu/h	Flow	Head Loss thru element 3/4" E	Pump Head	Feet of Baseboard based on 550 Btu/h per ft	1/2"		5/8"		3/4"	
					Velocity ft/sec	Tubing Length	Velocity ft/sec	Tubing Length	Velocity ft/sec	Tubing Length
A	B	C	D	E						
10,000	1	0.08	16.0	18	1.8	310	1.1	1712	0.6	6123
20,000	2	0.52	15.0	36	3.6	133	2.2	451	1.3	1627
30,000	3	1.59	14.5	55	5.4	57	3.3	194	1.9	702
40,000	4	3.50	13.8	73	7.2	27	4.3	92	2.5	333
50,000	5	6.46	13.0	91	9.0	12	5.4	39	3.2	142
60,000	6	10.69	12.3	109	10.8	9	6.5	7	3.8	24

Maximum Length of MLC Tubing Using a Typical Small Residential Circulator

(1/12 HP Circulator)

180F Supply Water Temperature with 20F Differential

Heat Load Btu/h	Flow	Head Loss thru element 3/4" E	Pump Head	Feet of Baseboard based on 550 Btu/h per ft	1/2"		5/8"		3/4"	
					Velocity ft/sec	Tubing Length	Velocity ft/sec	Tubing Length	Velocity ft/sec	Tubing Length
A	B	C	D	E						
10,000	1	0.08	24.5	18	1.8	475	1.1	2626	0.6	9392
20,000	2	0.52	23.8	36	3.6	213	2.2	724	1.3	2610
30,000	3	1.59	23.0	55	5.4	95	3.3	322	1.9	1164
40,000	4	3.50	22.8	73	7.2	51	4.3	172	2.5	625
50,000	5	6.46	22.0	91	9.0	27	5.4	93	3.2	338
60,000	6	10.69	21.0	109	10.8	58	6.5	44	3.8	161

Flow Rate and Pressure Loss

Use the following steps to find a specific flow rate and pressure loss.

1. Determine the amount of Btu/h required to heat a specific zone or loop.
2. Determine the gpm flow rate required to supply the Btu/h to that zone using the following formula: $$\textbf{gpm} = \frac{\text{Btu}}{10{,}000}$$
3. Locate the proper pressure loss chart (**pages 15 to 39**) for tubing size and water/glycol concentration.
4. Find the appropriate gpm in the pressure loss tables.
5. Cross the required gpm with the appropriate water temperature for the design to determine the pressure loss in feet for 1' of tubing.
6. Multiply that number by the total length of Uponor MLC tubing in the loop or zone.
7. Add the total pressure loss through the MLC tubing to the pressure loss through the baseboard elements.
8. If zoning with circulators, size the circulator to the appropriate gpm and head requirement for each zone.
9. If zoning with zone valves and a single circulator, size the circulator for the total system gpm and the worst-case zone pressure loss.

Note: The procedure listed above may also be used for sizing distribution piping for applications such as fan coils, radiators and manifold supplies. Simply add the pressure loss acquired through Step 6 to the unit manufacturer's published pressure loss in Step 7. Then proceed with Steps 8 or 9 for circulator sizing.

Note that even though most fin-tube baseboard has a ¾" element inside, it is typically not necessary to use ¾" MLC tubing to pipe these systems. A careful review of required flow rates and pressure losses will indicate that in many cases, ½" Uponor MLC may be used with excellent results. In cases where ½" MLC cannot deliver adequate flow, ⅝" Uponor MLC can be used. The determining factor will be the total load, pressure loss and total length of tubing in the zone.

Uponor MLC tubing can be used to offer room-by-room zoning in new construction or retrofit residential applications. Individual supply and return lines may be run to each room and then connected to baseboard, panel-type radiators or cast-iron radiators. In the mechanical room, these lines may be tied into an Uponor manifold, with telestats and thermostats providing individual zone control.

Other zoning options include zone valves, circulators, or thermostatic radiator valves (TRVs). TRVs are mounted in each room in conjunction with the specific radiation installed for local zone control. When using TRVs, Uponor recommends continuous system pump circulation with a pressure differential valve installed between the supply and return manifolds. Continuous circulation provides heat on demand when a TRV opens, while the pressure differential valve prevents "dead-heading" of the circulator when all zones are satisfied.

Uponor ½" MLC tubing should provide ample flow rates with minimal friction loss for these individual zones. Refer to the chart on **page 12** for specific pipe sizing and circulator sizing information. Uponor ½" MLC tubing provides the added advantage of a low-cost, easily installed system.

Room-by-room zoning is perfect for retrofit and remodel applications, especially when electric baseboard is being replaced with hydronic baseboard. Since MLC is flexible, the tubing may be run in a cramped, hard to reach area with minimal damage to the existing structure. In addition, the lack of solder joints in those hard to reach areas reduces the likelihood of torch damage and potential leaks at concealed fittings.

MLC Pressure Loss Charts

When using Uponor MLC tubing for radiant floor heating systems, refer to the Uponor Complete Design Assistance Manual (CDAM) for system design and layout assistance. The following charts beginning on **page 15** are provided for MLC pressure loss calculations.

½" **Uponor MLC** — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.29	0.00456	0.00425	0.00400	0.00380	0.00363	0.00349	0.00338
0.6	0.35	0.00620	0.00578	0.00545	0.00519	0.00497	0.00478	0.00462
0.7	0.41	0.00805	0.00752	0.00710	0.00676	0.00647	0.00624	0.00603
0.8	0.47	0.01010	0.00944	0.00892	0.00850	0.00815	0.00786	0.00760
0.9	0.53	0.01234	0.01155	0.01092	0.01042	0.00999	0.00964	0.00933
1.0	0.59	0.01477	0.01384	0.01310	0.01250	0.01199	0.01157	0.01121
1.1	0.65	0.01738	0.01630	0.01544	0.01474	0.01415	0.01366	0.01324
1.2	0.71	0.02018	0.01893	0.01794	0.01714	0.01646	0.01589	0.01541
1.3	0.76	0.02315	0.02174	0.02061	0.01969	0.01893	0.01828	0.01773
1.4	0.82	0.02630	0.02470	0.02344	0.02240	0.02154	0.02081	0.02018
1.5	0.88	0.02961	0.02783	0.02642	0.02526	0.02430	0.02348	0.02278
1.6	0.94	0.03310	0.03113	0.02955	0.02827	0.02720	0.02629	0.02551
1.7	1.00	0.03675	0.03458	0.03284	0.03142	0.03024	0.02924	0.02838
1.8	1.06	0.04057	0.03818	0.03628	0.03472	0.03343	0.03232	0.03138
1.9	1.12	0.04454	0.04194	0.03986	0.03817	0.03675	0.03554	0.03452
2.0	1.18	0.04868	0.04586	0.04360	0.04175	0.04021	0.03890	0.03778
2.1	1.23	0.05298	0.04992	0.04748	0.04548	0.04381	0.04239	0.04118
2.2	1.29	0.05743	0.05413	0.05150	0.04934	0.04754	0.04601	0.04470
2.3	1.35	0.06204	0.05850	0.05566	0.05335	0.05141	0.04976	0.04835
2.4	1.41	0.06680	0.06301	0.05997	0.05749	0.05541	0.05364	0.05213
2.5	1.47	0.07172	0.06766	0.06441	0.06176	0.05954	0.05764	0.05603
2.6	1.53	0.07678	0.07246	0.06900	0.06617	0.06380	0.06178	0.06006
2.7	1.59	0.08200	0.07740	0.07372	0.07071	0.06819	0.06604	0.06421
2.8	1.65	0.08737	0.08249	0.07858	0.07539	0.07271	0.07042	0.06848
2.9	1.70	0.09288	0.08771	0.08358	0.08019	0.07735	0.07494	0.07288
3.0	1.76	0.09854	0.09308	0.08871	0.08513	0.08213	0.07957	0.07739
3.1	1.82	0.10435	0.09859	0.09397	0.09019	0.08703	0.08433	0.08203
3.2	1.88	0.11030	0.10423	0.09937	0.09539	0.09205	0.08921	0.08679
3.3	1.94	0.11639	0.11001	0.10490	0.10071	0.09720	0.09421	0.09166
3.4	2.00	0.12263	0.11593	0.11056	0.10617	0.10248	0.09933	0.09666
3.5	2.06	0.12901	0.12199	0.11636	0.11174	0.10787	0.10458	0.10177
3.6	2.12	0.13553	0.12818	0.12228	0.11745	0.11339	0.10994	0.10700
3.7	2.17	0.14219	0.13450	0.12833	0.12328	0.11904	0.11542	0.11234
3.8	2.23	0.14899	0.14096	0.13451	0.12923	0.12480	0.12102	0.11780
3.9	2.29	0.15593	0.14755	0.14083	0.13531	0.13069	0.12674	0.12338
4.0	2.35	0.16301	0.15427	0.14726	0.14151	0.13669	0.13258	0.12907
4.1	2.41		0.16113	0.15383	0.14784	0.14281	0.13853	0.13488
4.2	2.47		0.16812	0.16052	0.15429	0.14906	0.14460	0.14080
4.3	2.53			0.16734	0.16086	0.15542	0.15079	0.14683
4.4	2.59				0.16755	0.16190	0.15709	0.15298
4.5	2.65					0.16850	0.16350	0.15924
4.6	2.70							0.16561

