Technical Information
Polybutene-1 System

Polybutene-1 (PB-1)

The Buteline PB-1 Plumbing System is the best modern plumbing system available to plumbers today.

The Buteline PB-1 Plumbing System offers a complete and well-engineered solution to the needs of the modern plumber and is backed by an experienced team of development engineers and reinforced by an ISO accredited Quality system.

Buteline sources all required Polybutene-1 (PB-1) granules of optimal quality from Basell.

Basell is acknowledged as the world's leading Polybutene-1 (PB-1) polymer manufacturer.

www.basell.com

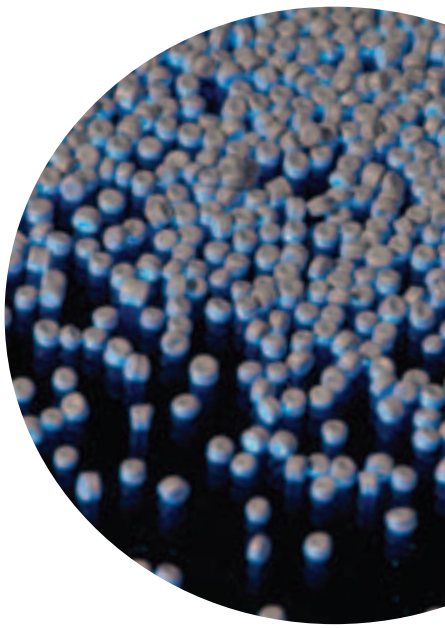
Key Advantages

As a material, Polybutene-1 (PB-1) is technically preferred for the manufacture of piping for reticulating hot and cold potable water systems, as it has many advantages over traditional and competitive materials. PB-1 resins are flexible, linear polyolefins offering a unique combination of properties.

The most important commercial application for Polybutene-1 (PB-1) is in plumbing pipe for residential and commercial use.

The important advantages of PB-1 are:

- ✓ Excellent resistance to creep
- ✓ Extremely high strength (high yield strength, high impact strength, high tear strength, high puncture resistance)
- ✓ Exceptional resistance to environmental stress cracking
- ✓ No corrosion
- ✓ Low noise transmission
- ✓ Pigmented against algae formation
- ✓ Low thermal conductivity
- ✓ Withstands many freeze/thaw cycles
- ✓ Larger pipe internal diameter resulting in better pipe hydraulics
- ✓ Low pipe weight



Drinking Water Safety

The Buteline Plumbing System is **hygienic, non-toxic** and complies with the requirements of AS/NZS 4020 – suitability of plumbing and water distribution system products for contact with potable water. Buteline can provide a complete non-metallic plumbing system, thus providing water of superior quality.

Corrosion Free

Polybutene-1 (PB-1) pipe will not corrode like traditional pipes made of copper or GI because it does not react with ionic species commonly found in water and the service environment. Use of Buteline PB-1 Pipe enables the use of a wide variety of Buteline polymer fittings, eliminating the use of solder and solvents. The Buteline PB-1 system, unlike copper, **will not corrode and leach harmful and dangerous substances into the potable water.**

No Scale Build-Up

A common and major problem encountered, particularly in "hard" water areas, is the build-up of scale on the internal walls of metal pipes, gradually reducing the internal bore and ultimately restricting flow and reducing water pressure at the faucet. This problem is costly and has a dramatic water wasting effect. Being non-metallic, **PB-1 pipes are not affected by scale build-up**, making them an ideal installation choice.

Light Transmittance

Buteline pipes are pigmented and this **prevents algae formation,** thus providing clean drinking water. Buteline pipes also comply with the requirements of AS/NZS 2642 which allow a maximum light transmittance of 0.2%.

PB-1 Pipe Performance Comparisons

Polybutene-1 (PB-1) offers many advantages over other plastic alternatives:

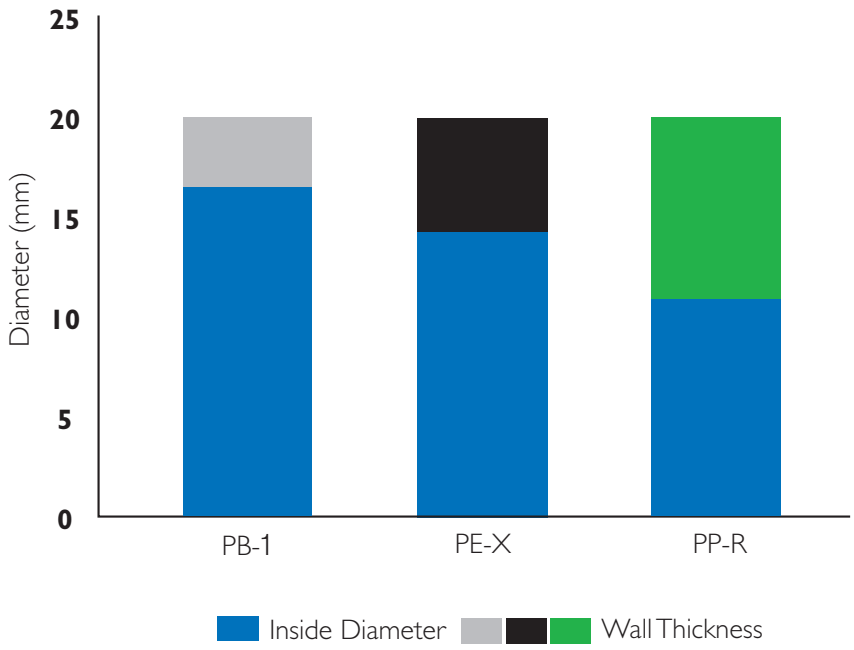
Comparative Pipe Performance			
	Polybutene-1 (PB-1)	PE-X	PP-R
Creep Resistance	Excellent	Poor	Good
Flexibility	Excellent	Good	Moderate
Chemical Resistance	Good	Good	Good
Weldability	Yes	No	Yes
Stress (Thermal Expansion/Contraction)	Low	Moderate	High
Impact Strength	Good	Good	Good

Diameter And Wall Thickness

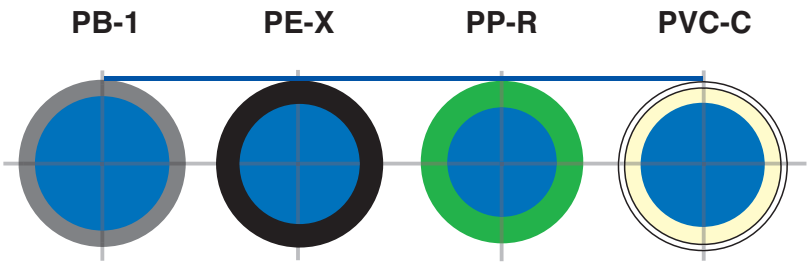
Due to the chemical properties of Polybutene-1 (PB-1) raw material, only Polybutene-1 (PB-1) piping can achieve high temperature and high stress but maintain lower wall thickness to ensure adequate water-flow through the pipe network.

A comparison of the inside diameter / thickness of Polybutene-1 (PB-1) with other plastic materials is shown in the following graph:

Different material thickness (service life class 2 ISO 10508)



A more visual comparison can also be made using a series of cut-away diagrams:



Buteline pipe sizes are similar to traditional metal pipe sizing, making size-for-size substitution possible. There is no need for upsizing, therefore **Buteline pipe is an economical choice**.

