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17/ENG05/1038

MECHATRONICS

MCT 322

Assignment 2

1. $\mu = 0.9$ poise $= 0.09 N/m^2$

$\rho = 0.9$

Specific weight $\gamma = 0.9 \times 9810 = 8829 N/m^2$
weight density

$D = 120mm = 0.12m$

$L = 12m$

Weight of oil collected in 25s = 785N

i. $Re = \frac{\rho \bar{u} D}{\mu}$ but $\bar{u}$ have not been found

Average velocity, $\bar{u} = \frac{Q}{Area}$

but $Q = \frac{\text{weight of Oil Collected}}{\text{weight density}}$

$$Q = \frac{\frac{785}{25}}{8829} = \frac{31.4}{8829} = 0.00355 m^3/s$$

$$\therefore \bar{u} = \frac{Q}{Area} = \frac{0.00355}{(\frac{\pi}{4})D^2} = \frac{0.00355}{\frac{3.14 \times 0.12^2}{4}}$$

$$= 0.314 m/s$$

$$\therefore Re = \frac{\rho \bar{U} D}{\mu} = \frac{0.9 \times 1000 \times 0.314 \times 0.12}{0.09}$$

$$= 376.8$$

Since $Re < 2000$, hence the FLOW is Laminar.

ii. Pressure Difference, $(P_1 - P_2) = \frac{32 \mu \bar{U} L}{D^2}$

$$= \frac{32 \times 0.09 \times 0.314 \times 12}{(0.12)^2}$$

$$= 753.6 \, N/m^2$$

2. $D = 60mm = 0.06m$

$L = 850m$

$Q = 8.5 \, L/s = 0.0085 \, m^3/s$

$\nu = 0.015 \, stokes = 0.015 \times 10^{-4} \, m^2/s$

Coefficient of friction, $f = \frac{0.0791}{(Re)^{1/4}}$

but $Re = \frac{Vn}{\nu}$

$$\text{but } V = \frac{Q}{A} = \frac{0.0085}{\frac{\pi \times 0.06^2}{4}} = 3.007 \, m/s$$

$$\therefore Re = \frac{VD}{\nu} = \frac{3.007 \times 0.06}{0.015 \times 10^{-4}} = 120280 \approx 120000$$

$$\therefore f = \frac{0.0791}{(120280)^{1/4}} = 4.24 \times 10^{-3} = 0.00424$$

i. Head Loss, $h_f = \frac{4fLv^2}{D \times 2g} = \frac{4 \times 0.00424 \times 850 \times 3.007^2}{0.06 \ 2 \times 9.81}$

$= 110.73m$

ii. Wall Shearing Stress, $\tau_o = \frac{fv^2\rho}{2} = \frac{0.00424 \times 3.007^2 \times 1000}{2}$

$= 19.17 N/m^2$

iii. Reynold's Number $= \frac{VD}{\nu} = \frac{3.007 \times 0.006}{0.015 \times 10^{-4}}$

$= 120280 \simeq 120,000$

Since $Re > 2000$, hence the flow is turbulent.