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

⅝" **Uponor MLC** — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.48	0.00330	0.00308	0.00290	0.00276	0.00265	0.00255	0.00246
0.6	0.58	0.00449	0.00420	0.00397	0.00378	0.00362	0.00349	0.00338
0.7	0.67	0.00584	0.00547	0.00517	0.00493	0.00473	0.00456	0.00441
0.8	0.77	0.00733	0.00687	0.00651	0.00621	0.00596	0.00575	0.00557
0.9	0.87	0.00897	0.00842	0.00797	0.00761	0.00731	0.00706	0.00684
1.0	0.96	0.01075	0.01009	0.00957	0.00914	0.00878	0.00848	0.00822
1.1	1.06	0.01266	0.01190	0.01129	0.01079	0.01037	0.01002	0.00972
1.2	1.15	0.01471	0.01383	0.01313	0.01255	0.01207	0.01167	0.01132
1.3	1.25	0.01689	0.01589	0.01508	0.01443	0.01389	0.01342	0.01303
1.4	1.35	0.01919	0.01806	0.01716	0.01643	0.01581	0.01529	0.01484
1.5	1.44	0.02163	0.02036	0.01936	0.01853	0.01784	0.01726	0.01676
1.6	1.54	0.02419	0.02278	0.02166	0.02075	0.01998	0.01933	0.01878
1.7	1.64	0.02687	0.02532	0.02408	0.02307	0.02223	0.02151	0.02089
1.8	1.73	0.02967	0.02797	0.02662	0.02551	0.02458	0.02379	0.02311
1.9	1.83	0.03259	0.03074	0.02926	0.02805	0.02703	0.02616	0.02543
2.0	1.92	0.03563	0.03362	0.03201	0.03069	0.02958	0.02864	0.02784
2.1	2.02	0.03879	0.03661	0.03487	0.03344	0.03224	0.03122	0.03035
2.2	2.12	0.04207	0.03972	0.03783	0.03629	0.03500	0.03390	0.03296
2.3	2.21	0.04546	0.04293	0.04090	0.03925	0.03785	0.03667	0.03566
2.4	2.31	0.04896	0.04625	0.04408	0.04230	0.04081	0.03954	0.03846
2.5	2.41	0.05258	0.04968	0.04736	0.04546	0.04386	0.04250	0.04134
2.6	2.50	0.05631	0.05322	0.05075	0.04872	0.04701	0.04556	0.04433
2.7	2.60	0.06015	0.05687	0.05423	0.05207	0.05026	0.04872	0.04740
2.8	2.69	0.06410	0.06062	0.05782	0.05553	0.05360	0.05196	0.05056
2.9	2.79	0.06817	0.06447	0.06151	0.05908	0.05704	0.05530	0.05382
3.0	2.89	0.07234	0.06843	0.06530	0.06273	0.06057	0.05873	0.05717
3.1	2.98	0.07662	0.07250	0.06919	0.06648	0.06420	0.06226	0.06060
3.2	3.08	0.08100	0.07666	0.07318	0.07032	0.06792	0.06587	0.06413
3.3	3.18	0.08550	0.08093	0.07726	0.07426	0.07173	0.06958	0.06774
3.4	3.27	0.09010	0.08530	0.08145	0.07829	0.07564	0.07337	0.07144
3.5	3.37	0.09480	0.08977	0.08573	0.08242	0.07963	0.07726	0.07523
3.6	3.46	0.09961	0.09434	0.09011	0.08664	0.08372	0.08123	0.07911
3.7	3.56	0.10453	0.09902	0.09459	0.09095	0.08790	0.08529	0.08307
3.8	3.66	0.10954	0.10379	0.09916	0.09536	0.09217	0.08945	0.08712
3.9	3.75	0.11467	0.10866	0.10383	0.09986	0.09653	0.09369	0.09126
4.0	3.85	0.11989	0.11363	0.10859	0.10445	0.10098	0.09801	0.09548
4.1	3.95	0.12522	0.11869	0.11345	0.10914	0.10552	0.10243	0.09979
4.2	4.04	0.13065	0.12386	0.11840	0.11391	0.11015	0.10693	0.10418
4.3	4.14	0.13618	0.12912	0.12344	0.11878	0.11486	0.11152	0.10866
4.4	4.23	0.14181	0.13448	0.12858	0.12374	0.11967	0.11619	0.11322
4.5	4.33	0.14754	0.13994	0.13381	0.12879	0.12456	0.12095	0.11787
4.6	4.43	0.15337	0.14549	0.13914	0.13392	0.12954	0.12579	0.12260
4.7	4.52	0.15931	0.15113	0.14455	0.13915	0.13460	0.13072	0.12741
4.8	4.62	0.16534	0.15687	0.15006	0.14447	0.13976	0.13574	0.13231

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

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Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
4.9	4.72		0.16271	0.15566	0.14987	0.14500	0.14084	0.13729
5.0	4.81		0.16864	0.16135	0.15536	0.15033	0.14602	0.14235
5.1	4.91			0.16714	0.16094	0.15574	0.15129	0.14750
5.2	5.00				0.16661	0.16124	0.15664	0.15272
5.3	5.10					0.16682	0.16208	0.15803
5.4	5.20						0.16760	0.16342
5.5	5.29							0.16889

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

¾" **Uponor MLC** — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.77	0.00243	0.00227	0.00215	0.00205	0.00196	0.00189	0.00183
0.6	0.92	0.00332	0.00311	0.00294	0.00280	0.00269	0.00260	0.00251
0.7	1.08	0.00432	0.00405	0.00384	0.00366	0.00352	0.00339	0.00329
0.8	1.23	0.00543	0.00510	0.00483	0.00462	0.00444	0.00428	0.00415
0.9	1.38	0.00665	0.00625	0.00593	0.00567	0.00545	0.00526	0.00511
1.0	1.54	0.00797	0.00750	0.00712	0.00681	0.00655	0.00633	0.00614
1.1	1.69	0.00940	0.00884	0.00840	0.00804	0.00774	0.00748	0.00726
1.2	1.84	0.01092	0.01029	0.00978	0.00936	0.00901	0.00872	0.00846
1.3	2.00	0.01255	0.01182	0.01124	0.01077	0.01037	0.01003	0.00975
1.4	2.15	0.01427	0.01345	0.01280	0.01226	0.01181	0.01143	0.01111
1.5	2.30	0.01609	0.01517	0.01444	0.01384	0.01334	0.01291	0.01255
1.6	2.46	0.01800	0.01698	0.01617	0.01550	0.01494	0.01447	0.01406
1.7	2.61	0.02000	0.01888	0.01798	0.01724	0.01663	0.01610	0.01565
1.8	2.76	0.02210	0.02087	0.01988	0.01907	0.01839	0.01781	0.01732
1.9	2.92	0.02428	0.02294	0.02186	0.02097	0.02023	0.01960	0.01906
2.0	3.07	0.02656	0.02509	0.02392	0.02296	0.02215	0.02146	0.02088
2.1	3.23	0.02892	0.02734	0.02606	0.02502	0.02415	0.02340	0.02277
2.2	3.38	0.03137	0.02966	0.02829	0.02716	0.02622	0.02541	0.02473
2.3	3.53	0.03391	0.03207	0.03059	0.02938	0.02837	0.02750	0.02676
2.4	3.69	0.03654	0.03456	0.03298	0.03168	0.03059	0.02966	0.02886
2.5	3.84	0.03925	0.03714	0.03544	0.03405	0.03288	0.03189	0.03104
2.6	3.99	0.04204	0.03979	0.03798	0.03650	0.03525	0.03419	0.03328
2.7	4.15	0.04492	0.04253	0.04060	0.03902	0.03770	0.03656	0.03560
2.8	4.30	0.04788	0.04534	0.04330	0.04162	0.04021	0.03901	0.03798
2.9	4.45	0.05093	0.04823	0.04607	0.04429	0.04280	0.04152	0.04043
3.0	4.61	0.05405	0.05121	0.04892	0.04704	0.04546	0.04411	0.04296
3.1	4.76	0.05726	0.05426	0.05184	0.04985	0.04818	0.04676	0.04554
3.2	4.91	0.06055	0.05739	0.05484	0.05274	0.05099	0.04948	0.04820
3.3	5.07	0.06392	0.06059	0.05791	0.05571	0.05386	0.05227	0.05092
3.4	5.22	0.06737	0.06387	0.06106	0.05874	0.05680	0.05513	0.05372
3.5	5.38	0.07091	0.06723	0.06428	0.06185	0.05981	0.05806	0.05657
3.6	5.53	0.07452	0.07067	0.06757	0.06503	0.06289	0.06106	0.05950
3.7	5.68	0.07820	0.07418	0.07094	0.06827	0.06603	0.06412	0.06249
3.8	5.84	0.08197	0.07777	0.07438	0.07159	0.06925	0.06725	0.06554
3.9	5.99	0.08582	0.08143	0.07789	0.07498	0.07254	0.07045	0.06866
4.0	6.14	0.08974	0.08516	0.08147	0.07844	0.07589	0.07371	0.07185
4.1	6.30	0.09374	0.08897	0.08513	0.08197	0.07931	0.07704	0.07510
4.2	6.45	0.09782	0.09286	0.08886	0.08557	0.08280	0.08043	0.07841
4.3	6.60	0.10198	0.09681	0.09265	0.08923	0.08635	0.08389	0.08179
4.4	6.76	0.10621	0.10084	0.09652	0.09297	0.08997	0.08742	0.08523
4.5	6.91	0.11051	0.10495	0.10046	0.09677	0.09366	0.09101	0.08874
4.6	7.06	0.11490	0.10912	0.10447	0.10064	0.09742	0.09466	0.09231
4.7	7.22	0.11935	0.11337	0.10855	0.10458	0.10124	0.09838	0.09594
4.8	7.37	0.12389	0.11769	0.11270	0.10859	0.10513	0.10217	0.09964

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Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
4.9	7.53	0.12850	0.12208	0.11691	0.11266	0.10908	0.10602	0.10340
5.0	7.68	0.13318	0.12655	0.12120	0.11680	0.11310	0.10993	0.10722
5.1	7.83	0.13793	0.13108	0.12556	0.12101	0.11718	0.11390	0.11111
5.2	7.99	0.14277	0.13569	0.12998	0.12528	0.12133	0.11794	0.11506
5.3	8.14	0.14767	0.14037	0.13447	0.12962	0.12554	0.12205	0.11906
5.4	8.29	0.15265	0.14511	0.13903	0.13403	0.12982	0.12621	0.12314
5.5	8.45	0.15770	0.14993	0.14366	0.13850	0.13416	0.13044	0.12727
5.6	8.60	0.16282	0.15482	0.14836	0.14304	0.13856	0.13473	0.13146
5.7	8.75	0.16802	0.15978	0.15312	0.14765	0.14303	0.13909	0.13572
5.8	8.91		0.16480	0.15795	0.15231	0.14756	0.14350	0.14003
5.9	9.06		0.16990	0.16285	0.15705	0.15216	0.14798	0.14441
6.0	9.21			0.16782	0.16185	0.15682	0.15252	0.14885
6.1	9.37				0.16671	0.16155	0.15713	0.15335
6.2	9.52					0.16633	0.16179	0.15791
6.3	9.68						0.16652	0.16253
6.4	9.83							0.16721

