Formelblad

<u>Medelhastighet</u>: $< \mathrm{v} > = \frac{1}{A}\int_A \ \mathbf{v}\cdot\mathbf{n}\, dA$

<u>Volymetrisk flödeshastighet</u>: $Q =< \mathrm{v} > A$

<u>Acceleration</u>: $\boldsymbol{a} = \frac{\partial \mathbf{v}}{\partial t} + \mathbf{v}\cdot\boldsymbol{\nabla}\mathbf{v}$

<u>Newtons viskositetslag</u>: $\tau_{ij} = \mu\left(\frac{\partial \mathrm{v}_i}{\partial x_{j;}} + \frac{\partial \mathrm{v}_j}{\partial x_i}\right)$; $\tau_{xy} = \mu\frac{d\mathrm{v_x}}{dy}$

<u>Kontinuitetsekvationen</u>: $\frac{\partial \rho}{\partial t} + \boldsymbol{\nabla}\cdot(\rho\mathbf{v}) = 0$; $\frac{\partial \rho}{\partial t} = -\left(\frac{\partial(\rho \mathrm{v}_x)}{\partial x} + \frac{\partial(\rho \mathrm{v}_y)}{\partial y} + \frac{\partial(\rho \mathrm{v}_z)}{\partial z}\right)$

<u>Navier-Stokes ekvation</u> för en inkompressibel fluid i rektangulära koordinater:

$$\rho\left(\frac{\partial \mathrm{v}_x}{\partial t} + \mathrm{v}_x\frac{\partial \mathrm{v}_x}{\partial x} + \mathrm{v}_y\frac{\partial \mathrm{v}_x}{\partial y} + \mathrm{v}_z\frac{\partial \mathrm{v}_x}{\partial z}\right) = -\frac{\partial p}{\partial x} + \mu\left[\frac{\partial^2 \mathrm{v}_x}{\partial x^2} + \frac{\partial^2 \mathrm{v}_x}{\partial y^2} + \frac{\partial^2 \mathrm{v}_x}{\partial z^2}\right] + \rho g_x \quad \text{i } x\text{-riktningen}$$
$$\rho\left(\frac{\partial \mathrm{v}_y}{\partial t} + \mathrm{v}_x\frac{\partial \mathrm{v}_y}{\partial x} + \mathrm{v}_y\frac{\partial \mathrm{v}_y}{\partial y} + \mathrm{v}_z\frac{\partial \mathrm{v}_y}{\partial z}\right) = -\frac{\partial p}{\partial y} + \mu\left[\frac{\partial^2 \mathrm{v}_y}{\partial x^2} + \frac{\partial^2 \mathrm{v}_y}{\partial y^2} + \frac{\partial^2 \mathrm{v}_z}{\partial z^2}\right] + \rho g_y \quad \text{i } y\text{-riktningen}$$
$$\rho\left(\frac{\partial \mathrm{v}_z}{\partial t} + \mathrm{v}_x\frac{\partial \mathrm{v}_z}{\partial x} + \mathrm{v}_y\frac{\partial \mathrm{v}_z}{\partial y} + \mathrm{v}_z\frac{\partial \mathrm{v}_z}{\partial z}\right) = -\frac{\partial p}{\partial z} + \mu\left[\frac{\partial^2 \mathrm{v}_z}{\partial x^2} + \frac{\partial^2 \mathrm{v}_z}{\partial y^2} + \frac{\partial^2 \mathrm{v}_z}{\partial z^2}\right] + \rho g_z \quad \text{i } z\text{-riktningen}$$

<u>Bernoullis lag</u>: $\frac{1}{2}\rho \mathrm{v}^2 + p + \rho g z = \text{konstant}$

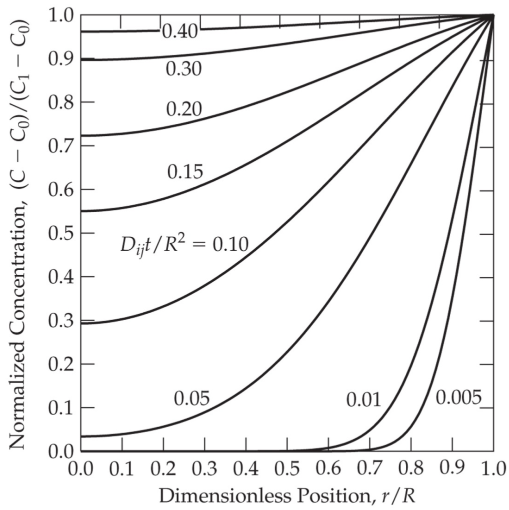
<u>Inloppslängd</u>: $L_e = 0.058\, D\, \mathrm{Re}$ (för cylindriskt rör)

<u>Poiseuilles lag:</u> $Q = \frac{\Delta p\, \pi\, R^4}{8\, \mu\, L}$ (för cylindriskt rör)

