NTNU

TEP4105: Fluidmekanikk

Øving 9: Høst 2014

Oppgaver fra White, 7. utgave

Oppgave 8.14 (8.12 i 6. utgave)

P8.12 Consider the flow due to a vortex of strength K at the origin. Evaluate the circulation from Eq. (8.15) about the clockwise path from $(r, \theta) = (a, 0)$ to $(2a, 0)$ to $(2a, 3\pi/2)$ to $(a, 3\pi/2)$ and back to $(a, 0)$. Interpret the result.

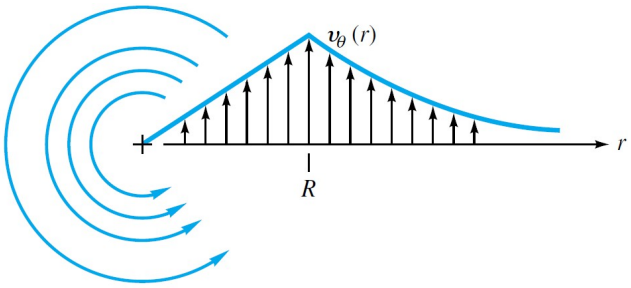
$$\Gamma = \oint_C V \cos\alpha \, ds = \int_C \mathbf{V} \cdot d\mathbf{s} = \int_C (u\,dx + v\,dy + w\,dz) \qquad (8.15)$$

Oppgave 8.16 (8.14 i 6. utgave)

P8.14 A tornado may be modeled as the circulating flow shown in Fig. P8.14, with $v_r = v_z = 0$ and $v_\theta(r)$ such that

$$v_\theta = \begin{cases} \omega r & r \le R \\ \dfrac{\omega R^2}{r} & r > R \end{cases}$$

Determine whether this flow pattern is irrotational in either the inner or outer region. Using the r-momentum equation (D.5) of App. D, determine the pressure distribution $p(r)$ in the tornado, assuming $p = p_\infty$ as $r \to \infty$. Find the location and magnitude of the lowest pressure.



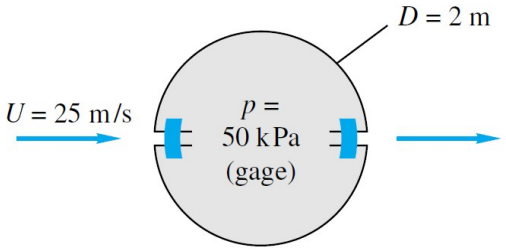
P8.14

The r-momentum equation:

$$\frac{\partial v_r}{\partial t} + (\mathbf{V}\cdot\nabla)v_r - \frac{1}{r}v_\theta^2 = -\frac{1}{\rho}\frac{\partial p}{\partial r} + g_r + \nu\left(\nabla^2 v_r - \frac{v_r}{r^2} - \frac{2}{r^2}\frac{\partial v_\theta}{\partial \theta}\right) \qquad (D.5)$$

Oppgave 8.52 (8.46 i 6. utgave)

P8.46 A cylinder is formed by bolting two semicylindrical channels together on the inside, as shown in Fig. P8.46. There are 10 bolts per meter of width on each side, and the inside pressure is 50 kPa (gage). Using potential theory for the outside pressure, compute the tension force in each bolt if the fluid outside is sea-level air.



P8.46

Oppgave 8.63 (8.57 i 6. utgave)

P8.57 In principle, it is possible to use rotating cylinders as aircraft wings. Consider a cylinder 30 cm in diameter, rotating at 2400 r/min. It is to lift a 55-kN airplane cruising at 100 m/s. What should the cylinder length be? How much power is required to maintain this speed? Neglect end effects on the rotating wing.