

THE PROPERTIES AND CHARACTERISTICS OF THE CROSS-LINKED POLYETHYLENE PIPE (PEX)

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Abstract:

Through the properties of a material we mean the totality of characteristics and predominant qualities of the material. Analyzing attentively the multitude of properties of a material, we can state that some of them are particular, fact that leads to the usage or application of the respective material in well determined aims and domains.

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I. GENERALITIES

Through the properties of a material we mean the totality of characteristics and predominant qualities of the material. Analyzing attentively the multitude of properties of a material, we can state that some of them are particular, fact that leads to the usage or application of the respective material in well determined aims and domains.

The polyethylene is a thermoplastic polymer, which is obtained through the polymerization of the ethylene. Through the cross-linking of the polyethylene, a material is obtained, high cross-linked polyethylene, capable to respond to the prescribed international normative exigents, concerning the domain in which is going to be used.

The cross-linked polyethylene is a polymer, through which we can obtain pipes that are flexible and resistant to high temperature. The shortened name of the cross-linked polyethylene is PEX, in which „PE” stands for the polyethylene, while „X” represents the so-called „cross-linked” molecular band.

In the continuation of this paper there are presented the properties and predominant characteristics of the cross-linked polyethylene, aiming to understand the motive of why they are used in special cases, for example in the alimentary industry, chemical industry or in the industry of heating pipe systems, gas and oil pipe systems.

II. THE PRINCIPLE PROPERTIES OF THE CROSS-LINKED POLYETHYLENE PIPE

○ Chemical and electrochemical resistance

The cross-linked polyethylene pipes are not affected by the aggressive waters with different added chemical agents, namely they are resistant to the different additives added to waters and to the high-speed of the transported fluid. For example, as we know drinking water is disinfected by adding a well determined amount of chlorine (the chlorine concentration added to drinking water is regulated by normatives), the cross-linked polyethylene pipe is not affected by chlorine, as well as it is not affected by the different building materials, like cement, lime, gypsum etc.

Due to its chemical composition, the cross-linked polyethylene pipe is not affected by electrochemical corrosion owing to the perturbation currents.

○ Resistance to corrosion and sediments

In comparison with metal pipes, the cross-linked polyethylene pipes do not corrode due to their chemical composition, which do not enter in reaction with the chemical compounds of the transported fluid and in this way the possibility of modification of the entry section of the fluid due to the sediments does not exist. This quality offers a constant debit in time and the possibility to foresee the usage from the phase of projection of some diameters smaller than the pipe. Owing to its roughness of 0.007 mm, obtained through the extrusion process are excluded the sediments of the micro particles in the transported fluid.

- **Resistance to abrasion**

The cross-linked polyethylene pipe is not subjected to the effect of abrasion. This fact is due to the resistance of the material of the cross-linked polyethylene in the case of contact with some small and hard particles existing in the transported fluid and in this way the thickness of the wall remains constant in time.

- **Reduced thermic conductivity**

The cross-linked polyethylene pipe has a reduced thermic conductivity in comparison with metal pipes, from here resulting small losses on the whole track. The thermic conductivity of the Pex pipe is $\approx 0,38 \text{ W/m}^\circ\text{C}$, while the thermic conductivity of the steel pipe is $45 \text{ W/m}^\circ\text{C}$ and $348 \text{ W/m}^\circ\text{C}$ for copper pipes, resulting evidently losses of heat much higher on the whole track in the case of metal pipe systems.

Another advantage that is important to mention is the attenuation of condensation formation on the exterior of the pipe.

- **High pressure resistance**

In permanent working conditions it resists to a working pressure of up to 10 bars and 95°C . The resistance to interior pressure at $20\text{-}30^\circ\text{C}$ is minimum 70 bar. It resists to interior pressure of 44 bar and 95°C for > 1000 hours.

