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Mechatronics
17/ENG05/021

$\mu = 0.9\ Ns/m^2$

$Q = 180\ Lit/min = 0.003 m^3/s$

$D = 100mm = 0.01m$

$L = 65m$ $\rho = 1260\ kg/m^3$

$A = \pi \frac{D^2}{4} = \frac{\pi \times 0.01}{4}$

$= 0.00007855 m^2$

$\bar{U} = \frac{Q}{A}$

Reynolds number $= \frac{\rho \bar{U} D}{\mu}$

$= \frac{1260 \times \left(\frac{0.003}{0.00007855}\right) \times 0.01}{0.9}$

$= 534.76$

Thus the flow is laminar

$f = \frac{64}{Re} = \frac{69}{534.76} = 0.11968$

$P_1 - P_2 = \frac{f \rho L V^2}{2D}$

$$P_1 - P_2 = \frac{0.11968 \times 1260 \times 65 \times (38.197)^2}{2 \times 0.01}$$

$$= 7.15 \times 10^8 \, N/m^2 //$$

2 Viscosity = 800 cp

Specific gravity = 0.85

$D = 65mm, \; 0.065m$

$\Delta P = 2000 \; kN/N1$

$L = 95m$

4 $$\Delta P = \frac{32 \mu \bar{U} L}{D^2}$$

$$\bar{U} = \frac{\Delta P \times D^2}{32 \times \mu \times L}$$

$$\bar{U} = \frac{8000 \times 10^3 \times (0.065)^2}{32 \times 0.8 \times 95}$$

$$\bar{U} = 3.47 \, m/s$$

$$Re = \frac{\rho U D}{\mu} = \frac{0.85 \times 1000 \times 3.47 \times 0.065}{0.8}$$

$$= 239.64$$

Thus the flow is Laminar

$\bar{U} = Q/A$

$Q = \bar{U}A$

$= 0.00\ 33183 \times 3.47$

$= 0.0115\ m^3/s$

$P = F_0 \times \bar{U}$

$= 6.63661 \times 3.47 = 23.02\ kW$

$\tau_0 = \mu \cdot \left(\frac{\partial u}{\partial y}\right)_{y=0}$

$\left(\frac{dy}{\partial y}\right)_{y=0} = \frac{\bar{\tau}_0}{\mu}$

$= \frac{342.1}{0.8}$

$= 427.625/s$

$U_{max} = 2\bar{U} = 2 \times 3.47 = 6.94\ m/s$

$F_0 = \bar{\tau}_0 \times \pi D L$

If $\bar{\tau}_0 = \frac{\Delta P}{L} \times \frac{R}{2}$

$$= \frac{2000 \times 10^3 \times 0.0065}{95 \times 2 \times 2}$$

$$= 342.1 N/m^2$$

$$F_o = 342.1 \times \pi \times 0.065 \times 95$$

$$= 6636.61 N //$$

$$F \quad r = R - y$$

$$y = 60mm, \ 0.06m$$

$$r = 0.0325 - 0.06$$

$$= -0.0275 //$$