Pipe Dimensions

New Zealand

PB-1 Pipe	Outside Diameter (OD)	Wall Thickness (WT)
Type 18 Class 16	15.8mm - 16.0mm	1.6mm - 1.8mm
Type 22 Class 16	22.1mm - 22.3mm	2.1mm - 2.5mm
Type 28 Class 16	27.9mm - 28.2mm	2.7mm - 3.1mm

Australia

PB-1 Pipe	Outside Diameter (OD)	Wall Thickness (WT)
Type 18 Class 16	15.8mm - 16.0mm	1.6mm - 1.8mm
Type 22 Class 16	22.1mm - 22.3mm	2.1mm - 2.5mm
Type 28 Class 16	27.9mm - 28.2mm	2.7mm - 3.1mm

Malaysia

PB-1 Pipe	Outside Diameter (OD)	Wall Thickness (WT)
Type 18 Class 16	15.8mm - 16.0mm	1.6mm - 1.8mm
Type 22 Class 16	22.1mm - 22.3mm	2.1mm - 2.5mm
Type 28 Class 16	27.9mm - 28.2mm	2.7mm - 3.1mm

United Kingdom

PB-1 Pipe	Outside Diameter (OD)	Wall Thickness (WT)
10mm Noml	9.9mm - 10.1mm	1.5mm - 1.8mm
16mm Noml	16.0mm - 16.3mm	1.8mm - 2.1mm
22mm Noml	21.9mm - 22.1mm	2.0mm - 2.3mm
28mm Noml	27.9mm - 28.1mm	2.6mm - 2.9mm

Design Stress

Pipes made from Polybutene-1 have very high tensile strength even at higher temperatures resulting in high-pressure resistance and higher design stress than other plastic pipes that are also at elevated temperatures. For example, **after 10 years exposure to continuously applied stress at 70°C, PB-1 pipe retains 40% more strength than PE-X pipe.**

Standardised dimensional criteria presented in ISO 10508 makes it possible to calculate the maximum allowable hoop stress of various polyolefin pipes for the various standardised application temperature classes.

Class	PB-1	PE-X	PP-R	PE-RT
1	5.73	3.90	3.10	3.56
2	5.06	3.59	2.16	3.29
4 (UFH)	5.46	4.04	3.30	3.64
5	4.31	3.28	1.90	2.89

From the above table, the maximum allowable hoop stress for Polybutene-1 (PB-1) is found to be:

- ✓ At least 35% higher than for PE-X (cross-linked polyethylene) pipes
- ✓ At least 65% higher than for PP-R (polypropylene) pipes
- ✓ Over 50% higher than for PE-RT (polyethylene of raised temperature resistance) pipes

This effectively means that at equivalent thickness, **Polybutene-1 pipes offer a significant safety factor over these alternative polymer materials for installed systems**.

Acoustics

The investment in plumbing must suit consumer needs. Research shows that the public demands quieter plumbing. The Buteline PB-1 Plumbing System eliminates noisy operation and water hammer commonly found with hard metal systems with quick acting valves.

Sound Attenuation

Polybutene-1 (PB-1) has the lowest density of all materials used in plumbing pipe work (as shown in the table below), and therefore has the greatest sound attenuation.

Material	Density (g/cm^3)	Sound Velocity (m/s)
Polybutene-1 (PB-1)	0.93	620
PE-X	0.95	800
Copper	7.20	3,900

As shown on previous pages, Polybutene-1 (PB-1) has a greater bore for a given outside diameter due to the comparative thinness of the pipe wall, and therefore less sound is generated from water-flow through the pipe.

Compared to other systems, sound attenuations are further enhanced in the Buteline PB-1 Plumbing System due to the use of smooth-bore engineering resin fittings instead of metal fittings.

Pressure Surge Behaviour (Water Hammer)

If installed according to the manufacturer's instructions, **Buteline PB-1 pipe virtually eliminates water hammer**. The elasticity of the product helps to absorb surge impact, both laterally and longitudinally, and the lower density of the Polybutene-1 (PB-1) absorbs the small sounds that occur within the pipe itself.

Obviously, the design of any installation is critical in ensuring the quiet operation of the installed plumbing system. Proper consideration should be given to the arrangement of rooms and the corresponding layout of sanitary equipment.

Flow Rates at Specific Velocities for Polybutene-1 Pipe

18PB	
Velocity	Flow Rate
1.6 m/s	11.8 L/min
2.4 m/s	17.7 L/min
3.0 m/s	22.1 L/min

22PB	
Velocity	Flow Rate
1.6 m/s	23.4 L/min
2.4 m/s	34.9 L/min
3.0 m/s	43.8 L/min

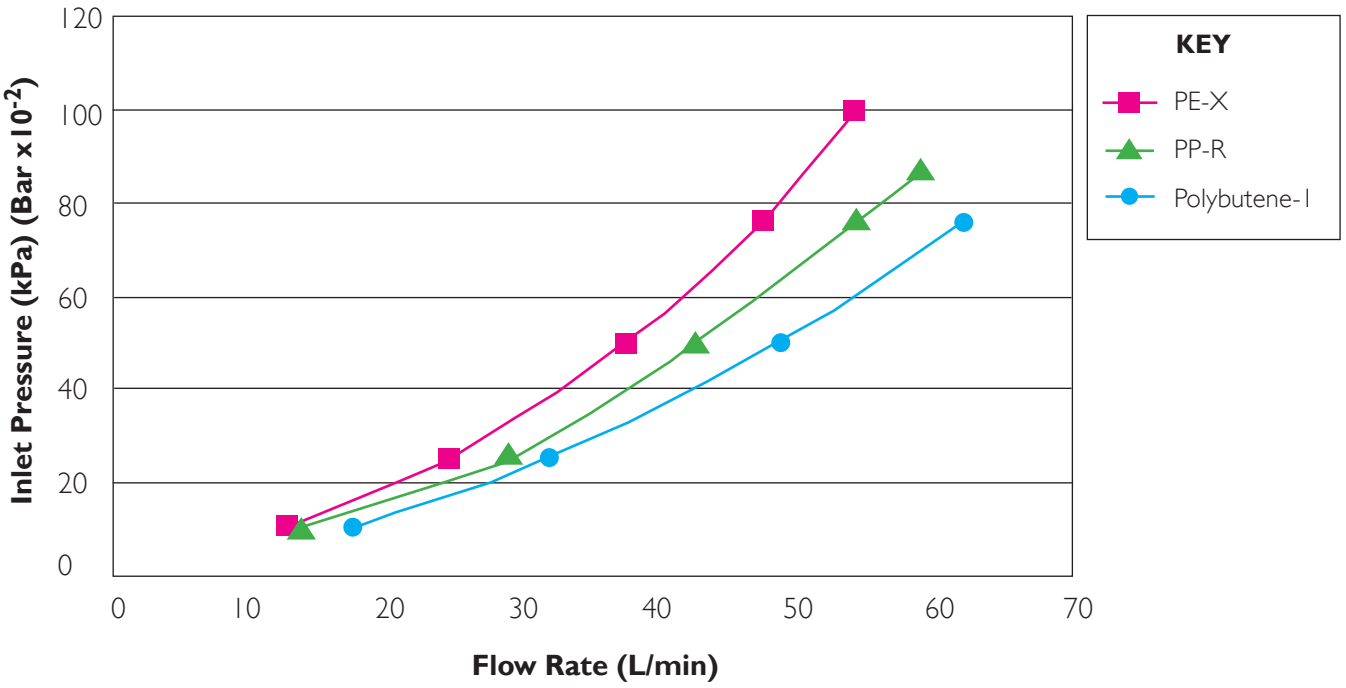
28PB	
Velocity	Flow Rate
1.6 m/s	37.9 L/min
2.4 m/s	56.8 L/min
3.0 m/s	71.0 L/min

