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17/ENG05/1010
Mechatronics Engineering

a) Reynolds number when flow is 785N of oil in 25 seconds

$$Re = \frac{\rho D u}{\mu}$$

∴ flow, Q = 785 in 25 secs
= $785\ kg\ m\ s^{-2}$

$F = mg$

$m = F/g$

$m = 758 / 9.81$

$= 80\ kg$

$\dot{m} = 80/25$

$= 3.20\ kg\ s^{-1}$

$\dot{m} = \rho u A$

where $A = \frac{\pi D^2}{4}$ $\rho = 900\ kg/m$

$= \frac{\pi (0.12)^2}{4}$

$= 0.0113\ m^2$

$u = \dot{m} / \rho A$

$= 3.20 / (0.112 \times 900)$

$u = 0.314 ms^{-1}$

$Re = \frac{900 \times 0.72 \times 0.514}{0.09}$

$= 376.8$ //

∴ the flow is laminar.

b $\Delta P = \frac{32 \mu \bar{u} L}{D^2}$

$= \frac{32 \times 0.09 \times 0.514 \times 12}{(0.12)^2}$

$= 755.6 Nm^{-2}$

$P = \rho g h$

$h = \frac{753.6}{9.8 \times 900}$

$h = 0.0853 m$ //

2 $D = 0.06m$

$\rho = 1000 kg$

$Q = 8.5 Lit/sec$

$= 8.5 \times 10^{-3} m^3/s$

h = 850m

V = 0.5 stokes

$= 0.00005 m^2/s$

$V = \mu/\rho$

$\mu = V \times \rho$

$= 0.00005 \times 1000$

$= 0.05 Ns m^{-1}$

$U = \frac{8.5 \times 10^{-3}}{2.83 \times 10^{-3}}$

$= 3.01 ms^{-1}$

$A = \frac{\pi (0.06)^2}{4}$

$= 2.827 \times 10^{-3} m^2$

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

$= \frac{32 \times 0.05 \times 3.01 \times 850}{(0.06)^2}$

$\Delta P = 1,130 kN m^{-2}$

Recall

$P = \rho g h$

$h = \frac{1,130 \times 10^3}{1000 \times 9.81}$

$= 100m$ // (approximately) //

b $\tau = \mu \frac{\delta u}{\delta y}$

$\tau_0 = -\left(\frac{\delta p}{\delta x}\right) \times \frac{\gamma}{2}$

$\gamma = D/2$

$= 0.06/2$

$= 0.03m$ //

$\left(\frac{\delta p}{\delta x}\right) = -\frac{1130 \times 10^3}{850}$

$= -\left(-\frac{1130 \times 10^3}{850}\right) \times \frac{0.03}{2}$

$= 20 Nm^{-2}$ (approximate value) //

C $Re = \frac{\rho D u}{\mu}$

$= \frac{1000 \times 0.06 \times 3.01}{0.05}$

$= 3612 \Rightarrow$ The flow is laminar //