Materials used for industrial pipe work

The material polyvinyl chloride chlorinated (PVC-C)

PVC-C properties (reference values)

Characteristics	Value *)	Units	Test Standard
Density	1.5	g/cm³	EN ISO 1183-1
Yield stress at 23 °C	≥ 53	N/mm²	EN ISO 527-1
Tensile e-modulus at 23 °C	≥ 2550	N/mm²	EN ISO 527-1
Charpy notched impact strength at 23 °C	≥ 6	kJ/m²	EN ISO 179-1/1eA
Ball indentation hardness (358N)	≥ 110	MPa	EN ISO 2039-1
Heat distortion temperature HDT A 1.80 MPa	≥ 102	°C	EN ISO 75-2
Vicat-heat distortion temperature B/50N	≥ 103	°C	ISO 306
Heat conductivity at 23 °C	0.15	W/m K	EN 12664
Water absorption at 23 °C	0.1	%	EN ISO 62
Colour	7038	-	RAL
Limiting oxygen index (LOI)	60	%	ISO 4589-1

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

General

The abbreviation PVC-C stands for chlorinated polyvinyl chloride, a material in use since 1958. PVC-C is an amorphous thermoplastic. It is made by post-chlorination of PVC whereby chlorine is attached to the PVC chain. Thus PVC-C is a transformed PVC-U material which, because of its chemical structure, is characterised by a higher temperature resistance than PVC-U, with simultaneously higher tensile strength, good toughness and an exceptional chemical resistance. Its flame resistance is even better than that of PVC-U. These characteristics have made PVC-C an interesting material for piping and fabrication of devices in the chemical industry as well as for several other industrial applications with high requirements (e. g. the aeroplane industry).

In pressure piping systems, PVC-C is suitable for strongly corrosive environments, where materials such as stainless steel or even GFK demonstrate only a short service life.

PVC-C is used for semi-finished products, pumps, valves as well as for the entire range of accessories associated with transport of liquids.

Some of the advantages of PVC-C for piping systems are:

- very good mechanical characteristics, also at increased temperatures
- outstanding chemical resistance
- no electrochemical corrosion
- long service life, even under intensely corrosive conditions
- no support of microbial growth
- simple installation using solvent cementing
- smooth inner surface
- very low heat conductivity
- exceptional flammability resistance
- no influence on drinking water

Mechanical properties

The mechanical short-term characteristics of PVC-C are very similar to those of PVC-U at room temperature. PVC-C is a material with high tensile strength and stiffness and simultaneously good impact strength. PVC-C's advantages are particularly prevalent at higher temperatures. The reason for this is its high chlorine content, which causes a strong interaction between the PVC-C chains. This, in turn, displaces the softening and the loss of attributes to higher temperatures and also has an effect on the outstanding long-term creep strength, which among the GF piping materials is only exceeded by PVDF.

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

Chemical and weathering resistance

The excellent chemical resistance of PVC-C extends to high temperatures and to high concentrations of media. Resistance against the influence of most mineral acids, bases and salt solutions is distinctive, but is also good against sodium hypochlorite and chlorine solutions. Resistance to aliphatic hydrocarbons and elemental chlorine is also good. PVC-C shows weakness against aromatic or chlorinated solvents, esters and ketones. Use with gases is also not recommended. If oils, varnish or fats are being considered, a prior investigation is advisable.

For detailed information, please refer to the detailed list of chemical resistance from GF or contact your GF subsidiary.

These specifications are also valid - with exceptions - for adhesive joints, which normally are implemented by applying strongly dissolving gap-filling solvent cement on the PVC-C.

PVC-C is weather resistant over the long term, so it can be exposed to direct sunlight as well as wind and rain. Resistance to ultraviolet radiation is very good in comparison to other materials, but nevertheless, PVC-C loses some of its impact strength. In extreme applications it can be advantageous to protect the material from direct sunlight exposure.

Thermal properties

PVC-C piping materials have a Vicat softening temperature (above 103 °C) that is over 20 °C higher than that of PVC-U. The highest temperature of application of +80 °C is derived from this heat resistance. GF recommends an operational temperature range from 0 °C to +80 °C. The material characteristics of PVC-C are ideal between +40 °C and +80 °C.

The thermal expansion coefficient of PVC-C at 0.06 to 0.07 mm/m K lies clearly above that of metals. On the other hand, with respect to the other materials used in industrial piping installations, PVC-C shows the lowest expansion coefficient. This is not a problem if the thermal expansion is taken into account during the planning of the installation.

Combustion behaviour

Due to its high chlorine content, PVC-C shows an exceptionally good combustion behaviour without the addition of flame retardants.

Under the influence of temperature, PVC-C self-ignites only above 400°C. PVC-C burns when exposed to an open flame, but immediately extinguishes when the flame is removed.

The oxygen index amounts to 60 %. (Materials that burn with less than 21 % of oxygen in the air are considered to be flammable).

PVC-C thus also falls in the best flammability class V0 according to UL94, and in the B1 (difficult to ignite) building material class with wall thicknesses $\leq$ 3.2 mm respective B2 (normally flammable) with wall thicknesses >3.2 mm according to DIN 4102-1. Smoke development is also low.

Since the combustion of PVC-C produces hydrogen chloride, which forms a corrosive acid in connection with water, immediate cleaning of areas susceptible to corrosion with water containing detergent is necessary after a fire. Danger to personnel from HCl is minimal because of its pungent odour even in very low concentrations (1-5 ppm), allowing an early escape from toxic combustion gases, mainly from the odourless carbon monoxide. Concerning the choice of fire-fighting agents, water, powder-type extinguishing agents or foam are recommended.

Electrical properties

PVC-C is, like all unmodified thermoplastics, non-conductive. This means that no electrochemical corrosion takes place in PVC-C systems. On the other hand, these non-conductive characteristics have to be taken into account because an electrostatic charge can develop in the piping. It is especially important to take this condition into account in areas where explosive gases can appear. There are various methods available to avoid the occurrence of an electrostatic charge on polymer piping systems. Please contact your GF representative if you should have applications where this needs to be considered.

The specific volume resistance is $>10^{15}$ Ωcm.

Physiological properties

PVC-C is an inert and toxically harmless material. Tests have shown that there is no support of microbiological growth in water systems from PVC-C.