Flow Rate Comparisions: Polybutene-1 vs PE-X vs PP-R

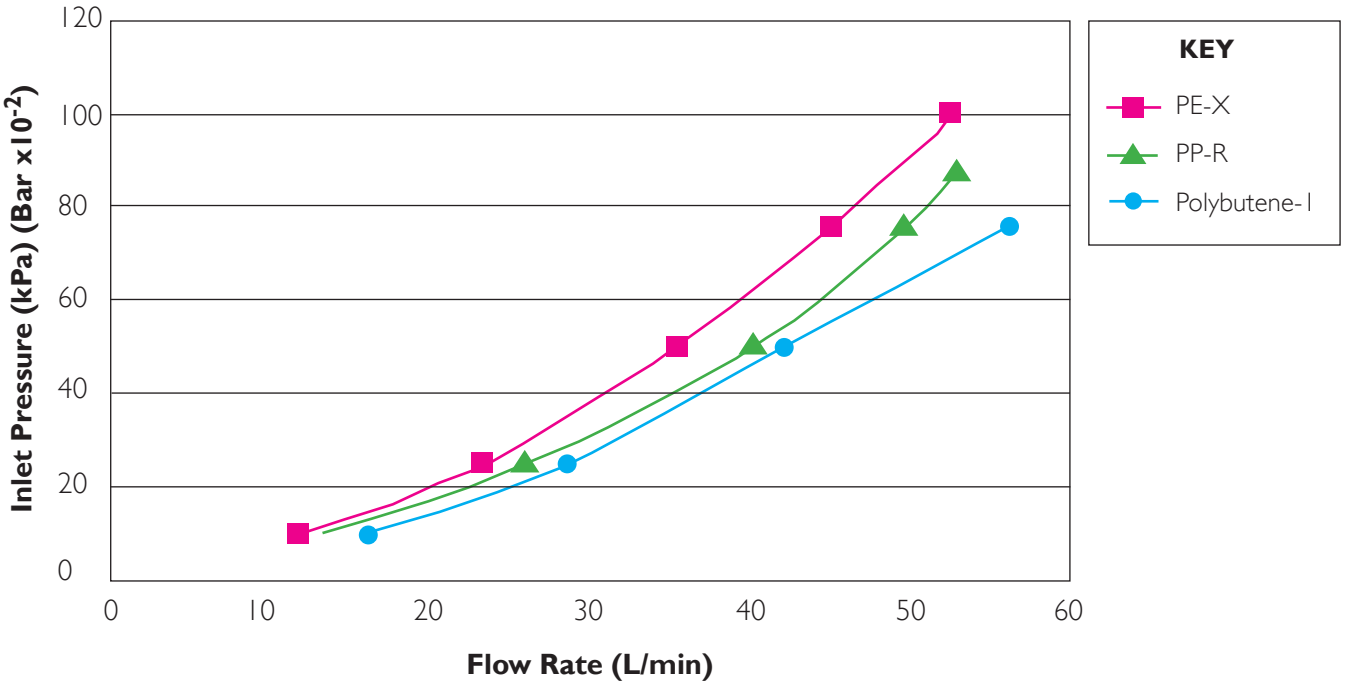
These below graphs show the relative flow rates for 1 metre of straight Polybutene-1 pipe compared to the PE-X and PP-R equivalents (for both Type 18 and Type 22 pipe, with a straight connector attached, and with an elbow connector attached).

You will note that **Polybutene-1 performs much better than both PE-X and PP-R.**

