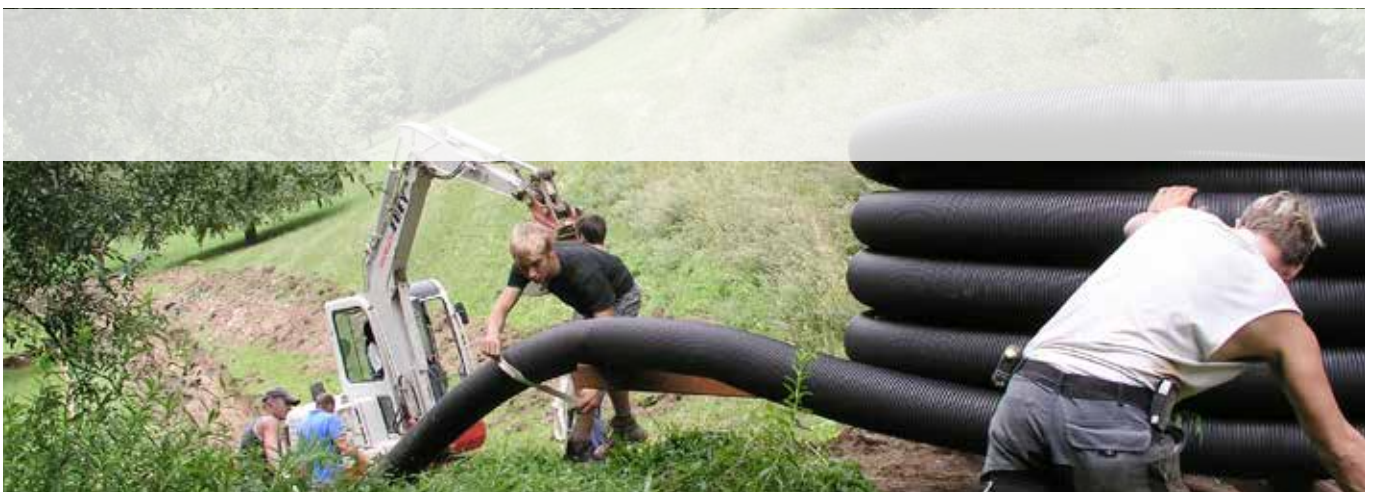


# Polybutene-1 piping compared to metals

PB-1 offers benefits across the full performance spectrum



# Introduction

**Polybutene-1: No corrosion, light weight, flexible, easy to handle and install with fewer fittings and tools and no use of chemicals or naked flame.**

Historically, products for the pipe and plumbing market were mostly made from metals. But since the introduction of thermoplastics in the 1950's; and along with continuous property improvements, the market share of plastics has continued to steadily grow to over 60%.

This has been due to the many advantages that plastic piping systems deliver which have been recognised in comparison to the traditional metal systems after more than 50 years of service in the field under continuous heat and pressure.





# PB-1 Piping System Benefits vs. Metals

## COST | Lower Overall Cost

- **Explanation**
  - Cost evolution
- **Reasons**
  - Lower project cost
  - Lower lifetime maintenance
  - Simple and fast installation
  - Durable system extends lifespan

Gradually over time, planners and contractors are recognising the benefits and long term user satisfaction due to extended product life, low maintenance and a reduced cost base for competitive project bids.

The advantages of plastic pipes over metal include: no corrosion, low (or no) incrustations, light weight and easy to install without the need for complicated tools, high temperature welding or soldering of pipe-fitting joints or the use of intrusive chemicals or flame.

In addition to those obvious benefits, special beneficial characteristics are listed that may not be so apparent, but still offer high value for the end-user, whether for privately owned properties or in public buildings such as hotels, hospitals, shopping malls or airport buildings.

Plastic piping systems deliver clear advantages over metals and as listed on the PBPSA website, comparing Polybutene-1 (Polybutylene, PB-1) with other competitive plastics, PB-1 is the most technically advanced piping material available with the lowest carbon footprint.

PB-1 is the most technically advanced piping material available with the lowest carbon footprint.



## PB-1 Piping System Benefits vs. Metals

### ELASTIC MODULUS | Ultra Flexible

- **Explanation**
  - Low elastic modulus means flexible pipes
- **Benefits**
  - Easy transportation and handling (in coils)
  - Efficient installation (prefabrication and less joints)
  - Low or no water hammer (rated “best in class” or “outstanding”)
  - Expansion loops not required

The elastic modulus is the ratio between stress and elongation and reflects the stiffness of a material in MPa. The higher the elastic modulus, the higher the stiffness.

