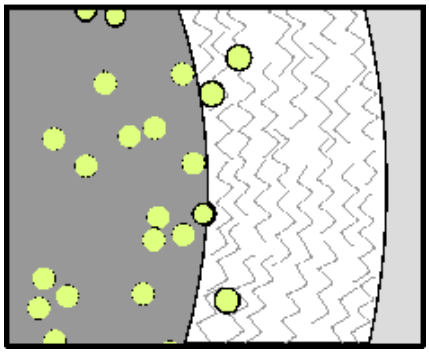
Diffusion Through Fluoroplastic Tubing

Permeant mechanics



Permeation molecular transport of a chemical through a barrier by:

1. Adsorbing and absorbing at the high concentration side
2. Diffusing through the material of the barrier and then
3. Resorbing from the low concentration side.

This is a very complex problem when discussed in combination with polymers.

The factors that influence permeation falls into three groups:

- Service conditions
- Physical properties of the polymer
- The chemistry of the permeate and the polymer

Changing an element of a situation involving permeation can often affect more than one of these factors, sometimes with unexpected results.

Service conditions

Permeant concentrations

A difference in concentration across the barrier is the primary driving force behind permeation. Higher differences will result in higher (linearly) permeation rates.

Temperature

Permeation is highly temperature dependent (exponential). Higher permeant temperature or energy increases the net mass transfer of the chemical substance. While higher polymer temperature will increase the space between the molecules in the barrier and thereby increase the permeation. Higher temperature may also increase the solubility.

Pressure

Pressure affects permeation for gases as it increases the vapor concentration. The effect is not significant in liquid systems.

Physical properties of the polymer

Void-free polymers

Lower free space or void-free regions reduce permeation.

Polymer thickness

Permeation rates are inversely proportional to the barrier thickness, but not necessarily linear.

Polymer crystallinity

Crystalline regions of polymers are essentially impermeable, with permeation occurring through the more amorphous regions. Therefore permeation decreases with higher crystallinity.

+46 (0)18 34 75 00
sales.habia@unitedflexible.com
Habia Teknofluor SE 741 80 Knivsta, Sweden

Polymer and Permeant chemistry

Permeant size / Shape

The size, shape and arrangements of the polymer chains profoundly affects the permeability in a given polymer. Large, bulky or stiff molecules will have a lower diffusion rate than small compact and flexible ones.

Permeant / Polymer chemistry

Chemical similarity between the permeant and the barrier polymer will increase solubility and permeation.

Polymer chain stiffness

Polymers with high chain stiffness resists diffusion better.

Polymer interchain forces

Polymers with high interchain forces also resists diffusion better.

Habia Teknofluor

The parameters that Habia Teknofluor can affect are:

- tubing material for the application
- processing methods and thus crystallinity and voids

Crystallinity should be kept at a minimum to maintain the flexibility of the hose. We have performed a series of tests of our gas-hoses that show the differences between materials at a given temperature and with a given media. These tests show that melt processible fluoropolymers are better. The tests were performed according to ISO 4080.

Test conditions

- Fluid: helium
- Pressure: 200 bar
- Temperature: 20°C

Typical results:

Dimension	Material	Diffusion
(ID*Wall)		(ml/hm)
6.0 x 1.0	Tefzel	78
6.4 x 1.0	PTFE	712
5.8 x 1.0	PFA 350J	504
5.7 x 1.0	PFA 420	349