1" Uponor MLC — 100% Water — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
1.5	3.78	1.18	1.11	1.06	1.02	0.98	0.95	0.92
1.6	4.03	1.32	1.25	1.19	1.14	1.10	1.07	1.04
1.7	4.28	1.47	1.39	1.32	1.27	1.22	1.19	1.15
1.8	4.53	1.62	1.53	1.46	1.40	1.36	1.31	1.28
1.9	4.78	1.78	1.69	1.61	1.54	1.49	1.45	1.41
2.0	5.03	1.95	1.84	1.76	1.69	1.63	1.58	1.54
2.1	5.29	2.12	2.01	1.92	1.84	1.78	1.73	1.68
2.2	5.54	2.30	2.18	2.08	2.00	1.93	1.88	1.83
2.3	5.79	2.49	2.36	2.25	2.17	2.09	2.03	1.98
2.4	6.04	2.68	2.54	2.43	2.34	2.26	2.19	2.13
2.5	6.29	2.88	2.73	2.61	2.51	2.43	2.36	2.29
2.6	6.55	3.09	2.93	2.80	2.69	2.60	2.53	2.46
2.7	6.80	3.30	3.13	2.99	2.88	2.78	2.70	2.63
2.8	7.05	3.52	3.34	3.19	3.07	2.97	2.88	2.81
2.9	7.30	3.75	3.55	3.40	3.27	3.16	3.07	2.99
3.0	7.55	3.98	3.77	3.61	3.47	3.36	3.26	3.18
3.1	7.80	4.21	4.00	3.83	3.68	3.56	3.46	3.37
3.2	8.06	4.46	4.23	4.05	3.90	3.77	3.66	3.57
3.3	8.31	4.71	4.47	4.27	4.12	3.98	3.87	3.77
3.4	8.56	4.96	4.71	4.51	4.34	4.20	4.08	3.98
3.5	8.81	5.22	4.96	4.75	4.57	4.42	4.30	4.19
3.6	9.06	5.49	5.21	4.99	4.81	4.65	4.52	4.41
3.7	9.31	5.76	5.47	5.24	5.05	4.89	4.75	4.63
3.8	9.57	6.04	5.74	5.49	5.29	5.12	4.98	4.86
3.9	9.82	6.33	6.01	5.75	5.55	5.37	5.22	5.09
4.0	10.07	6.62	6.29	6.02	5.80	5.62	5.46	5.32
4.1	10.32	6.91	6.57	6.29	6.06	5.87	5.71	5.57
4.2	10.57	7.21	6.86	6.57	6.33	6.13	5.96	5.81
4.3	10.82	7.52	7.15	6.85	6.60	6.39	6.22	6.06
4.4	11.08	7.83	7.45	7.14	6.88	6.66	6.48	6.32
4.5	11.33	8.15	7.75	7.43	7.16	6.94	6.74	6.58
4.6	11.58	8.48	8.06	7.73	7.45	7.22	7.02	6.85
4.7	11.83	8.81	8.38	8.03	7.74	7.50	7.29	7.12
4.8	12.08	9.14	8.70	8.34	8.04	7.79	7.57	7.39
4.9	12.33	9.48	9.02	8.65	8.34	8.08	7.86	7.67
5.0	12.59	9.83	9.35	8.97	8.65	8.38	8.15	7.95
5.1	12.84	10.18	9.69	9.29	8.96	8.68	8.45	8.24
5.2	13.09	10.54	10.03	9.62	9.28	8.99	8.75	8.54
5.3	13.34	10.90	10.38	9.95	9.60	9.31	9.05	8.84
5.4	13.59	11.27	10.73	10.29	9.93	9.62	9.36	9.14
5.5	13.85	11.65	11.09	10.63	10.26	9.95	9.68	9.45
5.6	14.10	12.03	11.45	10.98	10.60	10.27	10.00	9.76
5.7	14.35	12.41	11.82	11.34	10.94	10.61	10.32	10.07
5.8	14.60	12.80	12.19	11.69	11.29	10.94	10.65	10.40

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Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

Velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

continued from previous page

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
5.9	14.85	13.20	12.57	12.06	11.64	11.28	10.98	10.72
6.0	15.10	13.60	12.95	12.43	11.99	11.63	11.32	11.05
6.1	15.36	14.01	13.34	12.80	12.36	11.98	11.66	11.39
6.2	15.61	14.42	13.73	13.18	12.72	12.34	12.01	11.73
6.3	15.86	14.83	14.13	13.56	13.09	12.70	12.36	12.07
6.4	16.11	15.26	14.53	13.95	13.47	13.06	12.72	12.42
6.5	16.36	15.68	14.94	14.34	13.85	13.43	13.08	12.77
6.6	16.61	16.12	15.36	14.74	14.24	13.81	13.44	13.13
6.7	16.87	16.56	15.78	15.15	14.63	14.19	13.81	13.49
6.8	17.12	17.00	16.20	15.55	15.02	14.57	14.19	13.86
6.9	17.37	17.45	16.63	15.97	15.42	14.96	14.57	14.23
7.0	17.62	17.90	17.06	16.39	15.83	15.35	14.95	14.60
7.1	17.87	18.36	17.50	16.81	16.23	15.75	15.34	14.98
7.2	18.12	18.83	17.95	17.24	16.65	16.15	15.73	15.37
7.3	18.38	19.30	18.40	17.67	17.07	16.56	16.13	15.76
7.4	18.63	19.77	18.85	18.11	17.49	16.97	16.53	16.15
7.5	18.88	20.25	19.31	18.55	17.92	17.39	16.93	16.55
7.6	19.13	20.74	19.77	18.99	18.35	17.81	17.34	16.95
7.7	19.38	21.23	20.24	19.45	18.79	18.23	17.76	17.35
7.8	19.64	21.72	20.72	19.90	19.23	18.66	18.18	17.76
7.9	19.89	22.22	21.20	20.36	19.68	19.10	18.60	18.18
8.0	20.14	22.73	21.68	20.83	20.13	19.54	19.03	18.60
8.1	20.39	23.24	22.17	21.30	20.58	19.98	19.46	19.02
8.2	20.64	23.76	22.66	21.78	21.05	20.43	19.90	19.45
8.3	20.89	24.28	23.16	22.26	21.51	20.88	20.34	19.88
8.4	21.15	24.80	23.66	22.74	21.98	21.34	20.79	20.32
8.5	21.40	25.33	24.17	23.23	22.45	21.80	21.24	20.76
8.6	21.65	25.87	24.68	23.73	22.93	22.27	21.69	21.20
8.7	21.90	26.41	25.20	24.22	23.42	22.74	22.15	21.65
8.8	22.15	26.96	25.72	24.73	23.91	23.21	22.62	22.11
8.9	22.40	27.51	26.25	25.24	24.40	23.69	23.08	22.57
9.0	22.66	28.06	26.78	25.75	24.89	24.17	23.56	23.03
9.1	22.91	28.63	27.32	26.27	25.40	24.66	24.03	23.50
9.2	23.16	29.19	27.86	26.79	25.90	25.15	24.51	23.97
9.3	23.41	29.76	28.41	27.32	26.41	25.65	25.00	24.44
9.4	23.66	30.34	28.96	27.85	26.93	26.15	25.49	24.92

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

Velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

½" **Uponor MLC** — 30% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.29	0.00671	0.00594	0.00538	0.00496	0.00464	0.00438	0.00418
0.6	0.35	0.00905	0.00803	0.00730	0.00673	0.00631	0.00596	0.00569
0.7	0.41	0.01166	0.01038	0.00944	0.00872	0.00819	0.00775	0.00740
0.8	0.47	0.01454	0.01297	0.01182	0.01093	0.01027	0.00973	0.00930
0.9	0.53	0.01767	0.01579	0.01442	0.01335	0.01256	0.01190	0.01139
1.0	0.59	0.02106	0.01885	0.01723	0.01597	0.01503	0.01426	0.01365
1.1	0.65	0.02469	0.02213	0.02024	0.01878	0.01770	0.01679	0.01609
1.2	0.71	0.02855	0.02562	0.02347	0.02179	0.02054	0.01950	0.01869
1.3	0.76	0.03265	0.02934	0.02689	0.02499	0.02357	0.02239	0.02147
1.4	0.82	0.03698	0.03326	0.03051	0.02837	0.02677	0.02544	0.02440
1.5	0.88	0.04153	0.03739	0.03432	0.03194	0.03015	0.02867	0.02750
1.6	0.94	0.04630	0.04172	0.03832	0.03568	0.03370	0.03206	0.03076
1.7	1.00	0.05129	0.04625	0.04251	0.03960	0.03742	0.03561	0.03418
1.8	1.06	0.05649	0.05098	0.04689	0.04370	0.04131	0.03932	0.03776
1.9	1.12	0.06190	0.05590	0.05145	0.04797	0.04536	0.04319	0.04148
2.0	1.18	0.06752	0.06102	0.05618	0.05241	0.04958	0.04722	0.04536
2.1	1.23	0.07335	0.06632	0.06110	0.05702	0.05396	0.05140	0.04939
2.2	1.29	0.07938	0.07182	0.06619	0.06179	0.05850	0.05574	0.05357
2.3	1.35	0.08561	0.07750	0.07146	0.06674	0.06319	0.06023	0.05790
2.4	1.41	0.09204	0.08336	0.07690	0.07184	0.06804	0.06487	0.06237
2.5	1.47	0.09867	0.08941	0.08251	0.07711	0.07305	0.06966	0.06699
2.6	1.53	0.10549	0.09564	0.08829	0.08254	0.07821	0.07460	0.07175
2.7	1.59	0.11251	0.10204	0.09424	0.08813	0.08353	0.07968	0.07666
2.8	1.65	0.11972	0.10863	0.10036	0.09387	0.08900	0.08492	0.08171
2.9	1.70	0.12711	0.11539	0.10664	0.09978	0.09462	0.09029	0.08689
3.0	1.76	0.13470	0.12233	0.11309	0.10584	0.10038	0.09582	0.09222
3.1	1.82	0.14248	0.12944	0.11970	0.11205	0.10630	0.10148	0.09769
3.2	1.88	0.15044	0.13672	0.12647	0.11842	0.11237	0.10729	0.10329
3.3	1.94	0.15858	0.14418	0.13340	0.12494	0.11858	0.11324	0.10903
3.4	2.00	0.16691	0.15180	0.14050	0.13162	0.12493	0.11933	0.11491
3.5	2.06		0.15960	0.14775	0.13844	0.13144	0.12556	0.12093
3.6	2.12		0.16756	0.15516	0.14542	0.13808	0.13193	0.12707
3.7	2.17			0.16273	0.15255	0.14487	0.13843	0.13336
3.8	2.23				0.15982	0.15180	0.14508	0.13977
3.9	2.29				0.16724	0.15888	0.15186	0.14632
4.0	2.35					0.16609	0.15878	0.15301
4.1	2.41						0.16583	0.15982
4.2	2.47							0.16676