A low elastic modulus means high flexibility. PB-1 has the lowest elastic modulus of all pressure pipe materials.

The flexibility of PB-1 pipes compared with competitive plastics and particularly versus rigid metal pipes, enables major advantages in shipping, handling and installation, which in turn reduces costs. Pipes made of PB-1 can be shipped and delivered in bundled coils or lightweight prefabricated sections. This means extended pipe

PB-1 flexibility benefits shipping, handling and installation, significantly reducing the overall pipe installation costs.

lengths compared to metal pipes, which due to their stiffness and weight, must be delivered as limited lengths of a few meters only. Due to the extended PB-1 pipe lengths from flexible coils, the number of joints and fittings in a PB-1 piping system are considerably reduced compared to metal piping systems. This benefit delivers a major advantage for the required installation time and with less joints increases reliability and lifespan.

When comparing the cost of piping, it must be remembered that the cost of installation is by far the largest cost component of installed pipe (AMI 2018). In addition, the flexibility of PB-1 pipes allows pipe curvature to easily follow the shape of a structure or bypass obstructions such as trees or unsuitable ground. This is much more complicated with rigid metal pipes.



# PB-1 Piping System Benefits vs. Metals

## WEIGHT | Lower Overall Cost

- **Reason**
  - Low density
- **Benefits**
  - Ease of installation, shipping and handling
  - Low water hammer
  - Optimal LCA

The density of pipe material is the crucial factor for the weight of a piping system. The weight of PB-1 piping is only a fraction of metal pipes when comparing the equivalent lengths and internal diameters.

The lower the weight, the easier the shipping and onsite handling, lowering installation costs and reducing environmental impact.

Pipe weight for PB-1 is a fraction of metal for easier shipping and lower environmental impact.



## SOUND VELOCITY | Quieter Transmission

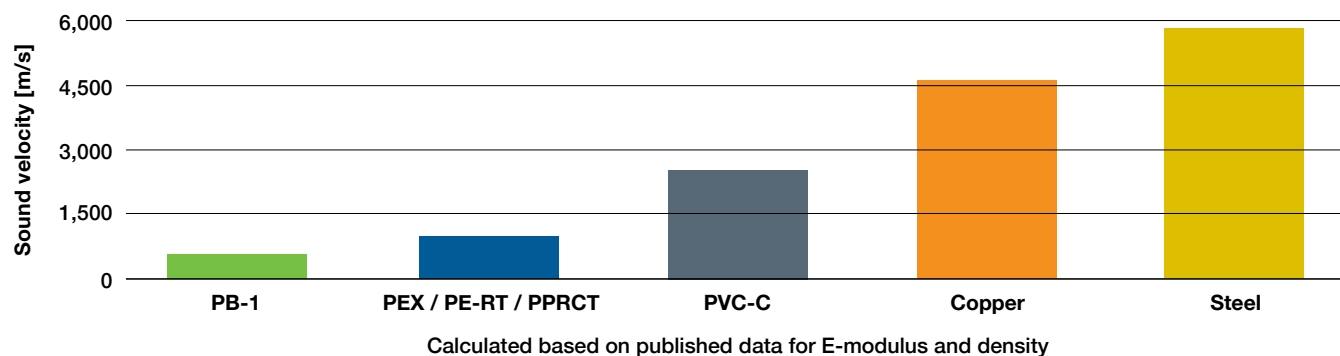
- **Reason**
  - Sound velocity. Low elastic modulus and low density mean silence
- **Benefit**
  - Quiet system/low water hammer/building comfort

The mechanical noises which accompany the heating and cooling cycles of heating pipe systems made from metals are almost completely eliminated when PB-1 piping systems are used. PB-1 pipes reduce and muffle the transmission of both mechanical noise and 'water hammer' effects.

Pipe-borne noise emissions of PB-1 piping systems is less than 10% of metal piping systems.