Flow Rate Comparison of Type 18 Pipe

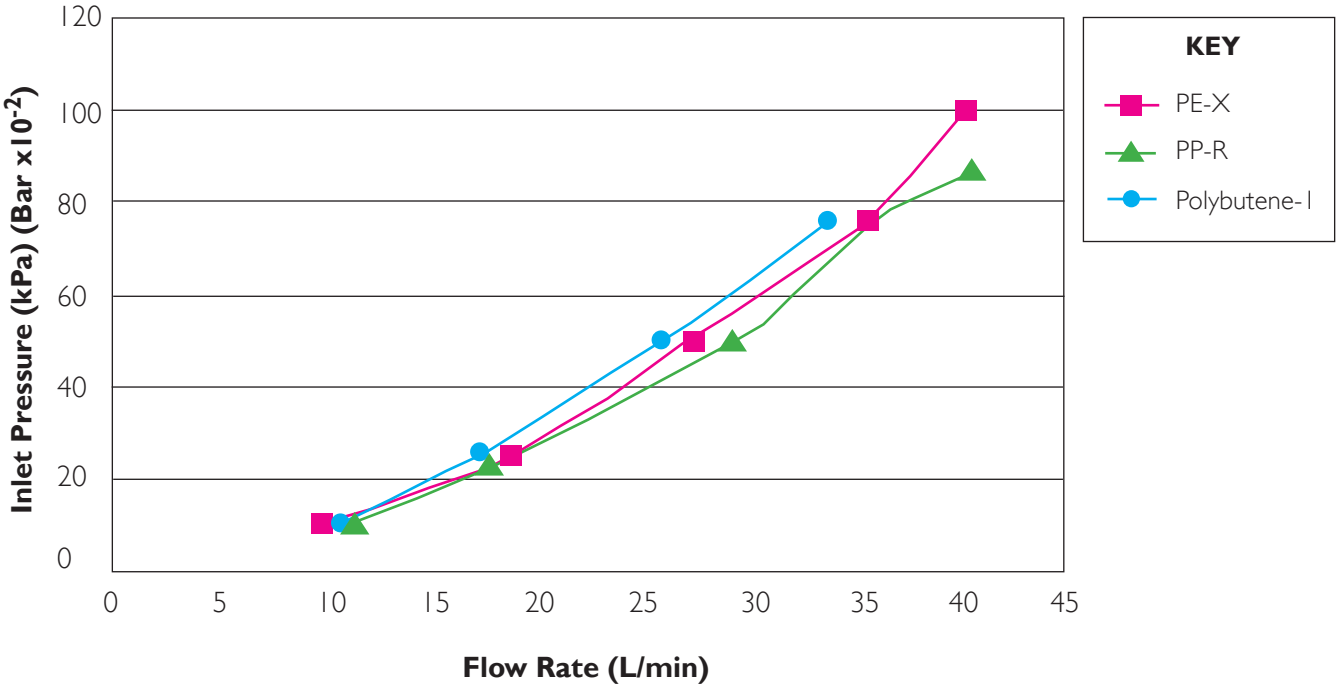


Flow Rate Comparison of Type 18 Pipe + Straight Connector

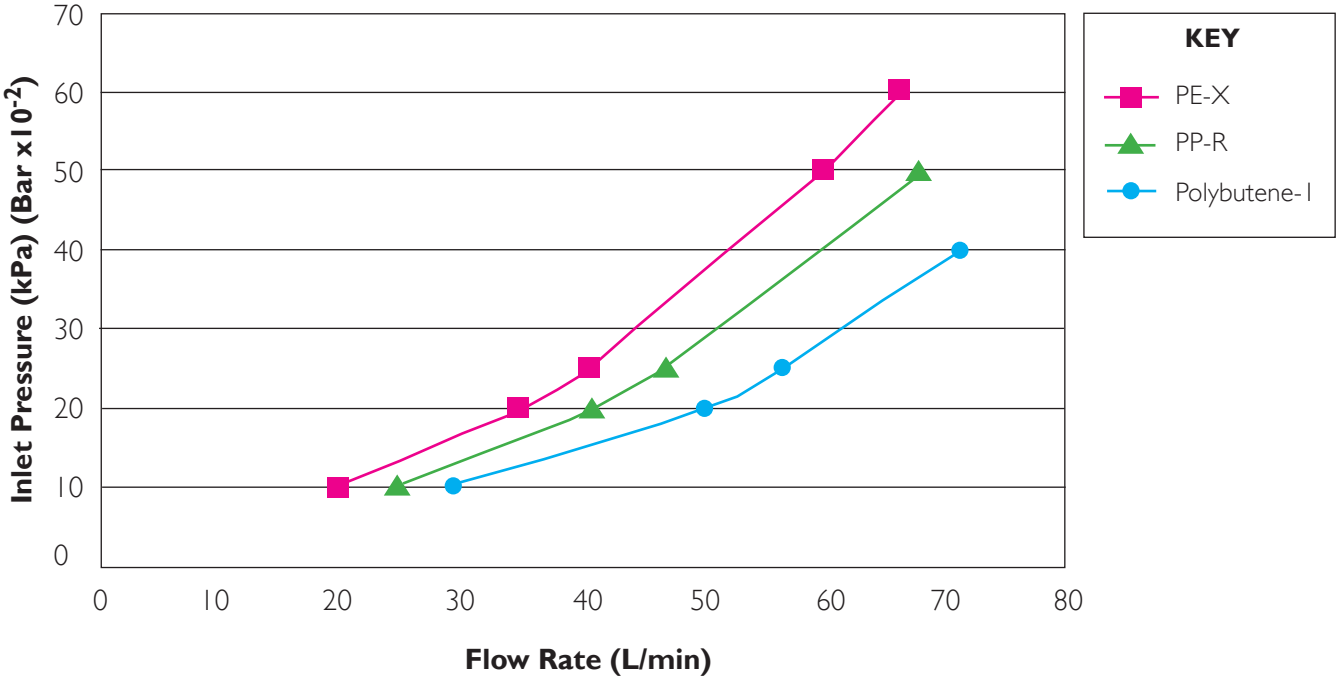


NOTE: To convert the Inlet Pressure from kPa to Bar, divide the value by 100.