- **Resistance to high temperature and freeze damage**

Due to this property the cross-linked polyethylene pipes do not melt at high temperature, but become much more flexible, in this way they can be used permanently at 95°C and in accidental mode (for a shorter period of time) at 110°C .

At low temperature (in the case of freezing) the pipes are flexible and they don't break, the circuit tension being overtaken through the temporary deformation of the pipe.

- **Flexibility**

This property is very important, because due to flexibility the time of installation is reduced. For example in practice, in the case of a pipe system one can frequently meet obstacles like: trees, buildings, other pipe systems or currents, etc... that must be avoided. Due to this property these impediments are resolved automatically, this being an essential fact in the execution of an installation work.

- **Ultraviolet (UV) resistance**

The cross-linked polyethylene pipe presents resistance to ultraviolet radiation. Even so, all the cross-linked polyethylene pipe producers prescribe the maximum admissible period, referring to the exposure of these pipes to ultraviolet radiation. In consequence, producers recommend the storage of these pipes in places free from these radiations and they forbid their installation in places that are unprotected against ultraviolet radiation.

III. THE PRINCIPAL CHARACTERISTICS OF THE CROSS-LINKED POLYETHYLENE PIPE

- **The easiness of installation**

The cross-linked polyethylene pipes are easily installable due to their flexibility and their reduced weight. Owing to their flexibility they are easy to manipulate and position to

the desired place. They are fabricated in rolls, for diameters comprehended up to $\varnothing 110$ and in bars of 12 m for diameters over $\varnothing 125\text{mm}$. The pipes have a very small specific weight, in comparison with other pipes used for the same purpose. For example, a cross-linked polyethylene pipe roll, with 50 m lengths and a diameter of $32 \times 4,4 \text{ mm}$ is not weighing more than 25kg.



Fig. 1. The presentation of the polyethylene pipes winded into rolls [3]

- **Stability in time**

The cross-linked polyethylene pipe has good stability in time. Using in average civil installations, at ordinary temperature and pressure, the estimated duration of life is approximately 50 years.

- **Toxicity**

Through its composition, the cross-linked polyethylene assures the hygiene of the transported water. It is not toxic and does not provoke physiological modifications, the material being used at places where special conditions of hygiene are imposed: medical apparatus, pharmaceutical industry, alimentary industry etc.

- **It comes back to its initial form**

This characteristic is a basic one and through this it is meant the tendency of the material of coming back to its initial form, after suffering a deformation. The most frequently met deformations in these cases are squash and strangulation. These can be remediated by subjecting the material at approximately $135 \text{ }^\circ\text{C}$, temperature generated by a warm-air generator.

- **Phonic isolator**

The cross-linked polyethylene pipes are very good phonic isolators, being in this way the ideal solution for the realization of the heating systems in the interior of the buildings, since these do not produce bigger noise than the limit reglemented and received of 30db.

- **High resilience**

The high resilience to shocks of the cross-linked polyethylene is undoubtedly an advantage, in this way being unnecessary the special measures concerning their manipulation or transport.

The values of the cross-linked polyethylene material are presented in the following chart.

Chart 1.

Density	$0,94 \text{ g/m}^3$
Elongation at rupture 20°C	400%

Thermal conductivity at 23°C	≈ 0,38 W/m*K
Degree of cross-linking	65 – 89%
Roughness	0,007 mm
Inflammability class	B2
Resistance to interior pressure, 95°C, 4,8MPa	>1 hour
Resistance to interior pressure, 95°C, 4,6MPa	>170 hours
Resistance to interior pressure, 95°C, 4,4MPa	>1000 hours
Resistance to traction, tearing	20 MPa
Surface resistivity	>10

IV. CONCLUSION

Owing to the special properties and characteristics of the material of the cross-linked polyethylene, presented in this study, results undoubtedly that is corresponding to the special applications like alimentary -, medical- or pharmaceutical industry. It is also efficient, economical and durable for the realization of gas-, thermic agent or oil transport systems.

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