

TECHNO-PEX

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| Description | Size |
|-------------|----------|
| PEX | 16 X 2 |
| PEX | 20 X 2 |
| PEX | 25 X 2.3 |
| PEX | 32 X 3 |

CROSS - LINKED POLYTHYLENE PIPES

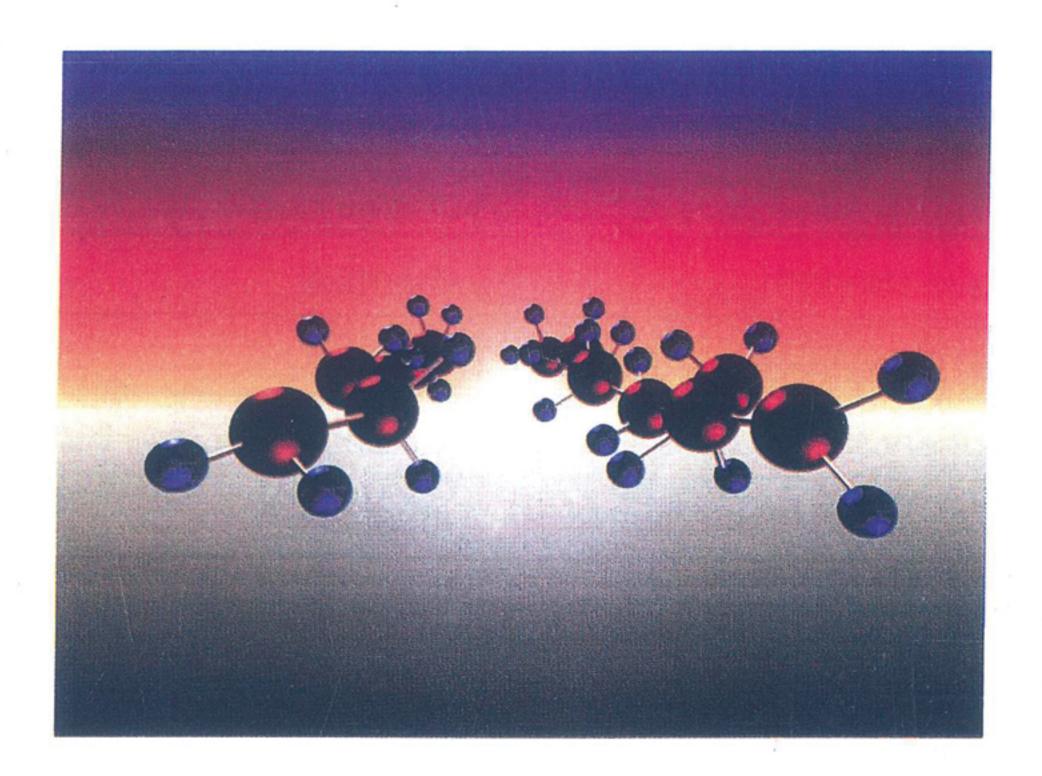
Introduction

PE-x is the chemical abbreviation of cross - linked polyethylene.