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

⅝" **Uponor MLC** — 30% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.48	0.00490	0.00435	0.00395	0.00364	0.00342	0.00323	0.00308
0.6	0.58	0.00661	0.00589	0.00536	0.00495	0.00465	0.00440	0.00421
0.7	0.67	0.00853	0.00762	0.00695	0.00643	0.00605	0.00573	0.00548
0.8	0.77	0.01065	0.00953	0.00870	0.00807	0.00759	0.00720	0.00689
0.9	0.87	0.01296	0.01162	0.01063	0.00986	0.00929	0.00881	0.00844
1.0	0.96	0.01546	0.01387	0.01271	0.01180	0.01112	0.01056	0.01012
1.1	1.06	0.01814	0.01630	0.01494	0.01389	0.01310	0.01245	0.01193
1.2	1.15	0.02099	0.01889	0.01733	0.01612	0.01522	0.01447	0.01388
1.3	1.25	0.02402	0.02164	0.01987	0.01850	0.01747	0.01661	0.01594
1.4	1.35	0.02722	0.02454	0.02256	0.02101	0.01986	0.01889	0.01813
1.5	1.44	0.03059	0.02760	0.02539	0.02366	0.02237	0.02129	0.02044
1.6	1.54	0.03412	0.03081	0.02836	0.02645	0.02501	0.02382	0.02288
1.7	1.64	0.03781	0.03418	0.03148	0.02937	0.02779	0.02646	0.02543
1.8	1.73	0.04166	0.03769	0.03473	0.03242	0.03068	0.02923	0.02809
1.9	1.83	0.04567	0.04134	0.03812	0.03560	0.03370	0.03212	0.03088
2.0	1.92	0.04984	0.04514	0.04164	0.03890	0.03685	0.03512	0.03377
2.1	2.02	0.05416	0.04908	0.04530	0.04234	0.04011	0.03825	0.03678
2.2	2.12	0.05863	0.05316	0.04909	0.04589	0.04349	0.04148	0.03990
2.3	2.21	0.06325	0.05738	0.05301	0.04958	0.04700	0.04484	0.04314
2.4	2.31	0.06802	0.06174	0.05706	0.05338	0.05062	0.04830	0.04648
2.5	2.41	0.07294	0.06624	0.06124	0.05731	0.05436	0.05188	0.04993
2.6	2.50	0.07800	0.07087	0.06554	0.06136	0.05821	0.05557	0.05349
2.7	2.60	0.08321	0.07564	0.06997	0.06553	0.06218	0.05937	0.05716
2.8	2.69	0.08857	0.08054	0.07453	0.06981	0.06626	0.06328	0.06093
2.9	2.79	0.09406	0.08557	0.07921	0.07422	0.07046	0.06730	0.06481
3.0	2.89	0.09970	0.09073	0.08402	0.07874	0.07477	0.07143	0.06880
3.1	2.98	0.10548	0.09603	0.08895	0.08338	0.07919	0.07567	0.07289
3.2	3.08	0.11139	0.10145	0.09400	0.08814	0.08372	0.08001	0.07708
3.3	3.18	0.11745	0.10700	0.09917	0.09301	0.08836	0.08446	0.08138
3.4	3.27	0.12364	0.11268	0.10446	0.09799	0.09311	0.08901	0.08578
3.5	3.37	0.12997	0.11849	0.10987	0.10309	0.09797	0.09367	0.09028
3.6	3.46	0.13644	0.12442	0.11540	0.10830	0.10294	0.09844	0.09488
3.7	3.56	0.14304	0.13047	0.12105	0.11362	0.10801	0.10331	0.09959
3.8	3.66	0.14977	0.13666	0.12681	0.11905	0.11320	0.10828	0.10439
3.9	3.75	0.15664	0.14296	0.13269	0.12460	0.11849	0.11335	0.10930
4.0	3.85	0.16364	0.14939	0.13869	0.13025	0.12388	0.11853	0.11430
4.1	3.95		0.15594	0.14480	0.13602	0.12939	0.12381	0.11941
4.2	4.04		0.16262	0.15103	0.14190	0.13499	0.12919	0.12461
4.3	4.14		0.16941	0.15738	0.14788	0.14071	0.13467	0.12991
4.4	4.23			0.16383	0.15397	0.14652	0.14026	0.13530
4.5	4.33				0.16017	0.15244	0.14594	0.14080
4.6	4.43				0.16648	0.15846	0.15172	0.14639
4.7	4.52					0.16459	0.15760	0.15208
4.8	4.62						0.16358	0.15786
4.9	4.72						0.16966	0.16374
5.0	4.81							0.16972

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

¾" **Uponor MLC** — 30% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.77	0.00367	0.00327	0.00297	0.00275	0.00258	0.00244	0.00233
0.6	0.92	0.00496	0.00443	0.00404	0.00374	0.00351	0.00333	0.00318
0.7	1.08	0.00641	0.00573	0.00524	0.00486	0.00457	0.00433	0.00415
0.8	1.23	0.00801	0.00718	0.00657	0.00610	0.00574	0.00545	0.00522
0.9	1.38	0.00975	0.00876	0.00802	0.00745	0.00703	0.00668	0.00640
1.0	1.54	0.01164	0.01047	0.00960	0.00893	0.00843	0.00801	0.00768
1.1	1.69	0.01366	0.01230	0.01130	0.01052	0.00993	0.00944	0.00906
1.2	1.84	0.01582	0.01426	0.01311	0.01221	0.01154	0.01098	0.01054
1.3	2.00	0.01811	0.01635	0.01504	0.01402	0.01325	0.01261	0.01211
1.4	2.15	0.02053	0.01855	0.01708	0.01593	0.01507	0.01435	0.01378
1.5	2.30	0.02308	0.02087	0.01923	0.01794	0.01698	0.01618	0.01554
1.6	2.46	0.02576	0.02331	0.02149	0.02006	0.01899	0.01810	0.01740
1.7	2.61	0.02856	0.02586	0.02385	0.02228	0.02110	0.02012	0.01934
1.8	2.76	0.03148	0.02853	0.02633	0.02460	0.02331	0.02223	0.02137
1.9	2.92	0.03452	0.03130	0.02890	0.02702	0.02561	0.02443	0.02350
2.0	3.07	0.03768	0.03419	0.03158	0.02954	0.02801	0.02672	0.02571
2.1	3.23	0.04095	0.03718	0.03437	0.03216	0.03049	0.02910	0.02800
2.2	3.38	0.04435	0.04028	0.03725	0.03487	0.03307	0.03157	0.03039
2.3	3.53	0.04785	0.04349	0.04023	0.03767	0.03574	0.03413	0.03285
2.4	3.69	0.05147	0.04681	0.04332	0.04057	0.03851	0.03677	0.03541
2.5	3.84	0.05521	0.05023	0.04650	0.04357	0.04136	0.03950	0.03804
2.6	3.99	0.05906	0.05375	0.04978	0.04665	0.04430	0.04232	0.04076
2.7	4.15	0.06301	0.05738	0.05315	0.04983	0.04732	0.04522	0.04356
2.8	4.30	0.06708	0.06110	0.05662	0.05310	0.05044	0.04821	0.04645
2.9	4.45	0.07125	0.06493	0.06019	0.05646	0.05364	0.05128	0.04941
3.0	4.61	0.07554	0.06886	0.06385	0.05991	0.05693	0.05443	0.05246
3.1	4.76	0.07993	0.07289	0.06761	0.06344	0.06030	0.05766	0.05558
3.2	4.91	0.08443	0.07702	0.07145	0.06707	0.06376	0.06098	0.05879
3.3	5.07	0.08903	0.08124	0.07540	0.07079	0.06731	0.06438	0.06207
3.4	5.22	0.09374	0.08557	0.07943	0.07459	0.07093	0.06786	0.06543
3.5	5.38	0.09855	0.08999	0.08355	0.07848	0.07465	0.07142	0.06888
3.6	5.53	0.10347	0.09451	0.08777	0.08245	0.07844	0.07506	0.07240
3.7	5.68	0.10849	0.09912	0.09208	0.08652	0.08232	0.07878	0.07599
3.8	5.84	0.11361	0.10383	0.09647	0.09067	0.08628	0.08258	0.07967
3.9	5.99	0.11884	0.10864	0.10096	0.09490	0.09032	0.08646	0.08342
4.0	6.14	0.12416	0.11353	0.10553	0.09922	0.09444	0.09042	0.08724
4.1	6.30	0.12959	0.11853	0.11020	0.10362	0.09864	0.09446	0.09115
4.2	6.45	0.13512	0.12361	0.11495	0.10811	0.10293	0.09857	0.09513
4.3	6.60	0.14074	0.12879	0.11979	0.11267	0.10729	0.10276	0.09918
4.4	6.76	0.14647	0.13406	0.12472	0.11733	0.11174	0.10703	0.10331
4.5	6.91	0.15230	0.13943	0.12973	0.12206	0.11626	0.11138	0.10751
4.6	7.06	0.15822	0.14488	0.13483	0.12688	0.12087	0.11580	0.11179
4.7	7.22	0.16424	0.15043	0.14002	0.13178	0.12555	0.12030	0.11615
4.8	7.37		0.15607	0.14529	0.13676	0.13031	0.12487	0.12057

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Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
4.9	7.53		0.16180	0.15065	0.14183	0.13515	0.12953	0.12507
5.0	7.68		0.16762	0.15609	0.14697	0.14007	0.13425	0.12965
5.1	7.83			0.16162	0.15220	0.14506	0.13905	0.13429
5.2	7.99			0.16723	0.15750	0.15014	0.14393	0.13901
5.3	8.14				0.16289	0.15529	0.14888	0.14381
5.4	8.29				0.16836	0.16051	0.15390	0.14867
5.5	8.45					0.16582	0.15900	0.15361
5.6	8.60						0.16418	0.15861
5.7	8.75						0.16942	0.16369
5.8	8.91							0.16885

1" Uponor MLC — 30% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
1.5	3.78	1.80	1.63	1.50	1.40	1.33	1.26	1.21
1.6	4.03	2.01	1.82	1.68	1.57	1.48	1.41	1.36
1.7	4.28	2.23	2.02	1.86	1.74	1.65	1.57	1.51
1.8	4.53	2.46	2.23	2.06	1.92	1.82	1.74	1.67
1.9	4.78	2.70	2.44	2.26	2.11	2.00	1.91	1.84
2.0	5.03	2.94	2.67	2.47	2.31	2.19	2.09	2.01
2.1	5.29	3.20	2.90	2.68	2.51	2.38	2.27	2.19
2.2	5.54	3.46	3.15	2.91	2.72	2.58	2.47	2.37
2.3	5.79	3.74	3.40	3.14	2.94	2.79	2.67	2.57
2.4	6.04	4.02	3.66	3.38	3.17	3.01	2.87	2.77
2.5	6.29	4.31	3.92	3.63	3.40	3.23	3.09	2.97
2.6	6.55	4.61	4.20	3.89	3.64	3.46	3.31	3.18
2.7	6.80	4.92	4.48	4.15	3.89	3.70	3.53	3.40
2.8	7.05	5.24	4.77	4.42	4.15	3.94	3.77	3.63
2.9	7.30	5.57	5.07	4.70	4.41	4.19	4.01	3.86
3.0	7.55	5.90	5.38	4.99	4.68	4.45	4.25	4.10
3.1	7.80	6.24	5.69	5.28	4.96	4.71	4.50	4.34
3.2	8.06	6.59	6.02	5.58	5.24	4.98	4.76	4.59
3.3	8.31	6.95	6.35	5.89	5.53	5.26	5.03	4.85
3.4	8.56	7.32	6.68	6.20	5.83	5.54	5.30	5.11
3.5	8.81	7.70	7.03	6.53	6.13	5.83	5.58	5.38
3.6	9.06	8.08	7.38	6.86	6.44	6.13	5.86	5.65
3.7	9.31	8.47	7.74	7.19	6.76	6.43	6.15	5.94
3.8	9.57	8.87	8.11	7.54	7.08	6.74	6.45	6.22
3.9	9.82	9.28	8.49	7.89	7.41	7.05	6.75	6.52
4.0	10.07	9.70	8.87	8.24	7.75	7.38	7.06	6.81
4.1	10.32	10.12	9.26	8.61	8.09	7.70	7.38	7.12
4.2	10.57	10.55	9.66	8.98	8.44	8.04	7.70	7.43
4.3	10.82	10.99	10.06	9.36	8.80	8.38	8.03	7.75
4.4	11.08	11.44	10.47	9.74	9.16	8.73	8.36	8.07
4.5	11.33	11.90	10.89	10.13	9.53	9.08	8.70	8.40
4.6	11.58	12.36	11.32	10.53	9.91	9.44	9.04	8.73
4.7	11.83	12.83	11.75	10.94	10.29	9.81	9.40	9.07
4.8	12.08	13.31	12.19	11.35	10.68	10.18	9.75	9.42
4.9	12.33	13.79	12.64	11.77	11.08	10.56	10.12	9.77
5.0	12.59	14.29	13.09	12.19	11.48	10.94	10.49	10.13
5.1	12.84	14.79	13.55	12.62	11.89	11.33	10.86	10.49
5.2	13.09	15.29	14.02	13.06	12.30	11.73	11.24	10.86
5.3	13.34	15.81	14.50	13.51	12.72	12.13	11.63	11.23
5.4	13.59	16.33	14.98	13.96	13.15	12.54	12.02	11.61
5.5	13.85	16.86	15.47	14.42	13.58	12.95	12.42	12.00
5.6	14.10	17.40	15.97	14.88	14.02	13.37	12.82	12.39
5.7	14.35	17.95	16.47	15.35	14.47	13.80	13.23	12.79
5.8	14.60	18.50	16.98	15.83	14.92	14.23	13.65	13.19