Flow Rate Comparison of Type 18 Pipe + Elbow Connector

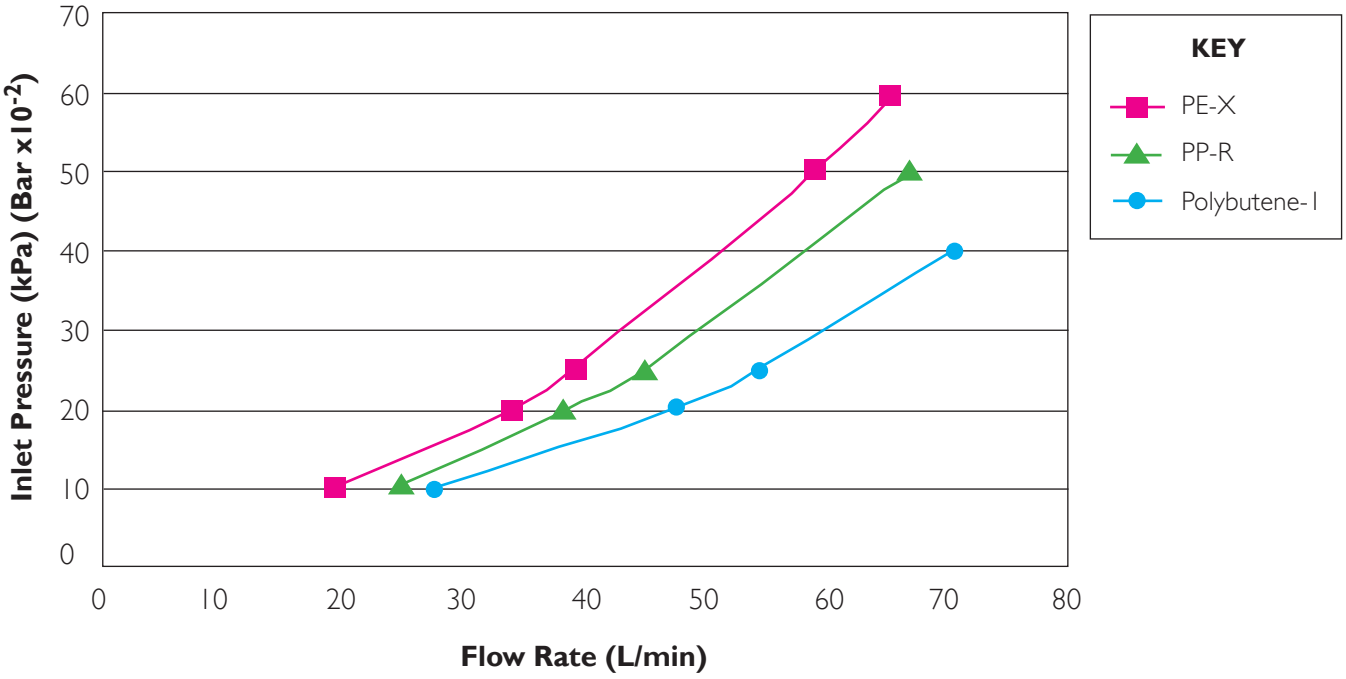


Flow Rate Comparison of Type 22 Pipe

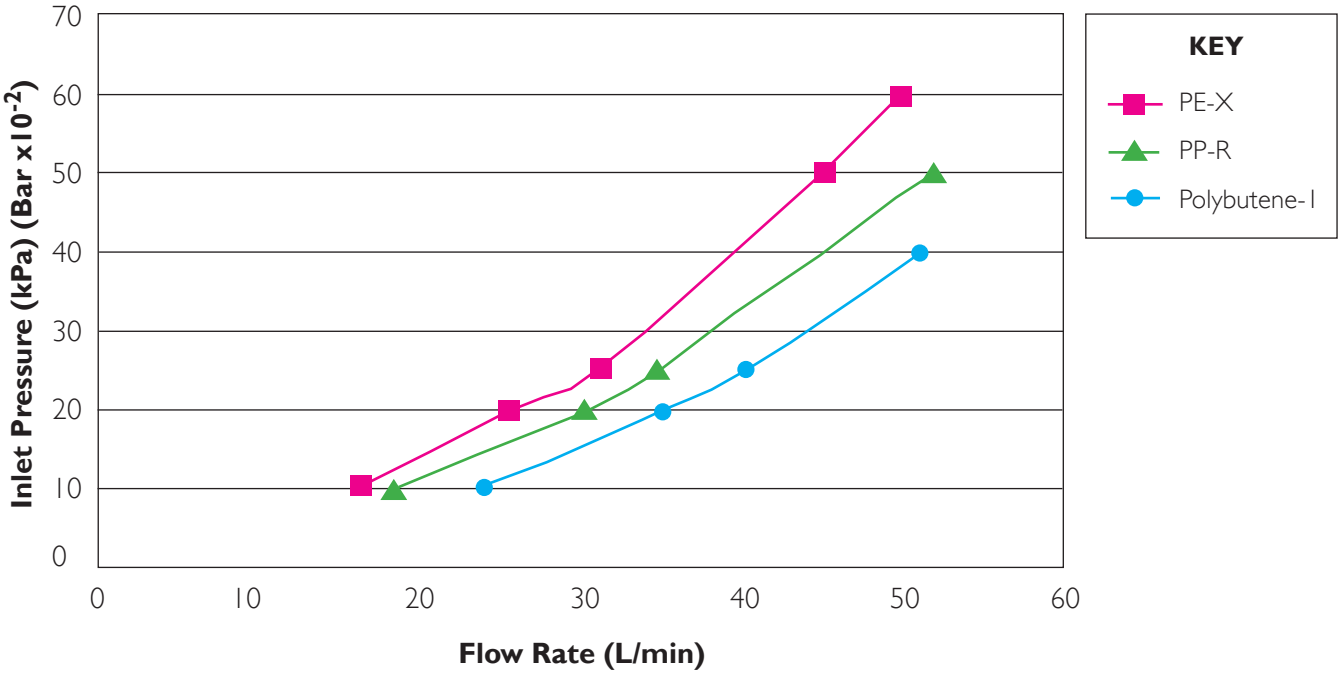


NOTE: To convert the Inlet Pressure from kPa to Bar, divide the value by 100.

Flow Rate Comparison of Type 22 Pipe + Straight Connector



Flow Rate Comparison of Type 22 Pipe + Elbow Connector



NOTE: To convert the Inlet Pressure from kPa to Bar, divide the value by 100.

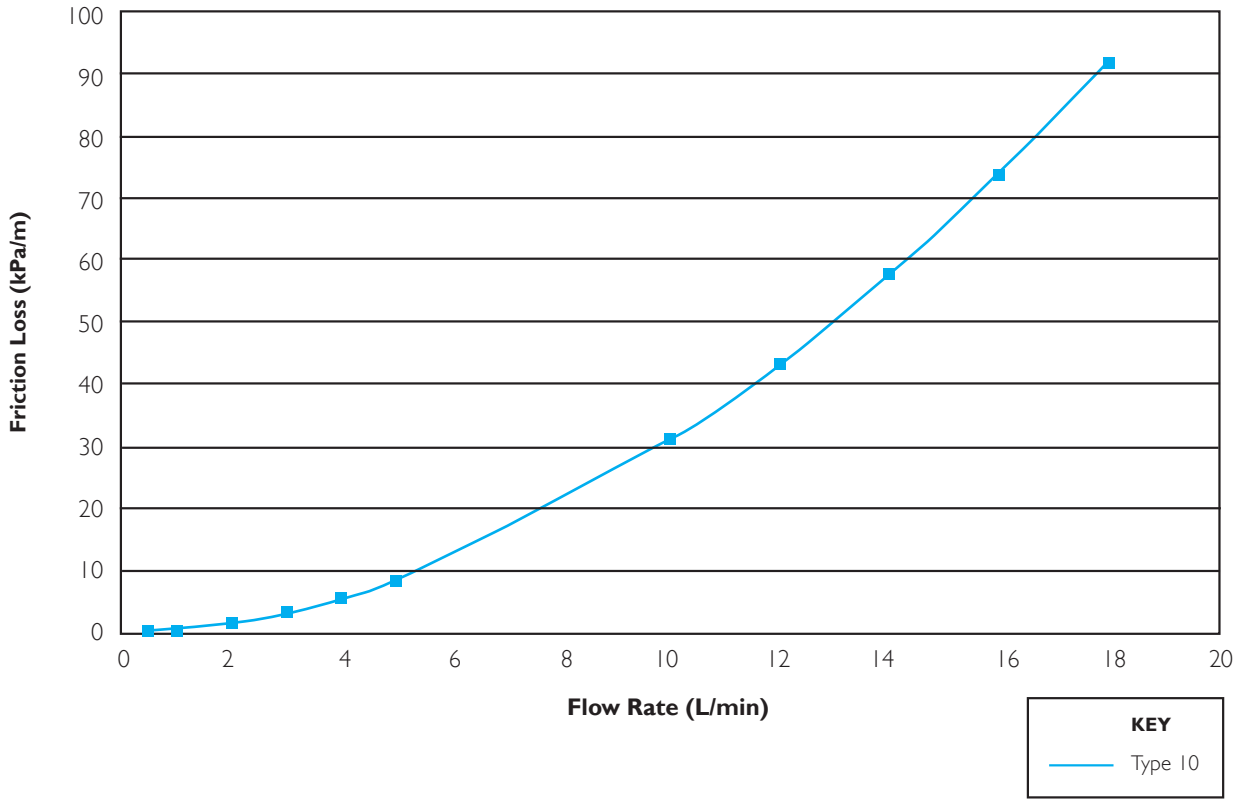
From the graphs it can be clearly seen that in both the 1/2" Noml (Type 18) and 3/4" Noml (Type 22) sizes, Buteline PB-1 pipe out-performs the other plastic pipes in terms of permissible flow through the pipe. In general terms, the graphs clearly demonstrate that a 3/4" Noml PB-1 pipe will deliver around 30% more water than the equivalent PE-X pipe at a similar pressure.

The **superior flow rate** of Buteline PB-1 pipe gives many advantages to the end user. **Energy costs are reduced** as less energy is required to move the water around the system, and the excellent flow characteristics of Buteline PB-1 pipe mean **less turbulence within the pipework**, in turn leading to **a quieter plumbing system.**