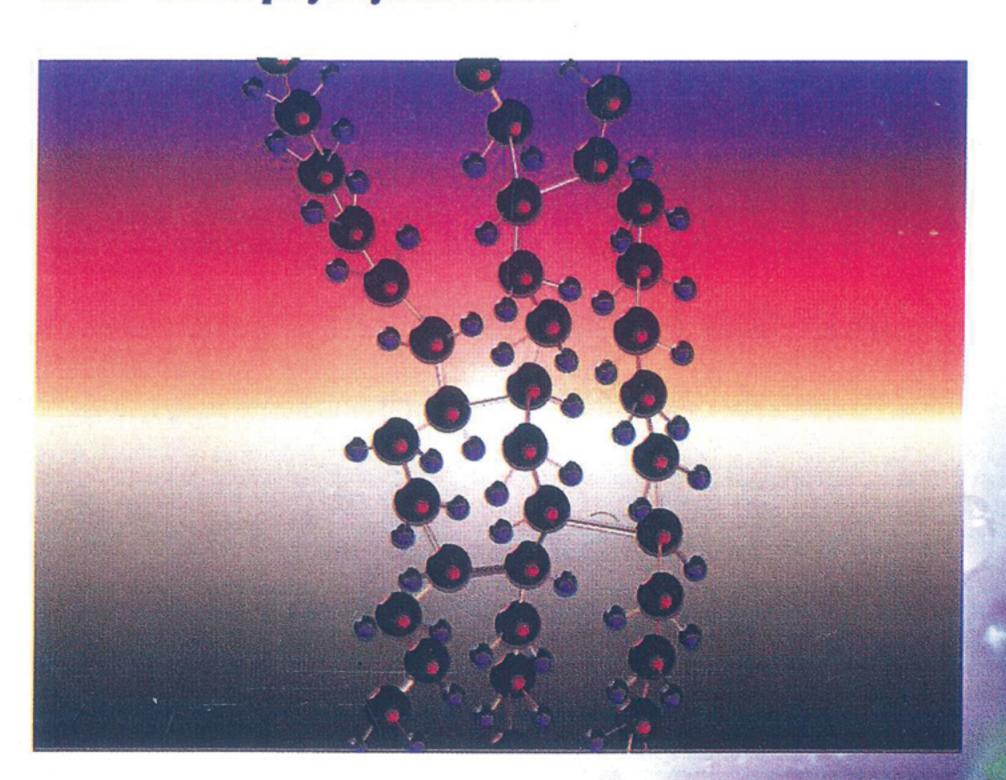
PE stands for polyethylene raw material and "X" for cross
linking. Three - dimensional molecular structure enables a lot of
superiorities in mechanical and chemical properties of PE-x pipes.

Normal linked Polyethylene chains

Normal linked polyethylene chains



Cross - linked polyethylene chains



Cross - Linked polyethylene pipes have a better;

- Resistance to both low and high temperatures
- Impact strength at low temperature
- Resistance to acid and other various chemicals

Variation of different properties in transition from Normal polyethylene to the cross - linked polyethylene is shown below

| Property | Comparison to normal PE | |
|---------------------------------|-------------------------|--|
| Melt flow index | Reduces | |
| Density | Identical / Reduces | |
| Tensile strength | Identical | |
| Burst elongation | Reduces | |
| Periphery stress crack strength | Increases | |
| Slow crack formation strength | Increases | |
| Creep strength | Increases | |
| Hydrostatic design stress | | |
| @ 23 °C | Identical | |
| @ 82 °C | Increases | |