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

Velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

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Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
5.9	14.85	19.06	17.49	16.31	15.38	14.67	14.07	13.60
6.0	15.10	19.63	18.02	16.80	15.84	15.11	14.50	14.01
6.1	15.36	20.20	18.55	17.30	16.31	15.56	14.93	14.43
6.2	15.61	20.78	19.09	17.80	16.79	16.02	15.37	14.85
6.3	15.86	21.37	19.63	18.31	17.27	16.48	15.81	15.28
6.4	16.11	21.97	20.18	18.83	17.76	16.95	16.26	15.72
6.5	16.36	22.57	20.74	19.35	18.25	17.42	16.72	16.16
6.6	16.61	23.18	21.30	19.88	18.75	17.90	17.18	16.61
6.7	16.87	23.80	21.87	20.41	19.26	18.38	17.64	17.06
6.8	17.12	24.42	22.45	20.96	19.77	18.87	18.12	17.51
6.9	17.37	25.05	23.03	21.50	20.29	19.37	18.59	17.98
7.0	17.62	25.69	23.62	22.06	20.81	19.87	19.08	18.45
7.1	17.87	26.34	24.22	22.62	21.34	20.38	19.56	18.92
7.2	18.12	26.99	24.82	23.18	21.88	20.89	20.06	19.40
7.3	18.38	27.65	25.43	23.75	22.42	21.41	20.56	19.88
7.4	18.63	28.31	26.05	24.33	22.97	21.94	21.06	20.37
7.5	18.88	28.99	26.67	24.92	23.52	22.47	21.57	20.87
7.6	19.13	29.67	27.30	25.51	24.08	23.00	22.09	21.37
7.7	19.38	30.35	27.94	26.10	24.65	23.54	22.61	21.87
7.8	19.64	31.05	28.58	26.71	25.22	24.09	23.14	22.38
7.9	19.89	31.75	29.23	27.31	25.80	24.64	23.67	22.90
8.0	20.14	32.46	29.88	27.93	26.38	25.20	24.21	23.42
8.1	20.39	33.17	30.54	28.55	26.97	25.77	24.75	23.95
8.2	20.64	33.89	31.21	29.18	27.56	26.34	25.30	24.48

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

Velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

½" **Uponor MLC** — 40% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.29	0.00767	0.00664	0.00591	0.00537	0.00498	0.00503	0.00472
0.6	0.35	0.01030	0.00895	0.00799	0.00728	0.00676	0.00682	0.00642
0.7	0.41	0.01324	0.01154	0.01032	0.00942	0.00877	0.00884	0.00833
0.8	0.47	0.01647	0.01439	0.01290	0.01179	0.01099	0.01108	0.01045
0.9	0.53	0.01998	0.01749	0.01571	0.01439	0.01342	0.01353	0.01277
1.0	0.59	0.02377	0.02085	0.01875	0.01719	0.01605	0.01618	0.01528
1.1	0.65	0.02782	0.02445	0.02202	0.02021	0.01888	0.01903	0.01799
1.2	0.71	0.03213	0.02828	0.02550	0.02342	0.02190	0.02207	0.02088
1.3	0.76	0.03670	0.03234	0.02920	0.02684	0.02512	0.02531	0.02395
1.4	0.82	0.04152	0.03664	0.03310	0.03046	0.02852	0.02873	0.02720
1.5	0.88	0.04658	0.04115	0.03721	0.03427	0.03210	0.03234	0.03063
1.6	0.94	0.05189	0.04588	0.04153	0.03826	0.03586	0.03613	0.03423
1.7	1.00	0.05743	0.05083	0.04604	0.04245	0.03980	0.04010	0.03801
1.8	1.06	0.06320	0.05599	0.05075	0.04682	0.04392	0.04424	0.04195
1.9	1.12	0.06920	0.06136	0.05566	0.05137	0.04821	0.04856	0.04606
2.0	1.18	0.07543	0.06694	0.06075	0.05610	0.05267	0.05305	0.05034
2.1	1.23	0.08189	0.07272	0.06604	0.06101	0.05730	0.05771	0.05478
2.2	1.29	0.08857	0.07870	0.07152	0.06610	0.06210	0.06254	0.05938
2.3	1.35	0.09546	0.08489	0.07718	0.07136	0.06707	0.06754	0.06414
2.4	1.41	0.10257	0.09127	0.08302	0.07680	0.07220	0.07270	0.06907
2.5	1.47	0.10990	0.09785	0.08905	0.08240	0.07749	0.07803	0.07414
2.6	1.53	0.11744	0.10462	0.09525	0.08818	0.08295	0.08352	0.07938
2.7	1.59	0.12519	0.11159	0.10164	0.09412	0.08857	0.08917	0.08477
2.8	1.65	0.13315	0.11874	0.10820	0.10024	0.09434	0.09498	0.09031
2.9	1.70	0.14132	0.12609	0.11494	0.10651	0.10027	0.10095	0.09601
3.0	1.76	0.14969	0.13362	0.12186	0.11295	0.10636	0.10708	0.10185
3.1	1.82	0.15826	0.14134	0.12894	0.11956	0.11261	0.11336	0.10785
3.2	1.88	0.16704	0.14925	0.13620	0.12633	0.11901	0.11980	0.11400
3.3	1.94		0.15734	0.14363	0.13326	0.12556	0.12640	0.12029
3.4	2.00		0.16561	0.15124	0.14034	0.13227	0.13314	0.12674
3.5	2.06			0.15901	0.14759	0.13913	0.14004	0.13333
3.6	2.12			0.16694	0.15500	0.14614	0.14709	0.14006
3.7	2.17				0.16256	0.15330	0.15430	0.14694
3.8	2.23					0.16061	0.16165	0.15397
3.9	2.29					0.16806	0.16915	0.16113
4.0	2.35							0.16845

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

⅝" **Uponor MLC** — 40% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.48	0.00546	0.00475	0.00424	0.00387	0.00360	0.00363	0.00341
0.6	0.58	0.00735	0.00641	0.00575	0.00525	0.00489	0.00493	0.00465
0.7	0.67	0.00946	0.00828	0.00744	0.00681	0.00635	0.00640	0.00604
0.8	0.77	0.01179	0.01035	0.00931	0.00854	0.00797	0.00803	0.00759
0.9	0.87	0.01432	0.01260	0.01135	0.01042	0.00974	0.00982	0.00928
1.0	0.96	0.01706	0.01503	0.01356	0.01247	0.01166	0.01175	0.01112
1.1	1.06	0.01999	0.01764	0.01594	0.01467	0.01373	0.01384	0.01310
1.2	1.15	0.02312	0.02043	0.01848	0.01702	0.01594	0.01606	0.01522
1.3	1.25	0.02643	0.02338	0.02117	0.01951	0.01829	0.01843	0.01747
1.4	1.35	0.02992	0.02650	0.02402	0.02216	0.02078	0.02094	0.01985
1.5	1.44	0.03359	0.02979	0.02702	0.02494	0.02341	0.02358	0.02237
1.6	1.54	0.03744	0.03324	0.03017	0.02787	0.02617	0.02635	0.02501
1.7	1.64	0.04147	0.03684	0.03347	0.03093	0.02906	0.02926	0.02778
1.8	1.73	0.04566	0.04060	0.03691	0.03413	0.03208	0.03230	0.03068
1.9	1.83	0.05003	0.04452	0.04050	0.03747	0.03523	0.03547	0.03370
2.0	1.92	0.05456	0.04859	0.04423	0.04094	0.03850	0.03877	0.03684
2.1	2.02	0.05926	0.05281	0.04810	0.04454	0.04190	0.04219	0.04010
2.2	2.12	0.06412	0.05718	0.05211	0.04827	0.04543	0.04574	0.04349
2.3	2.21	0.06914	0.06170	0.05625	0.05213	0.04908	0.04941	0.04699
2.4	2.31	0.07432	0.06637	0.06053	0.05612	0.05285	0.05320	0.05061
2.5	2.41	0.07966	0.07118	0.06495	0.06023	0.05674	0.05712	0.05435
2.6	2.50	0.08516	0.07613	0.06950	0.06447	0.06075	0.06115	0.05820
2.7	2.60	0.09081	0.08122	0.07418	0.06884	0.06488	0.06531	0.06217
2.8	2.69	0.09662	0.08646	0.07899	0.07333	0.06913	0.06958	0.06625
2.9	2.79	0.10258	0.09184	0.08394	0.07794	0.07350	0.07398	0.07045
3.0	2.89	0.10869	0.09735	0.08901	0.08268	0.07798	0.07849	0.07475
3.1	2.98	0.11495	0.10300	0.09421	0.08753	0.08258	0.08311	0.07917
3.2	3.08	0.12136	0.10879	0.09954	0.09251	0.08729	0.08785	0.08370
3.3	3.18	0.12792	0.11472	0.10500	0.09761	0.09212	0.09271	0.08834
3.4	3.27	0.13463	0.12078	0.11058	0.10282	0.09706	0.09768	0.09309
3.5	3.37	0.14148	0.12697	0.11628	0.10815	0.10211	0.10276	0.09795
3.6	3.46	0.14847	0.13330	0.12212	0.11360	0.10728	0.10795	0.10292
3.7	3.56	0.15562	0.13976	0.12807	0.11917	0.11255	0.11326	0.10800
3.8	3.66	0.16290	0.14636	0.13415	0.12485	0.11794	0.11868	0.11318
3.9	3.75		0.15308	0.14035	0.13065	0.12344	0.12421	0.11847
4.0	3.85		0.15993	0.14667	0.13657	0.12905	0.12985	0.12386
4.1	3.95		0.16692	0.15311	0.14259	0.13476	0.13560	0.12936
4.2	4.04			0.15968	0.14873	0.14059	0.14146	0.13497
4.3	4.14			0.16636	0.15499	0.14652	0.14742	0.14068
4.4	4.23				0.16136	0.15256	0.15350	0.14650
4.5	4.33				0.16783	0.15871	0.15968	0.15241
4.6	4.43					0.16497	0.16597	0.15844
4.7	4.52							0.16456

