

Behaviour of Polybutene PB at low temperatures

The behavior of piping systems at low temperatures differs greatly from their behavior at room temperature, since both materials, PB and the fluids that is transported through the piping system, does change their physical and mechanical properties. This fact is requiring a specific study that reproduces these conditions to determine if they are suitable for this application.

Nueva Terrain has in its laboratory the necessary facilities to test the behaviour of PB pipe and fittings at temperatures up to -40°C, verifying that the behaviour to these conditions is unbeatable.



Next, the system characteristics are explained:

❖ High static pressure resistance:

Resistance tests have been carried out at internal static pressure up to 25 bar at -40°C with ethylene glycol as a fluid.

The results of these tests are satisfactory, demonstrating that the system is capable to withstand such high pressures at such low temperatures.

❖ Good behaviour at dynamic pressure cycles (water hammer):

Tests of pressure cycles or "water hammer" have been carried out at -40°C of temperature. In these tests, the test installation were subjected to repeated pressure variations between 0 and 25 bar every 2 seconds.



Test installation in the cooling chamber

The PB at these temperatures retains much of its elasticity, allowing to absorb sudden variations in pressure without collapsing.

❖ **Good behaviour against freezing:**

The anomalous expansion of water, increasing its volume when freezing, is a serious problem for pipe networks exposed to intense cold. Therefore, they must always be isolated to avoid bursting problems. The PB keeps its elasticity at sub-zero temperatures, dilating instead of breaking when the water inside freezes.

The tests carried out with samples filled with water at network pressure and subjected to freezing temperatures (-20°C) shows that the installation of PB does not break when the volume of water increases when freezing.



❖ **Elasticity of PB:**

The elasticity of PB remains very high up to temperatures below -20°C. This allows an easy installation and helps to absorb the enormous expansions that occur in the refrigeration circuits when they stop working and are heated to room temperature. The expansion is less problematic with high flexible materials.

Dilation (expansion) by freezing instead of breaking



Ø22 pipe diameter increase due to internal pressure (freezing expansion)

❖ **High chemical resistance:**

The high chemical resistance of the PB makes possible the use of a wide range of fluids in the cooling circuits without danger of damage.

❖ **Thermal insulation (thermal conductivity):**

Polybutylene has a heat transfer coefficient of 0.19 W/m·K which is therefore a good thermal insulator, that greatly helps to avoid energy losses in the circuit.

❖ **Reduction of condensed water on the pipes:**

The low heat transfer coefficient of the PB greatly reduces the condensation on the outer pipe surface.

❖ Free of corrosion:

The plastic materials are free of corrosion, so both the interior and exterior of the pipes will keep their surface smooth over the years without increasing the pressure losses.



Condensation due to extreme temperature and humidity differences

Due to the condensations that occurs in this type of installation the steel pipes can get damaged from the outside if there is no maintenance, but PB is free of this problem.

❖ Wide range of possible temperatures:

The PB piping system of PB Nueva Terrain is suitable for operation in a wide range of temperatures ranging from very low temperatures up to 95°C. This allows to use the same product for different applications, maintaining uniformity and simplicity of installation.

❖ Wide product range:

The wide range of pipes and fittings, ranging from D15 mm to D160mm, allows to undertake all types of installation. It also has the possibility of using different methods of union, optimizing resources in each case.

Here the possible assembly technologies:

- *Push-Fit*: easy, fast and reliable union from D15 up to D50mm
- *Socketfusion*: D16 up to D63mm
- *Electrofusion*: D63 up to D160mm
- *Butt Welding*: D63 up to D160mm

Technical characteristics of PB:

PROPERTIES	STANDARD	VALUE	UNIT
Density	ISO 1183	0,939	g/cm ³
Elastic limit	ISO R 527	20,4	MPa
Stress rupture	ISO R 527	36,5	MPa
Elasticity Modulus (E-Modulus)	ISO 178	450	MPa
Thermal expansion coefficient	ASTM D696	$1,3 \cdot 10^{-4}$	m/mK
Thermal conductivity	ASTM C177	0,19	W/mK
Melting point	DSC	130	°C
Vicat softening temperature	ISO 306	120	°C
Glass transition temperature	DMTA	-16	°C

Comparison between different systems:

Characteristics	Units	PB	PEX	Carbon Steel	Remarks
Pipes and fittings made of the same material		YES	No	YES	PEX system use to have expensive fittings
Easy, fast and simple installation Velocity of the assembly →		High	Medium	Low	PushFit system is extreme fast and easy to install
Assembly technology		Push-Fit Socketfusion Electrofusion Butt Welding	Compression Press	Welding	The wellding of the steel pipes requires skilled installers and use to be expensive
Wide product range		High 15 – d160mm	Low	High	Important to avoid mix of different materials
Energy loss	W/m	Low	Low	High	Plastics have big advantage
Thermal conductivity	W/mk	0.19	0.41	50-55	PB is best
Weight	Kg	Low	Low	High	
Corrosion (from in- and outside)		No	No	YES	
Transmission of water hammer		Very low	Low	High	Steel pipes transmit very much the water hammer
E-Modulus (at 20°C)	N/m ²	450	600	210000	
Thermal expansion coefficient	Mm/mK	0.13	0.20	0.012	
Noise transmission		Very Low	Low	High	Important in luxury buildings
Condensation on pipe surface		Low	Low	High	