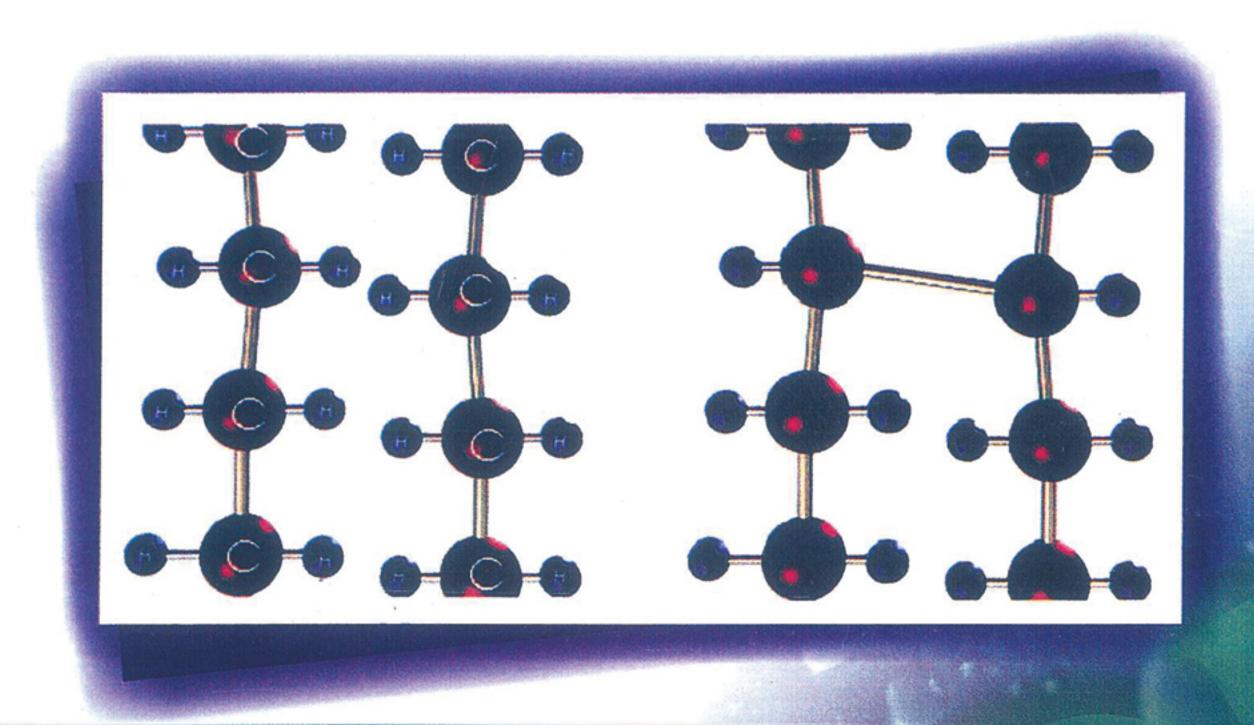
Products made of PE-X raw material are used in;

- Hot and cold water distribution systems
- Under floor heating systems
- Snow melt applications
- Convectors
- Central heating installations

Advantages of PE-X pipe systems:

- Easy and fast installation
- No calcification
- Odourless
- Non-corrosive.
- Environmentalist
- Compliance to hygiene conditions
- Lightness, easy connection and transportation
- Low friction coefficient
- Resistance to electrolyze
- Flexibility
- Long service life
- Resistance to chemicals

The main principal in cross - linking is to obtain a chemical bond between two carbon atoms that belong to free polyethylene chains. Two independent polyethylene chains that belong to normal polyethylene raw material are shown left figure below. Carbon atoms are symbolized as "C" and hydrogen atoms are symbolized as "H". By breaking of two hydrogen atoms from both chains a covalent bond is formed to create cross - linked polyethylene as shown in right figure below.



