ASITA OBONISO MCT 322
17/ENG 06 /014
MECHATRONICS ENGINEERING

1 $\mu = 0.9$ poise, $D = 0.12m$ $L = 12m$

a, Reynold number when flow is 785N of oil in 25secs

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

→ Flow $Q = 785N$ in 25secs $= 785 kg m s^{-2}$

$$F = mg$$

$$m_k = \frac{F}{g} = \frac{785}{9.81} = 80kg$$

$$\dot{m} = \frac{80}{25} = 3.20 kg s^{-1}$$

$\rho = 900 kg m^{-1}$

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

$$A = \frac{\pi D^2}{4} = \frac{\pi (0.12)^2}{4} = 0.0113 m^2$$

$$u = \frac{\dot{m}}{\rho A} = \frac{3.20}{900 \times 0.0113} = \frac{3.20}{10.17} = 0.315 ms^{-1}$$

$$\therefore Re = \frac{900 \times 0.12 \times 0.315}{0.09}$$

$$= \frac{34.02}{0.09} = 378$$

→ The flow is laminar

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

$$= \frac{32 \times 0.09 \times 0.315 \times 12}{0.12^2} = \frac{10.9864}{0.0144} = 756 Nm^{-2}$$

$P = \rho g h$

Making h the subject of the formula

$$h = \frac{P}{\rho g} = \frac{756}{900 \times 9.81} = \frac{756}{8829} = 0.0856\,m$$

2 $D = 0.06m$ $\rho = 1000 kgm^{-3}$ $L = 850m$ $Q = 8.5 \times 10^{-3} m^3 s^{-1}$

$V = 0.5$ stokes $\rightarrow 0.00005 m^2 s^{-1}$

$$M = V \times \rho$$
$$= 0.00005 \times 1000$$
$$= 0.05\ Nsm^{-1}$$

$$A = \frac{\pi D^2}{4} = \frac{\pi (0.06)^2}{4} = \frac{0.01131}{4} = 2.827 \times 10^{-3} m^2$$

$$Q = uA$$
$$u = \frac{Q}{A} = \frac{8.5 \times 10^{-3}}{2.827 \times 10^{-3}} = 3.01 ms^{-1}$$

a, $$\Delta P = \frac{32 M \bar{u} L}{D^2} = \frac{32 \times 0.05 \times 3.01 \times 850}{(0.06)^2}$$
$$= \frac{4093.6}{3.6 \times 10^{-3}} = 1,137\ kNm^{-2}$$

$$P = \rho g h$$
$$h = \frac{P}{\rho g} = \frac{1,137 \times 10^3}{1000 \times 9.81} = \frac{1,137 \times 10^3}{9810}$$
$$= 115.91$$
$$\approx 115m$$

b, $$\tau_0 = M \frac{\delta u}{\delta y}$$

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

$$r = \frac{D}{2}$$

$$= \frac{0.06}{2} = 0.03\,m$$

$$\left(\frac{\delta p}{\delta x}\right) = \frac{-1137 \times 10^3}{850}$$

$$= -\left(\frac{-1137 \times 10^3}{850}\right) \times \frac{0.03}{2}$$

$$= -(-1337.65) \times 0.015$$

$$= 20.06$$

$$\simeq 20\,Nm^{-2}$$

c, $R_e = \frac{\rho D u}{\mu}$

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

$$= \frac{180.6}{0.05} = 3612$$

→ The flow is laminar