Percolation

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1 Percolation

Percolation of pores media:

Darcy´s Law

$$v = k_f * i$$

v	Flow rate	[m/s]
k_f	coefficient of permeability	[m/s]
i	h/d hydraulic gradient	[-]

Advanced linear filter law

$$v = kf * (i_0 - i)$$

v	Flow rate	[m/s]
k_f	coefficient of permeability	[m/s]
i_o	Start gradient	[-]
i	h/d hydraulic gradient	[-]

2 Flow rate

Hagen-Poiseuilleschen Equation:

$$w_p = \frac{R^2}{4 \cdot \eta} \cdot \frac{dp}{l} \left[1 - \left(\frac{r}{R} \right)^2 \right]$$

w_p	Flow velocity	[m/s]
R	Radius of the pores	[m]
l	Length of the pores	[m]
r	velocity of the reaction	[m/s]
dp	difference of pressure	[N/m²]
η	dyn. Viscosity of Gases	[N·s/m²]

By integration over the complete cross section of the pores we get the following relation:

$$w_p = \frac{R^2}{8 \cdot \eta} \cdot \frac{dp}{l}$$

w_p	Flow velocity	[m/s]
R	Radius of the pores	[m]
l	Length of the pores	[m]
r	velocity of the reaction	[m/s]
dp	difference of pressure	[N/m²]

η	dyn. Viscosity of Gases	[N·s/m^2]

3 Equilibrium Concentration

Equilibrium concentration of harmful gas in scrubber liquid:

Henry- bzw. Dalton-Law

$$C_g = H\, C_L$$

C_g	Concentration of one gas component in the gas phase	[mg/m^3]
H	Absorption Constant (Henry-Constant)	[-]
C_L	Equilibrium concentration	[mg/m^3]

4 Diffusion

Mass Transport Diffusion:

Fick'sche Law:

$$n = -D \cdot \frac{dc}{dx}$$

n	Density of the mass stream	[mol/(m^2·s)]
D	Diffusion coefficient	[m^2/s]
$\frac{dc}{dx}$	Concentration gradient in x-direction	

The concentration gradient for gases is between:

D = 1 bis 2 * 10^{-5} [cm^2/s]

5 Gas Conductivity

The basis is the DARVY equation transformed for compressible fluids:

$$K_0 = \frac{v_{f,N} * l * \eta}{p_e - p_a} * \frac{2\, p_N}{p_e + p_a}$$

K_o	Permeability	$[m^2]$,
$v_{f,N}$	Pressure related to the normed density of the volume stream	[m/s],
l	Length of the probe	[m]
p_e	Pressure at the frond end of the probe	[Pa],
p_a	Pressure at the end of the probe	[Pa],
p_N	Norm pressure	[Pa]
h	dynamic Viscosity	[Pa×s].