### Sound velocity of materials





# PB-1 Piping System Benefits vs. Metals

## CONDUCTIVITY | Lower Thermal Conductivity

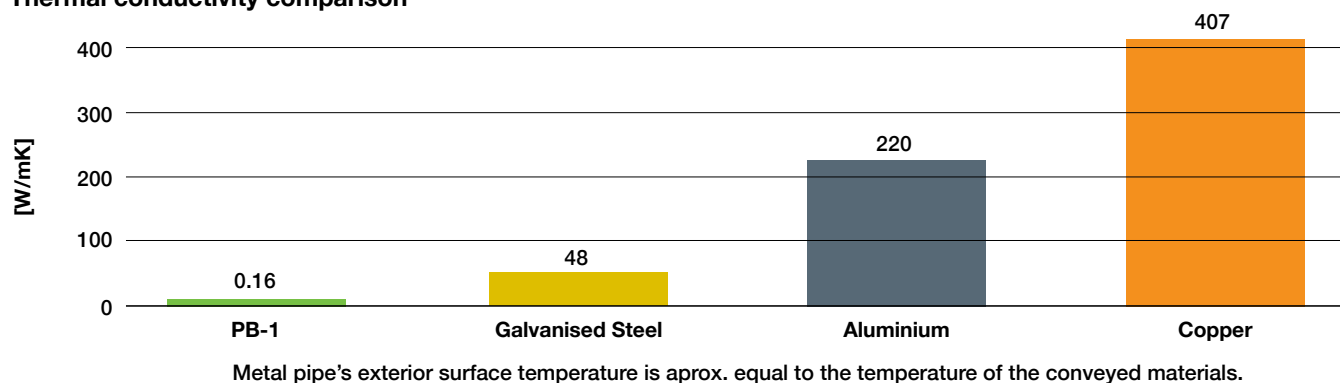
- **Reason**
  - PB-1 is a thermal insulator
- **Benefits**
  - Reduced energy consumption
  - Low system condensation
  - Mild surface temperature during maintenance

The high thermal conductivity of metal pipes means that the pipe's exterior surface temperature is approximately equal to the temperature of the fluid being conveyed.

PB-1 is an insulator, reducing pipe energy consumption and condensation versus metals.

Materials with low thermal conductivity, such as PB-1, contribute to the reduction of heat transmission flux in and out of the building reducing energy consumption and operating costs.

### Thermal conductivity comparison



## THERMAL EXPANSION

- **Benefit**
  - Thermal expansion of PB-1 pipes can be absorbed easily due to the material flexibility

As the pipe temperature changes from the installation condition to the operating condition, it expands or contracts. The extent of the expansion or contraction of a piping system is dependent upon the piping material's coefficient of linear expansion, the length of pipe between directional changes, and the temperature differential.

When a pipe expands or contract it has the potential of generating enormous force and stress in the system. It is crucial that the expansion and contraction of pipework are addressed at

Thermal expansion of PB-1 pipes is easily absorbed due to the material flexibility reducing stress.

the design stage of a project to avoid significant problems occurring. Problems such as snaking pipes or stress on pipe joints could eventually lead to leaks or burst pipes and all the related damage that such a failure could cause.

## PB-1 Piping System Benefits vs. Metals

### EXTREME COLD PERFORMANCE | Burst Resistant

- **Benefit**

- Versus metal pipes, PB-1 piping systems have significantly reduced incidence of pipe burst under freezing conditions

Increasingly, piping engineers are specifying PB-1 piping systems ahead of metal for projects in extremely cold environments, not only because of advantages in handling, installation and no corrosion; but also because of the significantly reduced incidence of pipe burst when compared to metal pipe performance under freezing conditions.

Two project examples from PBPSA member companies illustrate the reasons for the specification of PB-1 piping systems for major projects in sub-zero temperatures.

- **The Italian Research Base in Antarctica**

required a dependable, low-maintenance solution for the research center's external hot water piping system.

The extreme Antarctic temperatures posed a significant challenge because of the possibility of pipes, which are installed in and on permanently frozen ground, cracking and bursting.

Flexalen PB-1 pipes from Thermaflex were tested by the C.N.R. (National Research Council) in a climatic chamber at -80°C.

This conclusively demonstrated they were fit for purpose and nearly 1 km of PB-1 pipes are currently in service at the Italian Research Base.

- **The Säntis 2000 project** renovated and expanded facilities on the highest peak of the Alpstein massif in Switzerland.

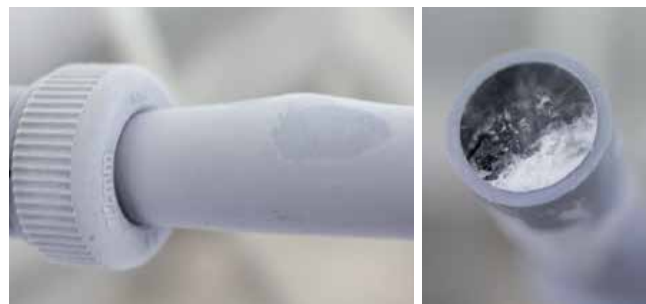
The project specified PB-1 piping from Georg Fischer Piping Systems because of its lightweight, ease of installation and resistance to cracking and bursting under freezing conditions.

PB-1 can be still be worked at extremely low temperatures.

With lowest temperatures around -30°C, the problem of frost protection was a major focus.