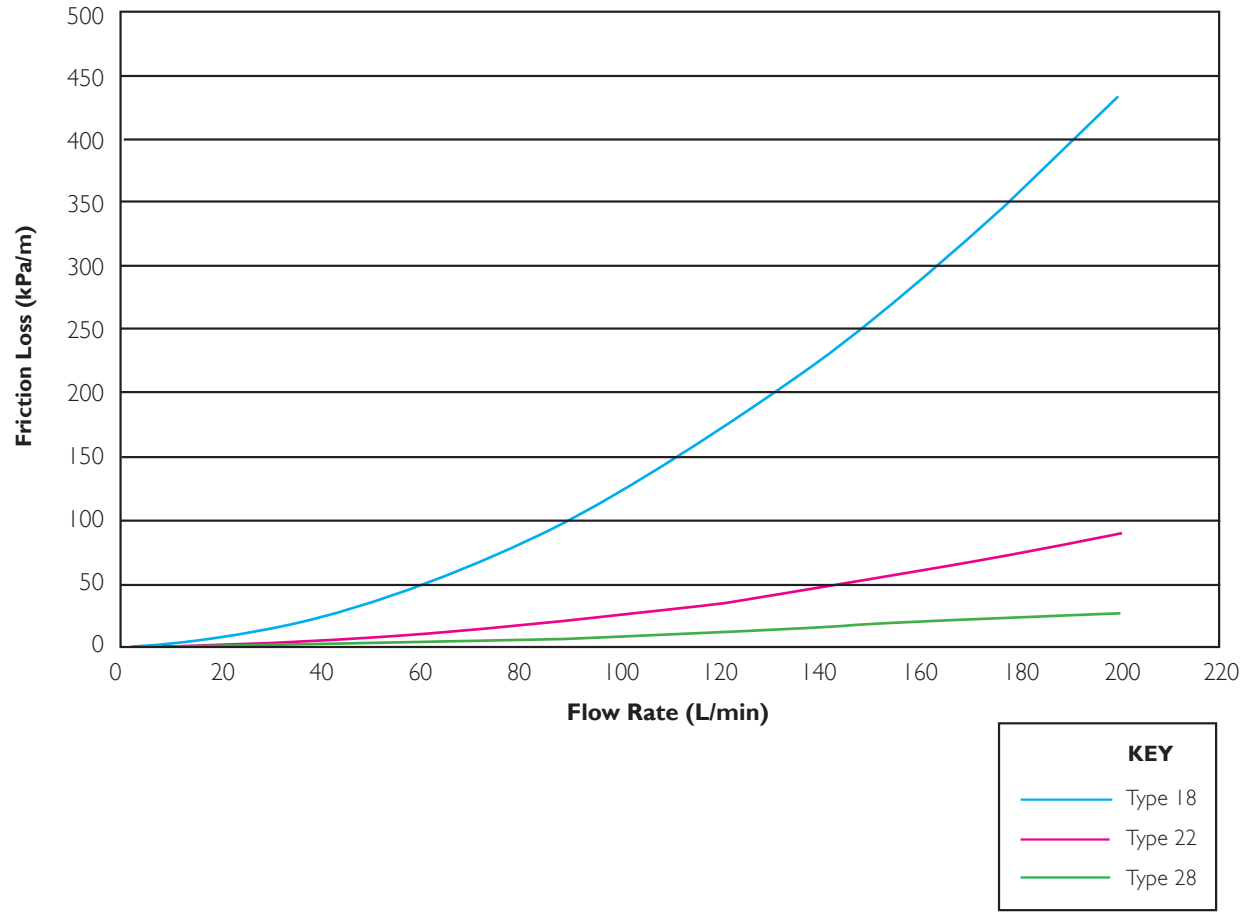
Friction Loss for Polybutene-1 Pipe

Flow Rate (L/min)	Type 10		Type 18		Type 22		Type 28	
	kPa/m	Bar/m	kPa/m	Bar/m	kPa/m	Bar/m	kPa/m	Bar/m
0.5	0.12	0.001	0.01	0.000	0.00	0.000	0.00	0.000
1	0.44	0.004	0.02	0.000	0.00	0.000	0.00	0.000
2	1.57	0.016	0.09	0.001	0.02	0.000	0.01	0.000
3	3.33	0.033	0.18	0.002	0.04	0.000	0.01	0.000
4	5.68	0.057	0.31	0.003	0.06	0.001	0.02	0.000
5	8.58	0.086	0.47	0.005	0.10	0.001	0.03	0.000
10	30.93	0.310	1.70	0.017	0.35	0.004	0.11	0.001
12	43.33	0.430	2.38	0.024	0.49	0.005	0.16	0.002
14	57.63	0.580	3.17	0.032	0.65	0.007	0.21	0.002
16	73.78	0.740	4.06	0.041	0.83	0.008	0.27	0.003
18	91.74	0.920	5.04	0.050	1.03	0.010	0.33	0.003
20	-	-	6.13	0.061	1.25	0.013	0.40	0.004
25	-	-	9.26	0.093	1.89	0.020	0.61	0.006
30	-	-	12.98	0.130	2.65	0.027	0.85	0.009
35	-	-	17.26	0.170	3.52	0.036	1.14	0.011
40	-	-	22.09	0.220	4.51	0.046	1.46	0.015
45	-	-	27.47	0.270	5.61	0.056	1.81	0.018
50	-	-	33.39	0.340	6.81	0.068	2.20	0.022
55	-	-	39.82	0.400	8.13	0.081	2.62	0.026
60	-	-	46.78	0.470	9.55	0.096	3.08	0.031
65	-	-	54.24	0.540	11.07	0.110	3.57	0.036
70	-	-	62.21	0.620	12.70	0.130	4.10	0.041
75	-	-	70.68	0.710	14.43	0.140	4.66	0.047
80	-	-	79.65	0.800	16.26	0.160	5.25	0.053
85	-	-	89.10	0.900	18.19	0.180	5.87	0.059
90	-	-	99.04	1.000	20.22	0.200	6.53	0.065
95	-	-	-	-	22.34	0.220	7.21	0.072
100	-	-	-	-	24.57	0.250	7.93	0.080
105	-	-	-	-	26.89	0.270	8.68	0.087
110	-	-	-	-	29.30	0.290	9.46	0.095
115	-	-	-	-	31.81	0.320	10.27	0.103
120	-	-	-	-	34.42	0.340	11.11	0.111
125	-	-	-	-	37.12	0.370	11.98	0.120
130	-	-	-	-	39.91	0.400	12.88	0.130
135	-	-	-	-	42.80	0.430	13.82	0.140
140	-	-	-	-	45.78	0.460	14.78	0.150
145	-	-	-	-	48.85	0.490	15.77	0.160
150	-	-	-	-	52.01	0.520	16.79	0.170
155	-	-	-	-	55.27	0.550	17.84	0.180
160	-	-	-	-	58.61	0.590	18.92	0.190
165	-	-	-	-	62.04	0.620	20.03	0.200
170	-	-	-	-	65.56	0.660	21.16	0.210
175	-	-	-	-	69.18	0.700	22.33	0.220
180	-	-	-	-	72.88	0.730	23.52	0.240
185	-	-	-	-	76.67	0.770	24.75	0.250
190	-	-	-	-	80.54	0.810	26.00	0.260
195	-	-	-	-	84.51	0.850	27.28	0.270
200	-	-	-	-	88.56	0.890	28.59	0.290

Friction Loss Through Polybutene-1 Type 10 Pipe



Friction Loss Through Polybutene-1 Pipe



Pipe Pressure Head Loss

The below table shows friction loss over 30 metres (or 100 feet) of Buteline PB-1 pipe:

Pipe Pressure Head Loss Per 30 Metres (100 Feet) of Polybutene-1 Pipe

Minimum Flow Required		Type 10		Type 18		Type 22		Type 28	
L/min	Gallons/min	kPa	Bar	kPa	Bar	kPa	Bar	kPa	Bar
0.5	0.11	3.63	0.036	0.20	0.002	0.04	0.000	0.01	0.000
1	0.22	13.11	0.131	0.72	0.007	0.15	0.001	0.05	0.000
2	0.44	47.18	0.472	2.59	0.026	0.53	0.005	0.17	0.002
3	0.67	100.00	1.000	5.50	0.055	1.12	0.011	0.36	0.004
4	0.89	170.38	1.704	9.37	0.094	1.91	0.019	0.62	0.006
5	1.11	257.28	2.573	14.14	0.141	2.89	0.029	0.93	0.009
10	2.22	-	-	51.00	0.510	10.41	0.104	3.36	0.034
12	2.67	-	-	71.46	0.715	14.59	0.146	4.71	0.047
14	3.11	-	-	95.04	0.950	19.40	0.194	6.26	0.063
16	3.56	-	-	121.67	1.217	24.84	0.248	8.02	0.080
18	4.00	-	-	151.29	1.513	30.88	0.309	9.97	0.100
20	4.44	-	-	183.86	1.839	37.53	0.375	12.11	0.121
25	5.56	-	-	277.82	2.778	56.71	0.567	18.30	0.183
30	6.67	-	-	389.27	3.893	79.46	0.795	25.65	0.256
35	7.78	-	-	517.73	5.177	105.68	1.057	34.11	0.341
40	8.89	-	-	662.82	6.628	135.29	1.353	43.67	0.437
45	10.00	-	-	824.19	8.242	168.23	1.682	54.30	0.543

NOTE: Please refer to the Appendices for a Pressure Conversion Chart.