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

¾" **Uponor MLC** — 40% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.77	0.00396	0.00346	0.00311	0.00284	0.00265	0.00267	0.00252
0.6	0.92	0.00535	0.00469	0.00422	0.00386	0.00361	0.00364	0.00343
0.7	1.08	0.00690	0.00607	0.00547	0.00502	0.00469	0.00473	0.00447
0.8	1.23	0.00861	0.00759	0.00685	0.00630	0.00589	0.00594	0.00562
0.9	1.38	0.01048	0.00925	0.00836	0.00770	0.00721	0.00726	0.00688
1.0	1.54	0.01249	0.01105	0.01000	0.00922	0.00864	0.00870	0.00825
1.1	1.69	0.01466	0.01298	0.01176	0.01085	0.01018	0.01025	0.00972
1.2	1.84	0.01696	0.01504	0.01365	0.01260	0.01182	0.01191	0.01130
1.3	2.00	0.01941	0.01723	0.01565	0.01445	0.01357	0.01367	0.01298
1.4	2.15	0.02199	0.01955	0.01776	0.01642	0.01543	0.01554	0.01475
1.5	2.30	0.02470	0.02198	0.02000	0.01850	0.01739	0.01751	0.01663
1.6	2.46	0.02755	0.02454	0.02234	0.02068	0.01945	0.01958	0.01861
1.7	2.61	0.03053	0.02722	0.02479	0.02296	0.02160	0.02175	0.02068
1.8	2.76	0.03364	0.03001	0.02736	0.02535	0.02386	0.02402	0.02284
1.9	2.92	0.03687	0.03292	0.03003	0.02783	0.02621	0.02639	0.02510
2.0	3.07	0.04023	0.03595	0.03280	0.03042	0.02866	0.02885	0.02745
2.1	3.23	0.04371	0.03908	0.03569	0.03311	0.03120	0.03141	0.02989
2.2	3.38	0.04732	0.04234	0.03867	0.03590	0.03384	0.03406	0.03242
2.3	3.53	0.05104	0.04570	0.04176	0.03878	0.03657	0.03680	0.03505
2.4	3.69	0.05489	0.04917	0.04496	0.04176	0.03939	0.03964	0.03776
2.5	3.84	0.05886	0.05275	0.04825	0.04484	0.04230	0.04257	0.04056
2.6	3.99	0.06294	0.05644	0.05165	0.04801	0.04530	0.04559	0.04344
2.7	4.15	0.06714	0.06023	0.05514	0.05127	0.04839	0.04870	0.04641
2.8	4.30	0.07145	0.06413	0.05873	0.05463	0.05157	0.05190	0.04947
2.9	4.45	0.07588	0.06814	0.06243	0.05808	0.05484	0.05519	0.05262
3.0	4.61	0.08042	0.07225	0.06621	0.06162	0.05820	0.05857	0.05585
3.1	4.76	0.08508	0.07646	0.07010	0.06525	0.06165	0.06203	0.05916
3.2	4.91	0.08985	0.08078	0.07408	0.06898	0.06518	0.06558	0.06256
3.3	5.07	0.09473	0.08520	0.07816	0.07279	0.06880	0.06922	0.06604
3.4	5.22	0.09972	0.08972	0.08233	0.07670	0.07250	0.07295	0.06960
3.5	5.38	0.10481	0.09434	0.08660	0.08069	0.07629	0.07676	0.07325
3.6	5.53	0.11002	0.09907	0.09096	0.08477	0.08016	0.08065	0.07698
3.7	5.68	0.11534	0.10389	0.09541	0.08894	0.08412	0.08463	0.08079
3.8	5.84	0.12076	0.10881	0.09996	0.09320	0.08816	0.08869	0.08468
3.9	5.99	0.12630	0.11383	0.10459	0.09754	0.09228	0.09284	0.08865
4.0	6.14	0.13193	0.11895	0.10932	0.10197	0.09649	0.09707	0.09270
4.1	6.30	0.13768	0.12416	0.11414	0.10649	0.10078	0.10138	0.09683
4.2	6.45	0.14353	0.12948	0.11906	0.11109	0.10515	0.10578	0.10104
4.3	6.60	0.14948	0.13489	0.12406	0.11578	0.10960	0.11026	0.10533
4.4	6.76	0.15554	0.14039	0.12915	0.12055	0.11414	0.11482	0.10970
4.5	6.91	0.16171	0.14599	0.13433	0.12541	0.11875	0.11946	0.11414
4.6	7.06	0.16797	0.15169	0.13960	0.13035	0.12345	0.12418	0.11867
4.7	7.22		0.15748	0.14496	0.13538	0.12823	0.12898	0.12327
4.8	7.37		0.16337	0.15041	0.14049	0.13308	0.13386	0.12795

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

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continued from previous page

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
4.9	7.53		0.16935	0.15594	0.14568	0.13802	0.13883	0.13270
5.0	7.68			0.16157	0.15096	0.14303	0.14387	0.13754
5.1	7.83			0.16728	0.15632	0.14813	0.14899	0.14245
5.2	7.99				0.16176	0.15330	0.15419	0.14743
5.3	8.14				0.16728	0.15855	0.15947	0.15250
5.4	8.29					0.16388	0.16483	0.15764
5.5	8.45					0.16929		0.16285
5.6	8.60							0.16814

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

1" Uponor MLC — 40% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
1.5	3.78	1.72	1.54	1.41	1.31	1.24	1.18	1.13
1.6	4.03	1.92	1.72	1.58	1.47	1.38	1.32	1.26
1.7	4.28	2.13	1.91	1.75	1.63	1.54	1.46	1.40
1.8	4.53	2.35	2.11	1.93	1.80	1.70	1.62	1.55
1.9	4.78	2.58	2.32	2.12	1.98	1.87	1.78	1.71
2.0	5.03	2.82	2.53	2.32	2.16	2.04	1.95	1.87
2.1	5.29	3.06	2.75	2.52	2.35	2.22	2.12	2.03
2.2	5.54	3.31	2.98	2.74	2.55	2.41	2.30	2.21
2.3	5.79	3.58	3.22	2.96	2.76	2.61	2.49	2.39
2.4	6.04	3.85	3.47	3.18	2.97	2.81	2.68	2.57
2.5	6.29	4.13	3.72	3.42	3.19	3.02	2.88	2.77
2.6	6.55	4.42	3.98	3.66	3.41	3.23	3.09	2.96
2.7	6.80	4.71	4.25	3.91	3.65	3.45	3.30	3.17
2.8	7.05	5.02	4.53	4.16	3.89	3.68	3.52	3.38
2.9	7.30	5.33	4.81	4.43	4.13	3.92	3.74	3.59
3.0	7.55	5.65	5.10	4.70	4.39	4.16	3.97	3.82
3.1	7.80	5.98	5.40	4.97	4.65	4.40	4.21	4.04
3.2	8.06	6.31	5.71	5.26	4.91	4.66	4.45	4.28
3.3	8.31	6.66	6.02	5.55	5.19	4.92	4.70	4.52
3.4	8.56	7.01	6.34	5.84	5.47	5.18	4.95	4.76
3.5	8.81	7.37	6.67	6.15	5.75	5.45	5.21	5.01
3.6	9.06	7.74	7.01	6.46	6.04	5.73	5.48	5.27
3.7	9.31	8.12	7.35	6.78	6.34	6.02	5.75	5.53
3.8	9.57	8.50	7.70	7.10	6.65	6.31	6.03	5.80
3.9	9.82	8.89	8.06	7.43	6.96	6.60	6.32	6.08
4.0	10.07	9.29	8.42	7.77	7.27	6.90	6.60	6.36
4.1	10.32	9.69	8.79	8.11	7.60	7.21	6.90	6.64
4.2	10.57	10.11	9.17	8.46	7.93	7.53	7.20	6.93
4.3	10.82	10.53	9.55	8.82	8.26	7.85	7.51	7.23
4.4	11.08	10.96	9.94	9.18	8.61	8.17	7.82	7.53
4.5	11.33	11.39	10.34	9.55	8.95	8.50	8.14	7.84
4.6	11.58	11.84	10.75	9.93	9.31	8.84	8.46	8.15
4.7	11.83	12.29	11.16	10.31	9.67	9.18	8.79	8.47
4.8	12.08	12.75	11.58	10.70	10.03	9.53	9.13	8.79
4.9	12.33	13.21	12.00	11.10	10.41	9.89	9.47	9.12
5.0	12.59	13.69	12.44	11.50	10.78	10.25	9.81	9.45
5.1	12.84	14.17	12.87	11.91	11.17	10.62	10.17	9.79
5.2	13.09	14.65	13.32	12.32	11.56	10.99	10.52	10.14
5.3	13.34	15.15	13.77	12.74	11.95	11.37	10.89	10.49
5.4	13.59	15.65	14.23	13.17	12.36	11.75	11.25	10.84
5.5	13.85	16.16	14.70	13.60	12.76	12.14	11.63	11.20
5.6	14.10	16.67	15.17	14.04	13.18	12.53	12.01	11.57
5.7	14.35	17.19	15.65	14.49	13.60	12.93	12.39	11.94
5.8	14.60	17.72	16.13	14.94	14.02	13.34	12.78	12.32

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

Velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

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Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
5.9	14.85	18.26	16.62	15.39	14.45	13.75	13.18	12.70
6.0	15.10	18.80	17.12	15.86	14.89	14.17	13.58	13.09
6.1	15.36	19.35	17.63	16.33	15.33	14.59	13.98	13.48
6.2	15.61	19.91	18.14	16.80	15.78	15.02	14.39	13.88
6.3	15.86	20.48	18.65	17.28	16.24	15.45	14.81	14.28
6.4	16.11	21.05	19.18	17.77	16.70	15.89	15.23	14.69
6.5	16.36	21.63	19.71	18.27	17.16	16.33	15.66	15.10
6.6	16.61	22.21	20.24	18.76	17.63	16.78	16.09	15.52
6.7	16.87	22.80	20.79	19.27	18.11	17.24	16.53	15.94
6.8	17.12	23.40	21.33	19.78	18.59	17.70	16.97	16.37
6.9	17.37	24.01	21.89	20.30	19.08	18.17	17.42	16.80
7.0	17.62	24.62	22.45	20.82	19.57	18.64	17.88	17.24
7.1	17.87	25.24	23.02	21.35	20.07	19.11	18.33	17.68
7.2	18.12	25.86	23.59	21.89	20.58	19.60	18.80	18.13
7.3	18.38	26.50	24.17	22.43	21.09	20.08	19.27	18.58
7.4	18.63	27.14	24.76	22.97	21.60	20.58	19.74	19.04
7.5	18.88	27.78	25.35	23.53	22.13	21.08	20.22	19.51
7.6	19.13	28.43	25.95	24.08	22.65	21.58	20.70	19.97
7.7	19.38	29.09	26.56	24.65	23.19	22.09	21.19	20.45
7.8	19.64	29.76	27.17	25.22	23.72	22.60	21.69	20.93
7.9	19.89	30.43	27.78	25.79	24.27	23.12	22.19	21.41
8.0	20.14	31.11	28.41	26.38	24.82	23.65	22.69	21.90
8.1	20.39	31.79	29.04	26.96	25.37	24.18	23.20	22.39
8.2	20.64	32.49	29.67	27.56	25.93	24.71	23.72	22.89
8.3	20.89	33.18	30.32	28.15	26.50	25.25	24.24	23.39
8.4	21.15	33.89	30.96	28.76	27.07	25.80	24.76	23.90
8.5	21.40	34.60	31.62	29.37	27.64	26.35	25.29	24.41
8.6	21.65	35.32	32.28	29.98	28.23	26.91	25.83	24.93
8.7	21.90	36.04	32.94	30.61	28.81	27.47	26.37	25.45
8.8	22.15	36.77	33.61	31.23	29.41	28.03	26.92	25.98
8.9	22.40	37.51	34.29	31.87	30.00	28.61	27.47	26.51
9.0	22.66	38.25	34.98	32.50	30.61	29.18	28.02	27.05
9.1	22.91	39.00	35.67	33.15	31.22	29.76	28.58	27.59