For the project test PB-1 piping was filled with water, put under a pressure of 5 bar, and exposed to the extreme weather conditions at the summit revealing no negative safety effects would result if the PB-1 piping installation froze.

The testing also concluded that it made no difference whether the entire piping system froze or only a part of it.



*The frozen pipe dilates without breaking, avoiding water leakage in installations exposed to low temperatures.*

## PB-1 Piping System Benefits vs. Metals

### CORROSION FREE | No Contamination

- **Benefit**

- No contamination of the water from PB-1 pipes from products of corrosion

PB-1 pipes provide completely corrosion-free drinking water and heating pipe systems. Freedom from corrosion means there is no contamination of the water at the tap by products of corrosion.

This means that even if the system is not used for an extended period of time, there is no risk of rust deposits or corrosion and water quality is not affected.

PB-1 piping is chemically inert with smooth internal surfaces eliminating problems of corrosion and incrustation typically found in metal pipes.

### LOW SCALE & INCRUSTATION | Clean Water

- **Benefit**

- Smooth PB-1 internal pipe surfaces are virtually free of limescale and retain their full internal diameter

Freedom from scale build-up and incrustation in hard water supply areas is guaranteed ensuring drinking water installations will be free of limescale.

Smooth internal pipe surfaces, combined with inert chemical properties leads to the elimination of calcium carbonate deposition, ensuring the pipes retain their full internal diameter and long-term efficiency for water heating and circulation. Flow and comfort remain constant at the same high level.



Corrosion typically found in metal pipes



Scale build-up and incrustation in metal pipes



## PB-1 Piping System Benefits vs. Metals



PB-1 piping is chemically inert with smooth internal surfaces eliminating problems of corrosion and incrustation found in metals

### WATER HAMMER | Significantly lower than metals

- **Reason**
  - Low density and low elastic modulus
- **Benefit**
  - Significantly lower levels of water hammer in PB-1 piping systems versus metal pipes

Water hammer is a phenomenon that can occur in any piping system where valves are used to control the flow of liquids. Water hammer is the result of a pressure surge, or high-pressure shockwave, that propagates through a piping system when a fluid in motion is forced to stop abruptly.

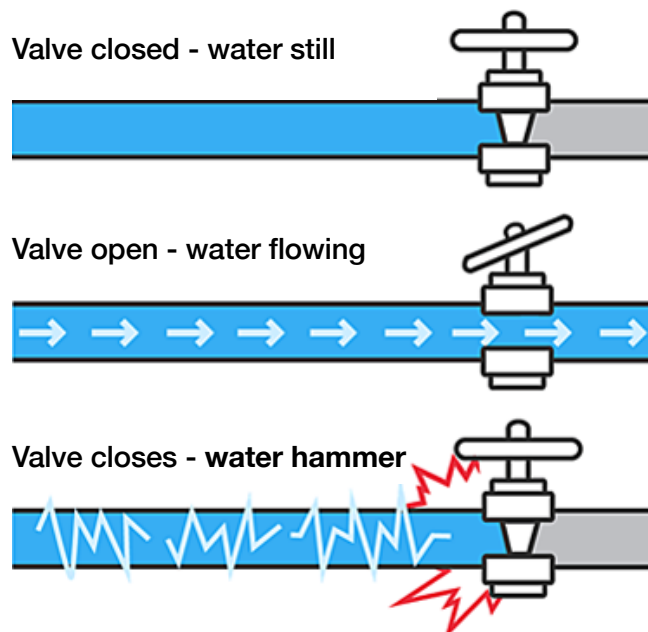
Repetitive water hammer can be destructive to pipe systems. Beside the nuisance of noise, water hammer can cause pipelines and fittings to break creating pipe bursts if the pressure is high enough.

Modern plumbing systems are often designed with air chambers to ease the damage caused by repetitive water hammer. However, PB-1 piping systems usually do not need such additional auxiliaries due to the ability of the material to absorb water hammer.

Due to the low density and high flexibility, the incidence of water hammer in a PB-1 piping system is 12 times lower compared to a steel pipe system.

This provides improvements in a system's acoustics and long term reliability.

Water hammer is 12 times lower in PB-1 piping systems than steel.



Repetitive water hammer impacts can be destructive to pipe systems. Beside the noise, water hammer can cause pipelines to break if the pressure is high enough

# PB-1 Piping System Benefits vs. Metals

## ENVIRONMENTAL | Greener

- **Reason**
  - Lower global warming impact
  - Better life cycle assessment
  - No installation chemicals, heat or naked flame
- **Benefits**
  - Longer system lifetime
  - Lowest carbon footprint vs. alternatives
- **Sustainability**
  - Learnings from PB-1 pressure piping systems

The European Plastic Pipes and Fittings Association (TEPPFA) commissioned an independent study by the Flemish Institute for Technological Research (VITO) to measure the environmental footprint of various plastic piping systems based on life-cycle assessment. The study was intended to raise awareness of the value that plastic pipe systems offer for a sustainable future and was validated by the Denkstatt sustainability consultancy in Austria.