<u>Ficks första lag</u>: $J_{i_x} = -D_{ij}\frac{dC_i}{dx}$; <u>Ficks andra lag</u>: $\frac{\partial C_i}{\partial t} = D_{ij}\frac{d^2 C_i}{dx^2}$

<u>Stoke-Einsteins ekvation</u>: $D_{ij} = \frac{k_B T}{\bar{f}}$; $\bar{f} = f = 6\pi\mu R$ för en sfär

<u>Instationär diffusion</u>
(i en sfär med radien R)



Dimensionslösa tal:

$\mathrm{Re} = \frac{\rho \mathrm{v} L}{\mu}$	$\mathrm{De} = \sqrt{\delta}\,\mathrm{Re}\,; \delta = \frac{a}{R}$	$\mathrm{Pe} = \frac{\mathrm{v} L}{D_{ij}}$	
$\alpha = R\sqrt{\omega/v}\,; v = \frac{\mu}{\rho}$	$\mathrm{Nu} = \frac{h_f L}{k}$	$\mathrm{Sh} = \frac{k_f L}{D_{ij}}$	$\mathrm{St} = \frac{L_x}{T < v_x >}$
$Pe_T = \frac{< \mathrm{v} > L}{\alpha}$	$\mathrm{Pr} = \frac{v}{\alpha} = \frac{C_p \mu}{k}$	$\mathrm{Sc} = \frac{v}{D_{ij}}$	

Darcys lag med gravitation: $\mathbf{v} = -K(\nabla p - \rho \mathbf{g})$

Permeabilitet: $k = K\mu$

Brinkmans ekvation: $\mu \nabla^2 \mathbf{v} - \frac{1}{K}\mathbf{v} - \nabla p = 0$

Konvektion-diffusionsekvationen: $\frac{\partial C}{\partial t} + \nabla \cdot (f \mathbf{v}_f C) = D_{eff} \nabla^2 C + \Phi_B - \Phi_L + Q$

Retardationskoefficienten: $f = \frac{v_s}{v_f}$

Starlings filtreringslag: $J_v = L_p S(\Delta p - \sigma_s \Delta \pi)$

Energiekvationen:

$$\rho C_p \left(\frac{\partial T}{\partial t} + v_x \frac{\partial T}{\partial x} + v_y \frac{\partial T}{\partial y} + v_z \frac{\partial T}{\partial z} \right) = k \left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} \right) + \dot{Q}_p + \dot{W}_t + \dot{\Phi}_v$$

$$\frac{\partial T}{\partial t} = \alpha \nabla^2 T \quad \text{(endast konduktiv värmetransport)}$$

Fouriers lag: $\mathbf{q} = -k\nabla T$

Differentiering, cartesiska koordinater:

$$\nabla \psi = \hat{\boldsymbol{x}} \frac{\partial \psi}{\partial x} + \hat{\boldsymbol{y}} \frac{\partial \psi}{\partial y} + \hat{\boldsymbol{z}} \frac{\partial \psi}{\partial z}$$

$$\nabla^2 \psi = \frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2}$$

Differentiering, cylindriska koordinater:

$$\nabla \psi = \hat{\boldsymbol{r}}_{\mathrm{c}} \frac{\partial \psi}{\partial r_{\mathrm{c}}} + \hat{\boldsymbol{\phi}} \frac{1}{r_{\mathrm{c}}} \frac{\partial \psi}{\partial \phi} + \hat{\boldsymbol{z}} \frac{\partial \psi}{\partial z}$$

$$\nabla^2 \psi = \frac{1}{r_{\mathrm{c}}} \frac{\partial}{\partial r_{\mathrm{c}}} \left(r_{\mathrm{c}} \frac{\partial \psi}{\partial r_{\mathrm{c}}} \right) + \frac{1}{r_{\mathrm{c}}^2} \frac{\partial^2 \psi}{\partial \phi^2} + \frac{\partial^2 \psi}{\partial z^2}$$

Differentiering, sfäriska koordinater:

$$\nabla \psi = \hat{\boldsymbol{r}} \frac{\partial \psi}{\partial r} + \hat{\boldsymbol{\theta}} \frac{1}{r} \frac{\partial \psi}{\partial \theta} + \hat{\boldsymbol{\phi}} \frac{1}{r \sin\theta} \frac{\partial \psi}{\partial \phi}$$

$$\nabla^2 \psi = \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{\partial \psi}{\partial r} \right) + \frac{1}{r^2 \sin\theta} \frac{\partial}{\partial \theta} \left(\sin\theta \frac{\partial \psi}{\partial \theta} \right) + \frac{1}{r^2 \sin^2\theta} \frac{\partial^{q} 2\psi}{\partial \phi^2}$$

$$= \frac{1}{r} \frac{\partial^2}{\partial r^2} (r\psi) + \frac{1}{r^2 \sin\theta} \frac{\partial}{\partial \theta} \left(\sin\theta \frac{\partial \psi}{\partial \theta} \right) + \frac{1}{r^2 \sin^2\theta} \frac{\partial^2 \psi}{\partial \phi^2}$$