NTNU

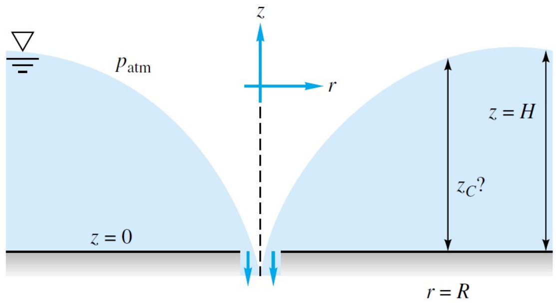
TEP4105: Fluidmekanikk

Øving 8:
Høst 2014

Oppgaver fra White, 7. utgave

Oppgave 4.70 (4.60 i 6. utgave)

P4.60 Liquid drains from a small hole in a tank, as shown in Fig. P4.60, such that the velocity field set up is given by $v_r \approx 0$, $v_z \approx 0$, $v_\theta = \omega R^2/r$, where $z = H$ is the depth of the water far from the hole. Is this flow pattern rotational or irrotational? Find the depth z_C of the water at the radius $r = R$.



P4.60

Oppgave 4.72 (4.62 i 6. utgave)

Show that the linear Couette flow between plates in Fig. 1.6 has a stream function but no velocity potential. Why is this so?

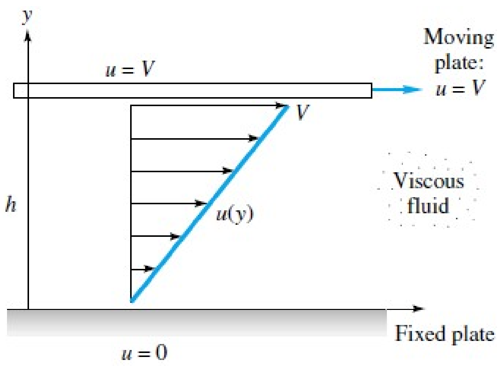


Fig. 1.6 Viscous flow induced by relative motion between two parallel plates.

(There is an error in White 6th edition – should there be Fig. 1.8)

Oppgave 4.75 (4.65 i 6. utgave)

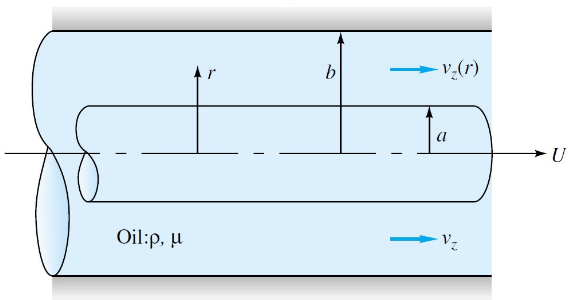
P4.65 A two-dimensional incompressible flow is defined by

$$u = -\frac{Ky}{x^2 + y^2} \qquad v = \frac{Kx}{x^2 + y^2}$$

where K = constant. Is this flow irrotational? If so, find its velocity potential, sketch a few potential lines, and interpret the flow pattern.

Oppgave 4.99 (4.88 i 6. utgave)

P4.88 The viscous oil in Fig. P4.88 is set into steady motion by a concentric inner cylinder moving axially at velocity U inside a fixed outer cylinder. Assuming constant pressure and density and a purely axial fluid motion, solve Eqs. (4.38) for the fluid velocity distribution $v_z(r)$. What are the proper boundary conditions?



P4.88

Eqs (4.38) in vector form:

$$\rho\vec{g} - \nabla p + \mu\nabla^2\vec{u} = \rho\frac{d\vec{u}}{dt}$$

See Appendix D for (4.38) in cylindrical form.

TEP 4105 FLUIDMEKANIKK

TILLEGG ØVING 8

OM PLANE POLARKOORDINATER (r, θ).

Først en opplysning:

$\nabla \times \vec{V}$ kan finnes ved bruk av determinanten

$$\nabla \times \vec{V} = \frac{1}{r} \begin{vmatrix} \vec{e}_r & r\vec{e}_\theta & \vec{e}_z \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial \theta} & \frac{\partial}{\partial z} \\ V_r & rV_\theta & V_z \end{vmatrix}$$

Oppgave: Vis at

$$\nabla \cdot \vec{V} = \frac{1}{r} \frac{\partial (r V_r)}{\partial r} + \frac{1}{r} \frac{\partial V_\theta}{\partial \theta},$$

ved å benytte nabla-operatoren $\nabla = \left(\frac{\partial}{\partial r}, \frac{1}{r}\frac{\partial}{\partial \theta}\right)$

på $\vec{V} = (V_r, V_\theta)$.

En har i disse koordinatene

$\vec{e}_r \cdot \vec{e}_r = 1$, $\vec{e}_\theta \cdot \vec{e}_\theta = 1$,

$\frac{\partial \vec{e}_r}{\partial \theta} = \vec{e}_\theta$, $\frac{\partial \vec{e}_\theta}{\partial \theta} = -\vec{e}_r$.