Thermal Characteristics of Polybutene-1

When any medium which has been heated to a temperature above that of the external environment is transported through pipes, there will inevitably be a loss of heat from the medium being transported, through the pipe wall and into the external environment. This heat loss is expressed in the amount of heat that will be lost in an applicable unit (W) times the length of pipe run (m). For the purposes of the calculation, the medium in the pipe is considered to be stationary. The result is a heat loss factor expressed in terms of energy lost per unit length of pipe (W/m).

The amount of heat lost to the outside environment is directly linked to the thermal characteristics of the material from which the pipe is manufactured. In general, metals exhibit high rates of thermal conductivity, whilst most plastics from which pipes are manufactured have relatively low rates of thermal conductivity. Because of this, plastic piping systems will transfer much smaller amounts of energy from the transported medium to the external environment, meaning that **in plumbing terms, heated water will remain hotter when transported in plastic pipes than in metal pipes, and cold water is less likely to freeze in plastic pipes than in metal pipes when exposed to very low temperatures**.

The thermal conductivity of Polybutene-1 (PB-1) is measured at 0.20W/m^2/°K, significantly better than many other thermoplastics of similar wall thickness. In terms of heat loss the following table applies:

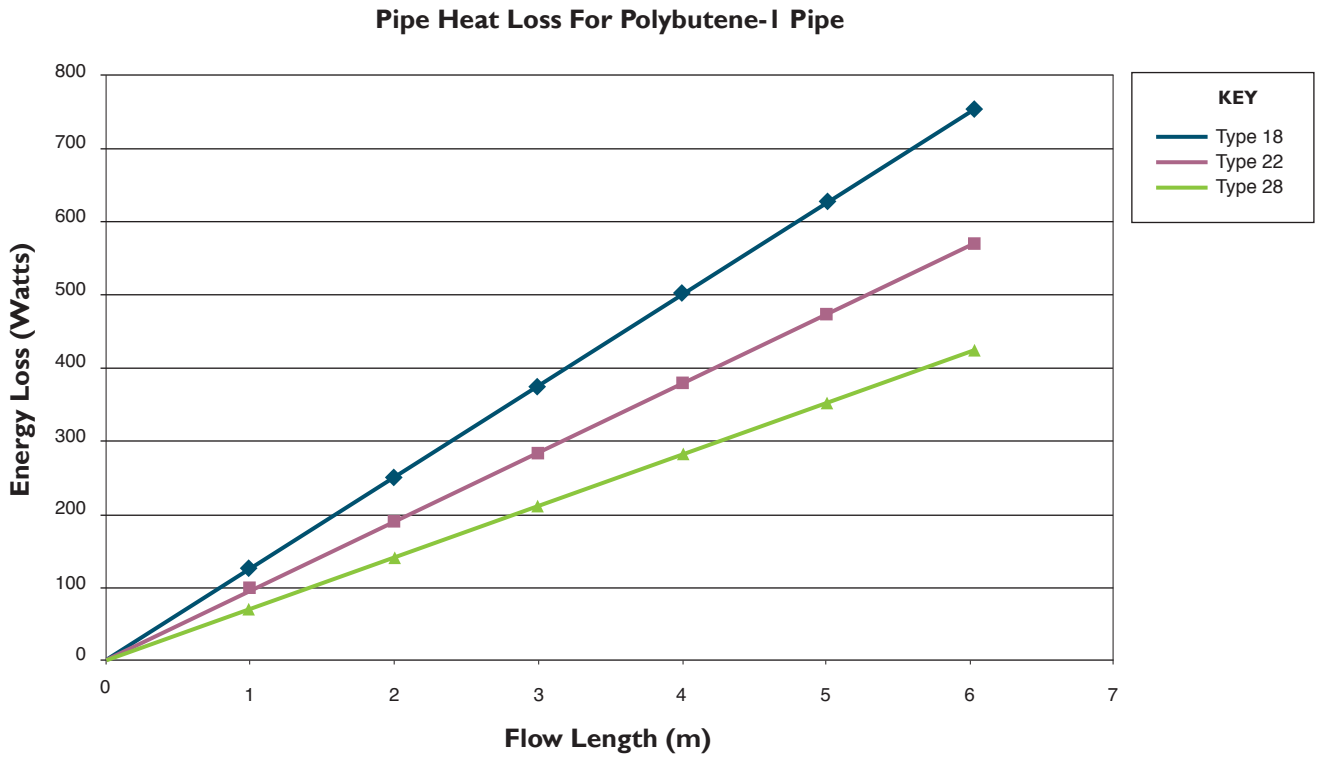
Thermal Conductivity of Polybutene-1 Pipe

O.D. (mm)	I.D. (mm)	Thickness (mm)	Heat Loss (W/m^2/°K)
10	7.0	1.5	660.0
16	12.5	1.6	620.0
22	17.6	2.1	95.2
28	22.3	2.8	70.2

To obtain a measure of heat loss, divide the thermal conductivity factor (0.20) by the wall thickness in metres.
For example: 0.20 divided by 0.0016 = 125.0 for 18mm OD pipe above.

Pipe Heat Loss Measured in Watts for Polybutene-1 Pipe

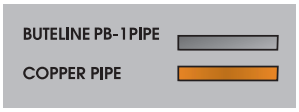
PB-1 Pipe	Length					
	1 metre	2 metres	3 metres	4 metres	5 metres	6 metres
Type 10	133.3	266.6	399.9	533.2	666.5	799.8
Type 18	125.0	250.0	375.0	500.0	625.0	750.0
Type 22	95.2	190.4	285.6	380.8	476.0	571.2
Type 28	70.2	140.4	210.6	280.8	351.0	421.2

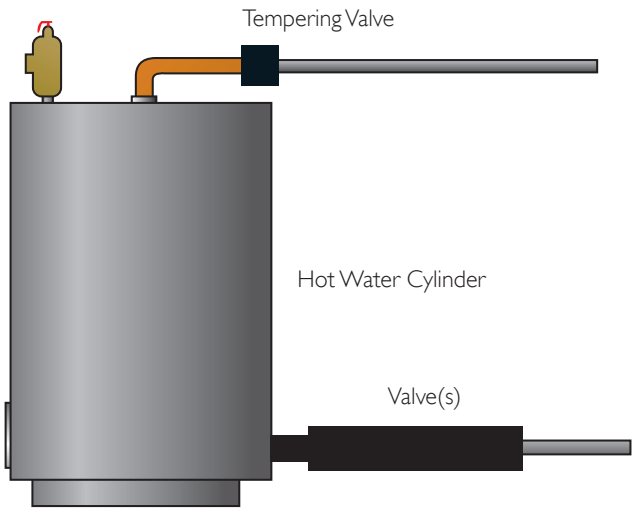


Polybutene-1 has a very low coefficient of thermal conductivity which, combined with its elasticity and flexibility, makes it ideal for the manufacture of plumbing pipes, especially those carrying cold water that may be exposed to freezing conditions.