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

Velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

½" **Uponor MLC** — 50% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.29	0.00886	0.00754	0.00662	0.00595	0.00545	0.00504	0.00474
0.6	0.35	0.01186	0.01013	0.00893	0.00804	0.00738	0.00685	0.00644
0.7	0.41	0.01519	0.01303	0.01151	0.01039	0.00955	0.00888	0.00836
0.8	0.47	0.01885	0.01621	0.01435	0.01298	0.01196	0.01112	0.01048
0.9	0.53	0.02282	0.01967	0.01746	0.01582	0.01458	0.01358	0.01281
1.0	0.59	0.02709	0.02341	0.02081	0.01888	0.01742	0.01624	0.01533
1.1	0.65	0.03166	0.02741	0.02440	0.02216	0.02047	0.01910	0.01804
1.2	0.71	0.03652	0.03167	0.02822	0.02567	0.02373	0.02215	0.02094
1.3	0.76	0.04165	0.03618	0.03228	0.02938	0.02719	0.02540	0.02403
1.4	0.82	0.04706	0.04093	0.03657	0.03331	0.03085	0.02884	0.02729
1.5	0.88	0.05274	0.04593	0.04107	0.03745	0.03470	0.03246	0.03073
1.6	0.94	0.05868	0.05117	0.04580	0.04179	0.03875	0.03626	0.03435
1.7	1.00	0.06488	0.05664	0.05074	0.04633	0.04299	0.04024	0.03813
1.8	1.06	0.07134	0.06234	0.05589	0.05107	0.04741	0.04440	0.04209
1.9	1.12	0.07805	0.06827	0.06126	0.05601	0.05201	0.04874	0.04621
2.0	1.18	0.08501	0.07442	0.06683	0.06113	0.05680	0.05325	0.05050
2.1	1.23	0.09222	0.08080	0.07260	0.06645	0.06177	0.05793	0.05496
2.2	1.29	0.09967	0.08740	0.07858	0.07196	0.06692	0.06277	0.05957
2.3	1.35	0.10736	0.09421	0.08476	0.07765	0.07224	0.06779	0.06435
2.4	1.41	0.11528	0.10124	0.09113	0.08353	0.07774	0.07297	0.06929
2.5	1.47	0.12344	0.10848	0.09770	0.08959	0.08341	0.07832	0.07438
2.6	1.53	0.13183	0.11593	0.10447	0.09584	0.08925	0.08383	0.07964
2.7	1.59	0.14046	0.12359	0.11142	0.10226	0.09526	0.08950	0.08504
2.8	1.65	0.14931	0.13146	0.11857	0.10886	0.10144	0.09533	0.09060
2.9	1.70	0.15839	0.13953	0.12591	0.11564	0.10779	0.10132	0.09632
3.0	1.76	0.16769	0.14781	0.13344	0.12260	0.11431	0.10747	0.10218
3.1	1.82		0.15629	0.14115	0.12973	0.12099	0.11378	0.10820
3.2	1.88		0.16497	0.14904	0.13703	0.12783	0.12024	0.11437
3.3	1.94			0.15713	0.14450	0.13484	0.12686	0.12068
3.4	2.00			0.16539	0.15215	0.14201	0.13364	0.12715
3.5	2.06				0.15996	0.14933	0.14056	0.13376
3.6	2.12				0.16795	0.15682	0.14764	0.14052
3.7	2.17					0.16447	0.15487	0.14742
3.8	2.23						0.16225	0.15447
3.9	2.29						0.16978	0.16166
4.0	2.35							0.16899

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

⅝" **Uponor MLC** — 50% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.48	0.00627	0.00537	0.00473	0.00427	0.00392	0.00364	0.00343
0.6	0.58	0.00842	0.00723	0.00640	0.00578	0.00532	0.00495	0.00467
0.7	0.67	0.01081	0.00932	0.00826	0.00749	0.00690	0.00643	0.00606
0.8	0.77	0.01343	0.01161	0.01032	0.00937	0.00865	0.00806	0.00761
0.9	0.87	0.01629	0.01411	0.01257	0.01143	0.01056	0.00985	0.00931
1.0	0.96	0.01937	0.01682	0.01500	0.01365	0.01263	0.01180	0.01116
1.1	1.06	0.02266	0.01971	0.01761	0.01604	0.01486	0.01389	0.01314
1.2	1.15	0.02616	0.02279	0.02039	0.01860	0.01724	0.01612	0.01527
1.3	1.25	0.02987	0.02606	0.02334	0.02131	0.01976	0.01850	0.01752
1.4	1.35	0.03378	0.02951	0.02646	0.02417	0.02244	0.02101	0.01992
1.5	1.44	0.03788	0.03314	0.02974	0.02719	0.02525	0.02366	0.02244
1.6	1.54	0.04218	0.03694	0.03318	0.03036	0.02821	0.02645	0.02509
1.7	1.64	0.04668	0.04092	0.03678	0.03368	0.03131	0.02937	0.02787
1.8	1.73	0.05135	0.04507	0.04054	0.03714	0.03455	0.03242	0.03078
1.9	1.83	0.05622	0.04938	0.04445	0.04075	0.03793	0.03560	0.03381
2.0	1.92	0.06127	0.05386	0.04852	0.04450	0.04143	0.03891	0.03696
2.1	2.02	0.06649	0.05850	0.05274	0.04839	0.04508	0.04235	0.04023
2.2	2.12	0.07190	0.06331	0.05710	0.05242	0.04885	0.04591	0.04363
2.3	2.21	0.07748	0.06827	0.06161	0.05659	0.05276	0.04959	0.04714
2.4	2.31	0.08324	0.07340	0.06627	0.06090	0.05679	0.05340	0.05077
2.5	2.41	0.08917	0.07868	0.07108	0.06534	0.06095	0.05733	0.05452
2.6	2.50	0.09527	0.08411	0.07602	0.06992	0.06524	0.06138	0.05839
2.7	2.60	0.10154	0.08970	0.08111	0.07463	0.06966	0.06555	0.06237
2.8	2.69	0.10798	0.09544	0.08635	0.07947	0.07420	0.06984	0.06647
2.9	2.79	0.11459	0.10134	0.09172	0.08444	0.07886	0.07425	0.07067
3.0	2.89	0.12136	0.10738	0.09723	0.08954	0.08365	0.07878	0.07500
3.1	2.98	0.12830	0.11357	0.10287	0.09477	0.08856	0.08342	0.07943
3.2	3.08	0.13539	0.11991	0.10866	0.10013	0.09359	0.08818	0.08397
3.3	3.18	0.14265	0.12640	0.11458	0.10562	0.09874	0.09305	0.08863
3.4	3.27	0.15007	0.13303	0.12063	0.11123	0.10401	0.09804	0.09340
3.5	3.37	0.15765	0.13981	0.12682	0.11697	0.10940	0.10314	0.09827
3.6	3.46	0.16539	0.14673	0.13315	0.12284	0.11491	0.10835	0.10325
3.7	3.56		0.15380	0.13960	0.12883	0.12054	0.11368	0.10835
3.8	3.66		0.16101	0.14619	0.13494	0.12629	0.11912	0.11355
3.9	3.75		0.16836	0.15291	0.14117	0.13215	0.12467	0.11885
4.0	3.85			0.15975	0.14753	0.13812	0.13033	0.12427
4.1	3.95			0.16673	0.15401	0.14422	0.13610	0.12978
4.2	4.04				0.16061	0.15042	0.14198	0.13541
4.3	4.14				0.16733	0.15675	0.14797	0.14114
4.4	4.23					0.16318	0.15407	0.14697
4.5	4.33					0.16973	0.16027	0.15291
4.6	4.43						0.16659	0.15895
4.7	4.52							0.16509

