Gas permeability of HDPE Pipe

Gas permeation through Plastic pipe walls follow the 1. Fick Law

For Pipes it is

$$V = P \cdot \frac{\pi \cdot da \cdot L \cdot p \cdot t}{s}$$

V	permeated gas volume	L	Pipe Length
P	permeation coefficient	p	partial gas pressure in the pipe
da	Pipe OD	t	time
		s	Pipe Wallthickness

Permeation Coefficients

The permeation coefficient depends on the type of gas and of the plastic .

For polyethylen the basic density is also relevant.

Following table indicates average values for polyethylen pressure pipe raw materials at 20°C (68°F).

Medium	Permeability coefficient $P\ \frac{cm^3}{m - bar - day}$	Medium	Permeability coefficient $P\ \frac{cm^3}{m - bar - day}$
Air	0,029	Helium	0,15
Argon	0,066	Hydrogen	0,22
Carbon dioxide	0,28	Methane	0,056
Carbon Monoxide	0,036	Natural Gas	0,056
Ethan	0,089	Nitrogen	0,018
		Oxygen	0,072

Exemplify Calculation for Natural Gas

Due to natural gas exists of 80% to 90% methane gas and the other ingrediants do have very similar permeation coefficient, it is possible to limit the calculation for gas pipes on methane only.

Methane as a sample has following miscellaneous losses.

Polyethylen pipe SDR 11 with wallthickness of S=11 mm at pressure of 4 bar (5 bar partial pressure) result in yearly losses each kilometer length as follows :

$$V = 0{,}056 \times \frac{cm^3}{m - bar - day} \pi \times 11 \times 1000m \times 5bar \times 365days$$

V = 3,5 m^3

Following above formula, the permeation per unit length of pipe is equal for all pipes of the same SDR class (as they have constant size / wall proportion).

The calculated result , confirmed either by practical meassurements on HDPE – Gaspipes of Engler –Bunte –Institut at University of Karlsruhe are economic, safety relevant and environmental entirely harmless.