An important objective of the project was to provide transparency about the impact of plastic piping systems on our environment. It was also an important step in the development of the Environmental Product Declarations for plastic pipes.

- **Energy Efficiency**
  - Learnings from PB-1 pressure piping systems

The Technical University of Berlin conducted an energy efficiency and environmental impact analysis on hot and cold water pressurized piping systems. The study made a comparison of the total energy

PB-1 piping systems have significantly lower environmental impact than those made from metals, particularly copper.

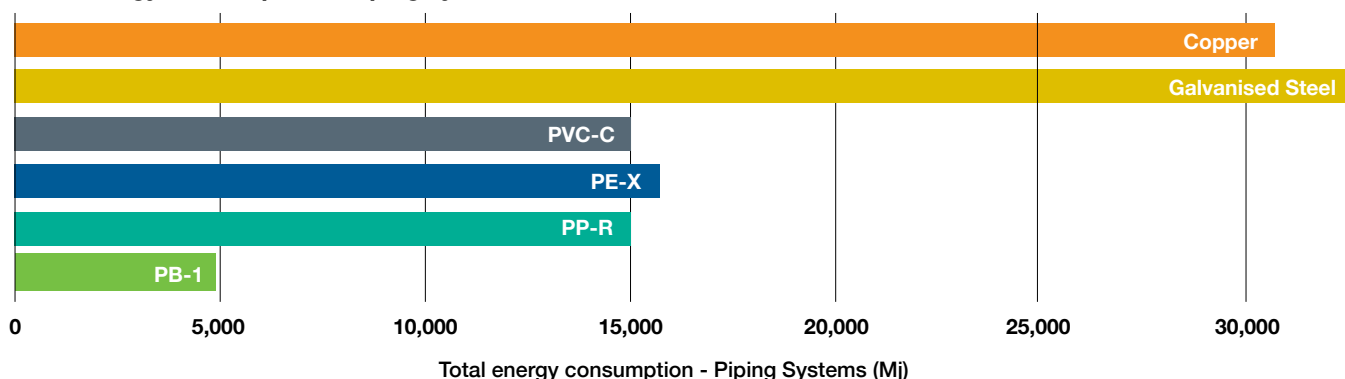
consumption for the production and installation of a piping system for a multiple dwelling with 16 apartments using a number of competitive metal and plastic systems.

PB-1 piping systems consumed around 33% less total energy for production and installation than the other systems in the study made from plastics.

A scientifically-based full Life Cycle Assessment (LCA) is the standardised method for fairly comparing a whole range of processes to calculate overall impacts, beginning with the manufacturing of raw materials, to transforming them into products; continuing through the product's transportation and installation, the product's lifetime of use, and ultimately, the product's disposal or reprocessing at the end of life.

For the purpose of a direct fair comparison between alternative materials the following identical functional unit was used in the LCA study for plumbing hot and cold solid wall systems – a 50 year lifetime has been assumed which aligns with the normal lifetime expectancy of a building.

## Total energy consumption - Piping systems



## PB-1 Piping Systems | Conclusions

Compared to metal pipes, PB-1 piping systems can offer the following benefits:

- **Lower overall project cost**
- **Highest flexibility**
- **Lower weight**
- **Much reduced sound transmission** (Quieter)
- **Much lower thermal conductivity**
- **Corrosion free** (Clean water, long lifetime)
- **Extreme freezing performance** (Burst resistant)
- **Low or no incrustation** (Reliability, hygiene)
- **Low or no water hammer** (Durability, comfort)
- **Much lower environmental footprint**

PB-1 piping systems:

- **EASIER** Shipping, handling and installation
- **REDUCED** Maintenance requirement and costs
- **IMPROVED** System lifespan
- **LOWER** Carbon footprint
- **HIGHEST** Building comfort





# PBPSA | Polybutene Piping Systems Association

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The Polybutene Piping Systems Association (PBPSA) is an international association of market leading companies committed to the use of the thermoplastic material, Polybutene-1 (PB-1) for the manufacture of piping systems. Also known as polybutylene, PB-1 is used worldwide in applications including piping systems for large-scale building projects, district energy networks, heating and cooling, and plumbing installations.



## Polybutene Piping Systems Association

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