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Resistance to temperature aging key to heating pipe

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THE DESIGN criteria of non-metallic tubing for heating and plumbing system applications are determined by a number of important factors to ensure an absolutely safe and reliable pipe, which will guarantee a long service life of the piping system. The most important design criteria requirements are:

- High resistance to temperature aging (water temperature to 200°F).
- High resistance to chemical solvents (water additives, antifreeze solutions, concrete additives or hydrocarbon fuels).
- Lowest possible 50-year safety factor.
- High tensile strength.
- High form stability
- High resistance to deformation.
- Lowest possible internal pressure drop.
- Dimensional pipe tolerances.
- High resistance to tubing erosion due to flow velocities.
- Internal and external pipe wall smoothness.
- Behavior during long-therm internal pressure creep test which takes into account the temperature – depending aging behavior of the pipe mate rial at water temperatures up to 200°F.

All the parameters for the above mentioned design criteria are outlined and specified in the ASTM standards and DIN (German industry standards.)

The tubing material which meets and exceeds the above criteria and standards is PEX.

PEX, cross-linked polyethylene, has been synonymous with plastic heating and plumbing pipe in many European countries for 25 years.

Long-therm bench tests, of over 30 years of continuous accelerated testing that projects pipe performance well in excess of 50 years, has confirmed the excellent long-therm real service life track record of PEX.

The molecules of any plastic material tend to slip and slide over one another fairly freely. As ambient and water temperatures rise, the plastic material softens and finally melts. This thermal oxidation of plastic material is a long-therm aging process which will eventually result in pipe failure.

To combat this premature aging, the molecules within the tubing are realigned in order to give greater stability to the material itself. The cross-linking process takes place within the molecular structure of the plastic material. The most common thermoplastic materials currently being used for heating and plumbing pipe are: polyethylene (PE), polypropylene (PP), and polybuten, which is a generic term for polybutylene (PB).

Among this family of polyolefins, only polyethylene has the molecular structure which lends itself perfectly to the cross-linking process.

“Un-cross-linked” polyethylene tubing, as it leaves the extruder where it receives its basic pipe dimension and wall thickness, is composed of long hydrocarbon string molecules forming a loosely held-together array of hydrogen and carbon atoms, which can be compared to a beaded curtain in a doorway.

This is basically the molecular composition of the polyethylene tubing which is available at any hardware store, and is suitable only for non-critical applications such as draining condensate from an air conditioning unit or recirculating water in a fish tank.

This pipe material, in this form, would be totally unsuitable for heating and plumbing applications. Within a relatively short period of time the pipe material would fatigue under the stress of water temperature and pressure as well as temperature cycling. The beaded curtain would split open without any resistance.

After cross-linking, the beads (the hydrocarbon string molecules), form

cross-connections, which are referred to as cross-linking bridges. The string molecules now form a three-dimensional network of hydrocarbon molecules. The beaded curtain becomes a fishing net with strength and stability.

The previously worthless polyethylene pipe has been transformed, after cross-linking, into a completely different material with all the desired characteristics we demand from a heating or plumbing pipe.

After cross-linking, its molecular mobility is severely impeded by the cross-linking bridges between the string molecules. The material holds its shape at all temperatures, even exposed to blowtorch temperatures until it chars or burns. The thermoplastic has been transformed into a thermoset material after cross-linking, eliminating the melting point or liquid phase of the material .The tubing material does not flow or melt and its form becomes stable against heat.

In my next article, I will discuss the various cross-linking techniques used to create PEX.

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