

# Materials used for industrial pipe work

## The material acrylonitrile-butadiene-styrene (ABS)

### ABS properties (reference values)

Characteristics	Value *)	Units	Test Standard
Density	≥ 1.035	g/cm <sup>3</sup>	ISO 1183-1
Yield stress at 23 °C	≥ 40	N/mm <sup>2</sup>	EN ISO 527-1
Tensile e-modulus at 23 °C	≥ 1600	N/mm <sup>2</sup>	EN ISO 527-1
Charpy notched impact strength at 23 °C	42	kJ/m <sup>2</sup>	EN ISO 179-1/1eA
Charpy notched impact strength at -40 °C	≥10	kJ/m <sup>2</sup>	EN ISO 179-1/1eA
Ball indentation hardness (358N/30s)	87	MPa	EN ISO 2039-1
Heat distortion temperature HDT A 1.82 MPa	≥ 74	°C	EN ISO 75-2
Vicat-heat distortion temperature B/50N	≥ 94	°C	ISO 306
Heat conductivity at 23 °C	0.17	W/m K	EN 12664
Water absorption at 23 °C	≤ 0.45	%	EN ISO 62
Colour	similar 7001	-	RAL
Limiting oxygen index (LOI)	19	%	ISO 4589-1

\*) Typical values measured on the material. These values should not be used for design purposes.

#### General

Acrylonitrile-Butadiene-Styrene (ABS) is a versatile standard polymer. In addition to its application in piping systems, ABS is mainly common in automotive applications and in high-quality household devices.

The wide area of application relates to the versatile characteristic profile of ABS. It can be adapted to the application by varying the composition of its three components: acrylonitrile, styrene and polybutadiene.

While acrylonitrile provides strength to the material and gives ABS an improved chemical resistance relative to polystyrene, the styrenic component provides both strength and a quality surface finish. The chemically bound polybutadiene-rubber particles, on the other hand, give the material its toughness and impact strength, even at very low temperatures.

The ABS used by GF shows a good balance between toughness and strength, making it especially suitable for low temperature applications. Accordingly the areas of application are mainly refrigeration and air-conditioning systems as well as water treatment.

The advantages of ABS include:

- high impact strength even at low temperatures
- corrosion resistance
- simple installation via solvent cement joints
- low heat conductivity
- halogen free
- non-toxic
- biologically inert; no support of microbial growth
- low weight
- low pressure losses due to smooth surfaces
- good abrasion resistance
- problem-free recycling

#### Mechanical properties

In addition to the good strength and stiffness, ABS is especially characterised by a very high impact strength. Impact strength is a measure of impact energy that the material absorbs until it breaks. For this test, a specimen is weakened with a sharp notch and then struck. Without a notch, there is no breakage of the test specimen. The exceptionally high notched impact strength values, even at low temperatures, indicate the material's high robustness and tolerance against surface damage.

GF ABS pipes are routinely tested for their toughness according to EN ISO 15493. In this test, a weight falling from a height of 2 metres hits the pipe that has been cooled to 0 °C. The mass of the falling weight varies, depending on the pipe dimensions, from 0.5 (d<sub>n</sub> = 20 mm) to 9 kg (d<sub>n</sub> = 225 mm). The high load in the falling-weight test ensures that the excellent toughness of the material is not reduced as a result of processing into pipe.

The internal pressure resistance is provided by the hydrostatic strength curve based on the EN ISO 15493 standard (also see the ABS Calculation and Long-Term Behaviour section). The application limits for pipes and fittings, as shown in the pressure-temperature diagram, can be derived from these curves.

#### Chemical, weathering and abrasion resistance

ABS is characterised by its good resistance to various chemicals. In general, ABS is resistant to water, salt solutions and most dilute acids and bases. Its resistance to alcohols, aliphatic hydrocarbons, oils and greases is, however, to be regarded as limited. ABS is not resistant to concentrated mineral acids, organic acids and solvents such as esters, ketones and chlorinated and aromatic hydrocarbons. For detailed information, please refer to the detailed list of chemical resistance from GF or contact your local GF subsidiary.

If the ABS piping system is exposed to direct sunlight over a long period, its surface loses its shine and the colour shifts to light grey. Due to the very high impact strength of ABS, the resulting loss of toughness generally causes no problems in moderate climate zones. For extreme weather conditions or very high loads on the piping system, we nevertheless recommend protecting the surface from direct sunlight.

In addition to the excellent impact strength, the polybutadiene rubber particles in ABS cause an outstanding resistance against abrasion. Because of this, ABS piping systems have been used for a long time to transport solids and slurries, for example, in mining applications.

Experience has shown that ABS, as well as PE, offers considerable advantages over metal and other plastics for many such applications. Please contact GF if you are planning such an application. We would be glad to advise you about the suitability of our ABS, PE and other materials for your media.

### **Thermal properties**

The outstanding characteristics of ABS allow its application in a wide temperature range between - 50 °C and + 60 °C. At higher temperatures, the tensile strength and stiffness of the material drop and at lower temperatures, they rise. Therefore, please consult the pressure-temperature diagram for your maximum working temperature.

As all thermoplastics, ABS shows a higher thermal expansion than metals. This is not a problem if the thermal expansion is taken into account during the planning stage of the piping system. The expansion coefficient amounts to 0.1 mm/m K in the application temperature range.

At 0.17 W/m K, the heat conductivity of ABS is very low. Because of the insulation properties of the material and the resulting savings in energy or insulation, an ABS piping system is notably more economical in comparison to a system made of copper (370 W/m K) or other metals.

Should there be a need for additional insulation, e. g. in cooling applications, GF offers COOL-FIT, a system specially dedicated to this market. COOL-FIT it is a pre-insulated ABS system that has the advantage of quick and easy installation.

### **Combustion behaviour**

ABS self-ignites at temperatures exceeding 450 °C. ABS burns when exposed to an open flame. After removing the flame, the material continues burning. The oxygen index amounts to 19 %. (Materials that burn with less than 21 % of oxygen in the air are considered to be flammable).

According to UL-94, ABS has a HB (Horizontal Burning) flammability coefficient and falls into building material class B2 (conventional inflammable, non-dripping) according to DIN 4102-1. Basically, toxic substances are released by all burning processes. Carbon monoxide is generally the combustion product most dangerous to humans. When ABS burns, primarily carbon dioxide, carbon monoxide and water are formed. Tests have shown that the relative toxicity of the products of combustion are similar or even lower than those of natural products such as wood, wool and cotton. ABS combustion gases are not corrosive. Nevertheless, the burn-

ing forms soot. Because of this, smoke develops during combustion. Water, foam and carbon dioxide are suitable fire-fighting agents.

### **Electrical properties**

ABS has good electrical insulation capacity. The specific volume resistance is  $3.5 \times 10^{16} \Omega\text{cm}$  and the specific surface resistance is  $10^{13} \Omega$ . These figures have to be taken into account wherever there is a danger of fires or explosion.

### **Physiological properties**

The GF ABS is toxicologically harmless and biologically inert. Drinking water approvals in the UK (DWI) and in Germany (KTR) have been applied for.