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17/ENG05/009
MECHATRONICS ENGINEERING
MCT 322

QUESTION 1

1. $\mu = 0.9 \text{ Poise} = 0.09 Ns/m^2$

Relative density = 0.9 Density = 0.9×1000

Weight density = $0.9 \times 9810 = 8829 N/m^3$

Diameter = 120mm = 0.12m

L = 12m $A = (\pi/4)(0.12)^2$

Weight of oil in 25secs = 785N

$$Re = \frac{\rho V D}{\mu} \quad \ldots\ldots (1)$$

$$V = \bar{u} \quad \ldots\ldots (2)$$

$$\bar{u} = \frac{Q}{A} \quad \ldots\ldots (3)$$

$$\frac{N}{s} = \frac{N}{m^3} \times \frac{m^3}{s} \quad \ldots\ldots (4)$$

$$\frac{N}{s} = w \times Q$$

$\frac{785}{25} = 8829 \times Q$

$Q = \frac{8829}{785} \times \frac{25}{25} \times \frac{785}{8829} \times \frac{1}{8829}$

$Q = 8.55 \times 10^{-3}$

sub $Q = 3.55 \times 10^{-3}$ in (3)

$\bar{u} = \frac{3.55 \times 10^{-3}}{(\pi/4)(0.12)^2}$

$\bar{u} = 0.314 m/s$

Recall $\nu = \bar{u} = 0.314$

$\therefore Re = \frac{(0.9 \times 1000) \times 0.314 \times 0.12}{0.09}$

$Re = 376.8$

Pressure difference

$$(p_1 - p_2) = \frac{32\mu VL}{D^2}$$

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

$$p_1 - p_2 = 753.6\ N/m^{-2}$$

$$hf = \frac{p_1 - p_2}{w} = \frac{753.6}{8829} = 0.085m \text{ of oil}$$

QUESTION 2

Diameter of pipe, D = 60mm = 0.06m

Length of the pipe, L = 850m

Discharge, Q = 8.5lit/sec = 0.0085

kinematic viscosity of water, v = 0.015 stokes = $0.015 \times 10^{-4} m^2/s$

Mean velocity $V = \frac{Q}{A} = \frac{0.0085}{\frac{\pi}{4} \times (0.06)^2} = 3.0m/s$

$Re = \frac{VD}{\nu} = \frac{3.0 \times 0.06}{0.015 \times 10^{-4}} = 5600\ 120{,}000$

$f = \frac{0.0791}{Re^{1/4}} = \frac{0.0791}{120000^{1/4}} = 0.01021\ 4.2499 \times 10^{-3}$

(i) $h_f = \frac{4fLV^2}{D \times 2g} = 4 \times \frac{0.01021 \times 850 \times 3^2}{0.06 \times 2 \times 9.81}\ 4 \times \frac{4.2499 \times 10^{-3} \times 850 \times 3^2}{0.06 \times 2 \times 9.81}$

$h_f = 110.47\,m$

(ii) $\tau_0 = \frac{fV^2\rho}{2} = 4 \times \frac{4.2499 \times 10^{-3} \times 3^2 \times 1000}{2}$

$\tau_0 = 19.12\,N/m^2$

(iii) $Re = 120{,}000$

(iv) Turbulent flow