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

¾" **Uponor MLC** — 50% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
0.5	0.77	0.00454	0.00390	0.00346	0.00313	0.00288	0.00268	0.00252
0.6	0.92	0.00610	0.00527	0.00468	0.00424	0.00392	0.00365	0.00344
0.7	1.08	0.00785	0.00680	0.00605	0.00550	0.00508	0.00474	0.00448
0.8	1.23	0.00978	0.00849	0.00757	0.00689	0.00638	0.00596	0.00563
0.9	1.38	0.01187	0.01033	0.00923	0.00842	0.00780	0.00729	0.00690
1.0	1.54	0.01413	0.01232	0.01103	0.01007	0.00933	0.00873	0.00827
1.1	1.69	0.01655	0.01446	0.01296	0.01184	0.01099	0.01029	0.00975
1.2	1.84	0.01913	0.01673	0.01502	0.01373	0.01275	0.01195	0.01133
1.3	2.00	0.02185	0.01915	0.01720	0.01575	0.01463	0.01372	0.01302
1.4	2.15	0.02473	0.02170	0.01951	0.01787	0.01662	0.01560	0.01480
1.5	2.30	0.02776	0.02438	0.02195	0.02012	0.01872	0.01757	0.01669
1.6	2.46	0.03093	0.02720	0.02450	0.02248	0.02093	0.01965	0.01867
1.7	2.61	0.03425	0.03014	0.02718	0.02494	0.02324	0.02183	0.02074
1.8	2.76	0.03770	0.03321	0.02997	0.02752	0.02565	0.02411	0.02292
1.9	2.92	0.04130	0.03641	0.03288	0.03021	0.02817	0.02648	0.02518
2.0	3.07	0.04503	0.03973	0.03590	0.03300	0.03079	0.02896	0.02754
2.1	3.23	0.04889	0.04317	0.03903	0.03590	0.03350	0.03152	0.02999
2.2	3.38	0.05289	0.04674	0.04228	0.03891	0.03632	0.03419	0.03253
2.3	3.53	0.05702	0.05043	0.04564	0.04201	0.03924	0.03694	0.03516
2.4	3.69	0.06128	0.05423	0.04910	0.04523	0.04225	0.03979	0.03788
2.5	3.84	0.06567	0.05815	0.05268	0.04854	0.04536	0.04273	0.04069
2.6	3.99	0.07019	0.06219	0.05637	0.05195	0.04856	0.04576	0.04358
2.7	4.15	0.07484	0.06634	0.06016	0.05547	0.05186	0.04888	0.04657
2.8	4.30	0.07961	0.07061	0.06405	0.05908	0.05526	0.05209	0.04963
2.9	4.45	0.08451	0.07499	0.06806	0.06279	0.05875	0.05539	0.05279
3.0	4.61	0.08953	0.07949	0.07216	0.06660	0.06233	0.05878	0.05603
3.1	4.76	0.09467	0.08409	0.07638	0.07051	0.06600	0.06226	0.05935
3.2	4.91	0.09994	0.08881	0.08069	0.07452	0.06976	0.06583	0.06276
3.3	5.07	0.10533	0.09364	0.08510	0.07862	0.07362	0.06948	0.06625
3.4	5.22	0.11083	0.09858	0.08962	0.08281	0.07757	0.07322	0.06983
3.5	5.38	0.11646	0.10362	0.09424	0.08710	0.08160	0.07704	0.07349
3.6	5.53	0.12220	0.10878	0.09896	0.09149	0.08573	0.08095	0.07723
3.7	5.68	0.12807	0.11404	0.10378	0.09596	0.08994	0.08494	0.08105
3.8	5.84	0.13405	0.11941	0.10870	0.10054	0.09424	0.08902	0.08495
3.9	5.99	0.14014	0.12489	0.11371	0.10520	0.09863	0.09318	0.08893
4.0	6.14	0.14635	0.13047	0.11883	0.10996	0.10311	0.09743	0.09300
4.1	6.30	0.15268	0.13615	0.12404	0.11480	0.10768	0.10176	0.09714
4.2	6.45	0.15912	0.14194	0.12935	0.11974	0.11233	0.10617	0.10137
4.3	6.60	0.16568	0.14784	0.13475	0.12477	0.11707	0.11066	0.10567
4.4	6.76		0.15384	0.14026	0.12989	0.12189	0.11524	0.11005
4.5	6.91		0.15994	0.14585	0.13510	0.12680	0.11990	0.11451
4.6	7.06		0.16614	0.15155	0.14040	0.13180	0.12464	0.11905
4.7	7.22			0.15733	0.14579	0.13687	0.12946	0.12367
4.8	7.37			0.16321	0.15127	0.14204	0.13436	0.12836

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

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Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
4.9	7.53			0.16919	0.15683	0.14728	0.13934	0.13314
5.0	7.68				0.16249	0.15262	0.14440	0.13798
5.1	7.83				0.16823	0.15803	0.14954	0.14291
5.2	7.99					0.16353	0.15476	0.14791
5.3	8.14					0.16911	0.16006	0.15299
5.4	8.29						0.16544	0.15815
5.5	8.45							0.16338
5.6	8.60							0.16868

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

1" Uponor MLC — 50% Propolyene Glycol — Feet of Head per Foot of Tubing

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
1.5	3.78	2.00	1.77	1.60	1.47	1.37	1.29	1.22
1.6	4.03	2.23	1.97	1.78	1.64	1.53	1.44	1.37
1.7	4.28	2.47	2.19	1.98	1.82	1.70	1.60	1.52
1.8	4.53	2.73	2.41	2.18	2.01	1.88	1.77	1.68
1.9	4.78	2.99	2.64	2.39	2.21	2.06	1.94	1.85
2.0	5.03	3.26	2.89	2.62	2.41	2.25	2.12	2.02
2.1	5.29	3.54	3.14	2.85	2.62	2.45	2.31	2.20
2.2	5.54	3.83	3.40	3.08	2.84	2.66	2.51	2.39
2.3	5.79	4.13	3.67	3.33	3.07	2.87	2.71	2.58
2.4	6.04	4.44	3.95	3.58	3.31	3.10	2.92	2.78
2.5	6.29	4.76	4.23	3.85	3.55	3.32	3.14	2.99
2.6	6.55	5.09	4.53	4.12	3.80	3.56	3.36	3.20
2.7	6.80	5.43	4.83	4.39	4.06	3.80	3.59	3.42
2.8	7.05	5.78	5.14	4.68	4.33	4.05	3.83	3.65
2.9	7.30	6.14	5.47	4.97	4.60	4.31	4.07	3.88
3.0	7.55	6.50	5.79	5.27	4.88	4.57	4.32	4.12
3.1	7.80	6.88	6.13	5.58	5.17	4.84	4.58	4.37
3.2	8.06	7.26	6.48	5.90	5.46	5.12	4.84	4.62
3.3	8.31	7.66	6.83	6.23	5.76	5.41	5.11	4.88
3.4	8.56	8.06	7.19	6.56	6.07	5.70	5.39	5.14
3.5	8.81	8.47	7.56	6.90	6.39	5.99	5.67	5.41
3.6	9.06	8.89	7.94	7.24	6.71	6.30	5.96	5.69
3.7	9.31	9.32	8.33	7.60	7.04	6.61	6.25	5.97
3.8	9.57	9.76	8.72	7.96	7.38	6.93	6.55	6.26
3.9	9.82	10.20	9.12	8.33	7.72	7.25	6.86	6.55
4.0	10.07	10.66	9.53	8.70	8.07	7.58	7.17	6.85
4.1	10.32	11.12	9.95	9.09	8.43	7.92	7.49	7.16
4.2	10.57	11.59	10.38	9.48	8.79	8.26	7.82	7.47
4.3	10.82	12.07	10.81	9.88	9.16	8.61	8.15	7.79
4.4	11.08	12.56	11.25	10.28	9.54	8.97	8.49	8.12
4.5	11.33	13.06	11.70	10.69	9.92	9.33	8.83	8.45
4.6	11.58	13.56	12.15	11.11	10.32	9.70	9.18	8.78
4.7	11.83	14.08	12.62	11.54	10.71	10.07	9.54	9.12
4.8	12.08	14.60	13.09	11.97	11.12	10.45	9.90	9.47
4.9	12.33	15.13	13.56	12.41	11.53	10.84	10.27	9.82
5.0	12.59	15.67	14.05	12.86	11.94	11.24	10.65	10.18
5.1	12.84	16.21	14.54	13.31	12.37	11.64	11.03	10.55
5.2	13.09	16.77	15.04	13.77	12.80	12.04	11.41	10.92
5.3	13.34	17.33	15.55	14.24	13.23	12.45	11.80	11.29
5.4	13.59	17.90	16.07	14.72	13.68	12.87	12.20	11.68
5.5	13.85	18.48	16.59	15.20	14.13	13.30	12.61	12.06
5.6	14.10	19.06	17.12	15.68	14.58	13.73	13.02	12.46
5.7	14.35	19.66	17.66	16.18	15.05	14.17	13.43	12.86
5.8	14.60	20.26	18.20	16.68	15.51	14.61	13.85	13.26
5.9	14.85	20.87	18.75	17.19	15.99	15.06	14.28	13.67
6.0	15.10	21.48	19.31	17.70	16.47	15.51	14.71	14.09

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

Velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

continued from previous page

Velocity (ft./sec.)	GPM	80°F 27°C	100°F 38°C	120°F 49°C	140°F 60°C	160°F 71°C	180°F 82°C	200°F 93°C
6.1	15.36	22.11	19.88	18.23	16.96	15.97	15.15	14.51
6.2	15.61	22.74	20.45	18.75	17.45	16.44	15.59	14.93
6.3	15.86	23.38	21.03	19.29	17.95	16.91	16.04	15.36
6.4	16.11	24.03	21.62	19.83	18.46	17.39	16.50	15.80
6.5	16.36	24.69	22.21	20.38	18.97	17.88	16.96	16.24
6.6	16.61	25.35	22.81	20.93	19.49	18.37	17.43	16.69
6.7	16.87	26.02	23.42	21.50	20.01	18.86	17.90	17.15
6.8	17.12	26.70	24.04	22.06	20.55	19.37	18.38	17.61
6.9	17.37	27.39	24.66	22.64	21.08	19.87	18.86	18.07
7.0	17.62	28.08	25.29	23.22	21.63	20.39	19.35	18.54
7.1	17.87	28.79	25.93	23.81	22.18	20.91	19.85	19.02
7.2	18.12	29.49	26.57	24.40	22.73	21.43	20.35	19.50
7.3	18.38	30.21	27.22	25.00	23.29	21.96	20.85	19.98
7.4	18.63	30.94	27.88	25.61	23.86	22.50	21.37	20.47
7.5	18.88	31.67	28.54	26.22	24.43	23.04	21.88	20.97
7.6	19.13	32.41	29.21	26.84	25.01	23.59	22.41	21.47
7.7	19.38	33.15	29.89	27.46	25.60	24.15	22.93	21.98
7.8	19.64	33.91	30.57	28.10	26.19	24.71	23.47	22.49
7.9	19.89	34.67	31.26	28.74	26.79	25.27	24.01	23.01
8.0	20.14	35.44	31.96	29.38	27.39	25.85	24.55	23.54
8.1	20.39	36.21	32.67	30.03	28.00	26.42	25.10	24.06
8.2	20.64	37.00	33.38	30.69	28.62	27.01	25.66	24.60
8.3	20.89	37.79	34.10	31.35	29.24	27.59	26.22	25.14
8.4	21.15	38.59	34.82	32.02	29.87	28.19	26.78	25.68
8.5	21.40	39.39	35.55	32.70	30.50	28.79	27.36	26.23
8.6	21.65	40.20	36.29	33.38	31.14	29.39	27.93	26.79
8.7	21.90	41.02	37.04	34.07	31.79	30.01	28.52	27.35
8.8	22.15	41.85	37.79	34.77	32.44	30.62	29.10	27.91
8.9	22.40	42.69	38.55	35.47	33.09	31.25	29.70	28.48
9.0	22.66	43.53	39.31	36.17	33.76	31.87	30.30	29.06
9.1	22.91	44.38	40.08	36.89	34.42	32.51	30.90	29.64
9.2	23.16	45.23	40.86	37.61	35.10	33.15	31.51	30.22
9.3	23.41	46.09	41.64	38.33	35.78	33.79	32.12	30.82
9.4	23.66	46.96	42.43	39.07	36.47	34.44	32.74	31.41
9.5	23.91	47.84	43.23	39.80	37.16	35.10	33.37	32.01
9.6	24.17	48.73	44.04	40.55	37.86	35.76	34.00	32.62
9.7	24.42	49.62	44.85	41.30	38.56	36.42	34.64	33.23
9.8	24.67	50.52	45.66	42.05	39.27	37.10	35.28	33.85
9.9	24.92	51.42	46.49	42.82	39.98	37.77	35.92	34.47

Recommended Head Loss Design Range

5.5 ft./sec. is an industry standard for velocity limit in hydronic distribution systems.

Velocities in excess of 8 ft./sec. may cause erosion to metal components in the system.

Notes

Notes

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