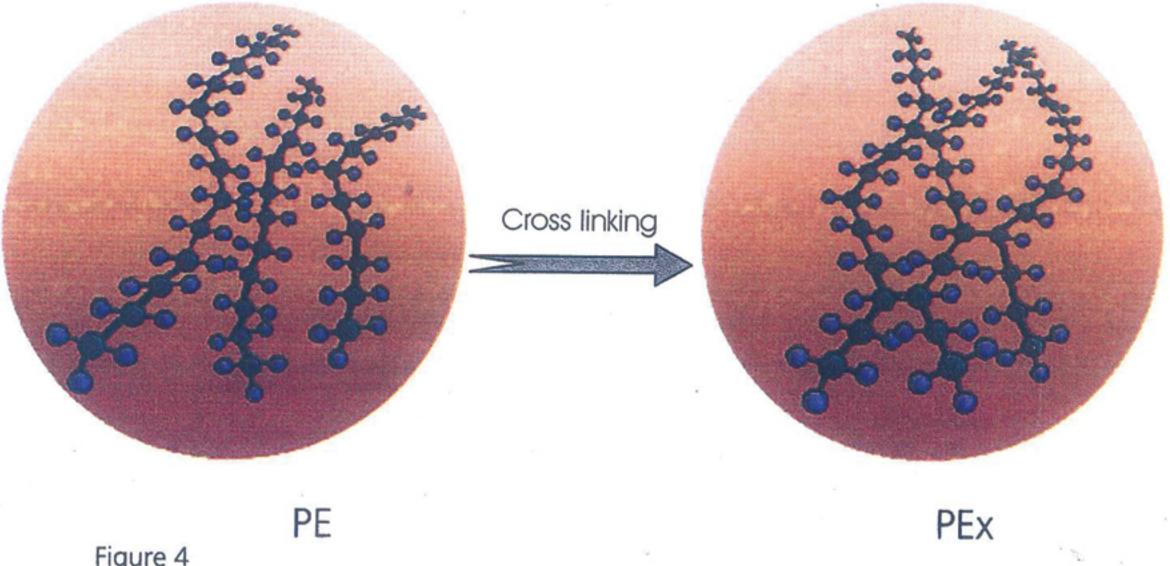


Figure 4

The ratio number of cross - linked monomers to the main chain is called PEx density.

As it mentioned above there are different methods that are used to transform the polyethylene into cross - linked polyethylene.

- 1. Engel process: During the manufacturing by using the cross - linked agent peroxide, together with high temperature and pressure, chemical bonds, so-called cross - links, are formed between the long molecular chains of the polyethylene. This cross - link is named PX-a
- 2. Silane process: During the extrusion, silane is mixed into the raw material. The polyethylene chain is grafted with Silane molecule. This is classified as PX-b. The anti - oxidant amount in material is one of the considerable factors that affect the pipe life.
- 3. Radiation process: With this method cross-linked chains are formed physically by application of gamma or beta radiation to the polyethylene. The cross - link obtained is known PX-c. It is known that in Gamma process there are a lot of risky points. In beta radiation risks are eliminated.
- 4. Azo process: Molecular chains are became cross linked in Azo medium and named PX-d.

PEx pipes, without considering the cross - link forming method, are defined by same standards. All PEx pipes are therefore functionally suitable if they are manufactured according to standards. However, due to the cross - link forming method some characteristic differences appear.

PEx standards determine the minimum needed crosslink densities due to the cross-link method as it is shown in table below.

| Pipe Type | Process | Minimum Cross - link density |
|-----------|-----------|---------------------------------|
| PEx-a | Peroxide | % 75 |
| PEx-b | Silan | % 65 |
| PEx-c | Radiation | % 60 |
| PEx-d | Azo | % 60 |

High cross - link density increases the brittleness while the strength of material is increased. It means that the high - density PEx types are less flexible and more brittle at low temperatures. Our production is realized appropriate to DIN 16893, DIN 4729 and TSE 10761 standards. After production, the PEx-b pipe is subjected to steam cure in order to complete the cross - link process.

The Cross - link test of pipes according to TS EN 579 test standard and pressure test according to DIN 16892 and TS 10762 are carried out in our own equipped laboratories.

Mechanical and thermal properties

| | Value | Temp. |
|--------------------------------|--|--------|
| Density | 0.95 gr/cm ³ | 20 °C |
| Tensile strength | 2.9 kg / mm ² | 20 °C |
| Tensile strength | 2 kg/mm ² | 100 °C |
| Burst elongation | 300 % | 20 °C |
| Burst elongation | 500 % | 100 °C |
| Elasticity Module | 19000 kg / cm ² | -40 °C |
| Elasticity Module | 15000 kg / cm ² | 0 °C |
| Elasticity Module | 12000 kg / cm ² | 20 °C |
| Elasticity Module | 5000 kg / cm ² | 80 °C |
| Shore hardness | 71 kg / mm ² | 20 °C |
| VICAT Softening temperature | 140 °C. | |
| Linear expansion coefficient | 1.4 x 10 ⁻⁴ | 20 °C |
| Linear expansion coefficient | 2.5 x 10 ⁻⁴ | 100 °C |
| Heat | 0.41 kcal / mh °C | 20 °C |
| Thermal expansion coefficient | 2.1 x 10 ⁻⁴ K ⁻¹ | 20 °C |
| Operation interval temperature | +95 °C / -50 °C | |
| | | |

Service life us proportional stress in different operation temperatures