Heat Retention

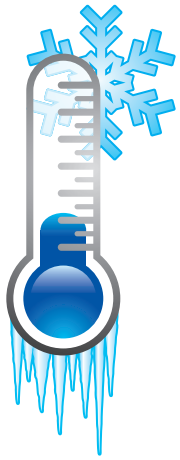
The heat retention of Polybutene-1 is good, making it perfect for use with hot water. Polybutene-1 pipe can be used from hot water cylinders after 1 metre of copper pipe (as pictured below). Because there is less heat loss from Polybutene-1 pipe compared to copper pipe, there are **energy savings**.





Environmental Stresses And Flammability

Freezing Conditions



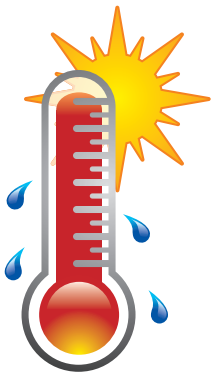
Buteline PB-1 pipe is the preferred choice for water reticulation in climates where freezing conditions are possible. It can endure the most freeze-thaw cycles compared to other polymer materials due to its inherent elasticity and strength.

Buteline PB-1 pipe will absorb the expansion of frozen water within itself as well as the additional expansion created by the water freezing inside a rigid fitting and expanding into the pipe.

Lagging of pipes is recommended when installing the system in places exposed to continuous freezing temperatures.

Flammability And Excessive Heat Protection

Buteline products are difficult to ignite, and are therefore defined as combustible, but not highly flammable.



When Class 16 Buteline PB-1 pipe is heated in air, melting will occur at approximately 125°C, and decomposition will commence at about 300°C with the release of volatile lower molecular weight hydrocarbons. A flame or radiant heat source can ignite these. Once ignition has occurred, sufficient heat will be generated to continue decomposition, provided there is sufficient oxygen. Burning is accompanied by the release of flaming molten droplets of polymer.

Where Buteline PB-1 pipe is installed and penetrates fire resistant construction, the fire resistant integrity of the construction must be retained. This can commonly be achieved through the use of fire-stop collars but refer to the local building code.

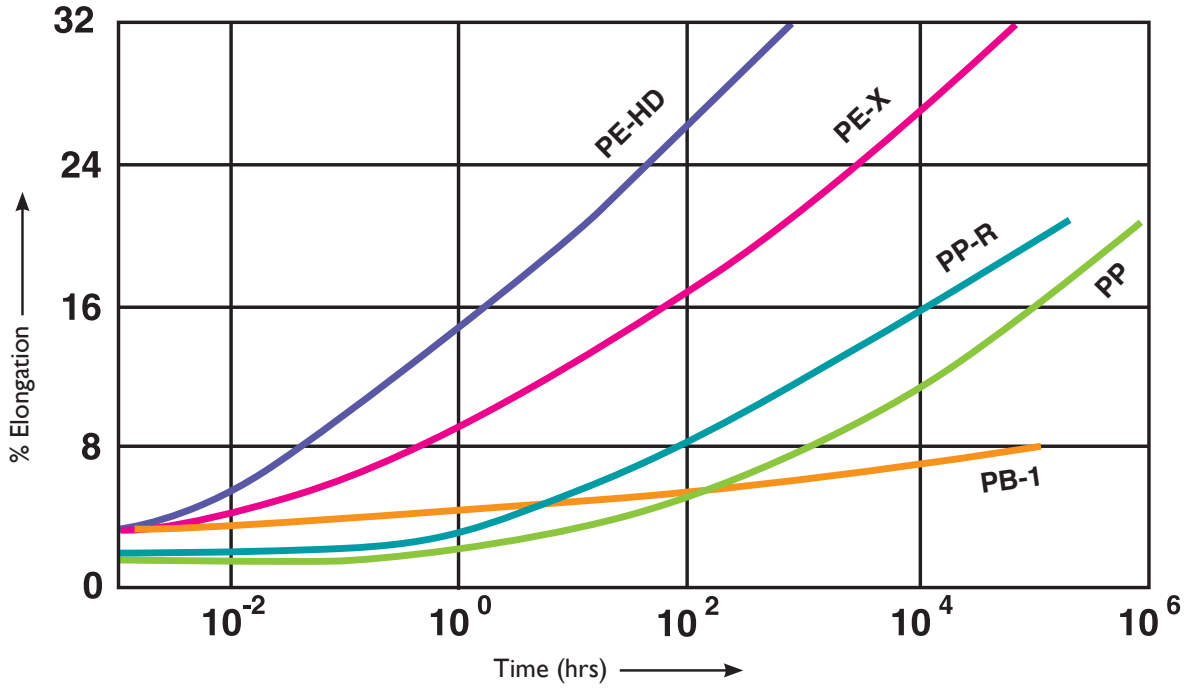
Creep Resistance of Polybutene-1

All thermoplastics essentially act like elastic when stressed for a short period of time and will return to their pre-stressed state when the stress is removed. However, when stressed continually over a long period, they will "creep", as the deflection of the material will increase with time.

The amount of "creep" that any plastic part experiences is influenced by several factors – the material from which it is made, the stress under which it is used, and the temperature at which it is exposed to the stress.

Because all plumbing systems (hot water plumbing systems in particular) are subject to continuous hoop stress from the pressure of the water within the pipes and to elevated temperatures from the transport of hot water, the creep resistance of the materials used within these systems is of vital importance.

Below is a comparison of Polybutene-1 (PB-1) compared to some other polyolefins:



Polybutene-1 is the material of choice for pipes used in hot water plumbing, as it is a very high molecular weight polymer, and the bulky ethyl radicals in its structure provide an extremely strong interaction between the molecules – all of which provide a high resistance to creep, even at elevated temperatures.

Thus Buteline Polybutene-1 (PB-1) pipe has excellent creep resistance that cannot be attained by any other polymer used for plumbing purposes today. This means that PB-1 pipes maintain their unique pressure performance over very long service lifetimes.

As stipulated in ISO 10508, the lifetime of Polybutene-1 (PB-1) pipe is 50 years and longer, according to permissible working pressure/temperature, as shown below:

Pipe Pressure / Temperature Rating for Polybutene-1 Pipe

Pipe Pressure / Temperature Rating (Working Pressures) for Polybutene-1 Class 16 Pipe					
Temperature	20°C	40°C	60°C	70°C	80°C
Working Pressure (kPa)	1600	1370	1050	880	740
Working Pressure (Bar)	16.0	13.7	10.5	8.8	7.4
Working Pressure (P.S.I.)	232	198	152	128	108

NOTE: Buteline PB-1 pipe has a maximum long term operating temperature of 80˚C. PB-1 pipe is not recommended for applications where the continuous operating temperature may exceed this limit. Buteline will not guarantee its PB-1 pipe and fittings system where long term operating may exceed 80˚C.