OBARAKPO EMMANUEL .C.
17/ENG05/024
MECHATRONICS ENGINEERING.
MCT 322 Ass.

① * Dynamic viscosity (μ) = 0.9 Poise = $\frac{0.9}{10}$ Ns/m² = 0.09 Ns/m²

* relative density = 0.9 ∴ density = 0.9 × 1000 = 900 kg/m³

* Diameter = 120mm = $\frac{120}{1000}$ m = 0.12 m

* Length = 12m

Since 785N was collected in 25 seconds; W = 785 N

mass, m = W/g ——— ①

and, volume = $\frac{\text{mass}}{\text{density}}$ ——— ②

Substitute eqn ① into ②; $V = \frac{W/g}{\rho} = \frac{785/9.81}{900} = 0.0889\ m^3$

$Q = \frac{0.0889}{25}\ m^3/s = 3.556 \times 10^{-3}\ m^3/s$

$\text{Area} = \frac{\pi D^2}{4} = \frac{3.142 \times 0.12^2}{4} = 0.0113\ m^2$

$\text{Velocity}, V = \frac{Q}{A} = \frac{3.556 \times 10^{-3}}{0.0113} = 0.314\ m/s$

$Re = \frac{\rho V D}{\mu} = \frac{900 \times 0.314 \times 0.12}{0.09} = 376.8$ //

→ Since $Re < 2000$: the flow is Laminar.

⑥ $P_1 - P_2 = \frac{32 \mu V L}{D^2} = \frac{32 \times 0.09 \times 0.314 \times 12}{0.12^2} = 753.6\ N/m^2$ //

$h_f = \frac{P_1 - P_2}{\rho g}$

$= \frac{753.6}{900 \times 9.81} = 0.0853$

$= 0.085\ m$ of oil //

(2) * $D = 60\,mm = \frac{60}{1000}\,m = 0.06\,m$

* $L = 850\,m$

* $Q = 8.5\,Lit/sec$

* Kinematic viscosity, $\gamma = 0.015$ stokes.

$= 0.015 \times 10^{-4}\,m^2/sec$

* $Q = 8.5\,Lit/sec = \frac{8.5}{1000} = 8.5 \times 10^{-3}\,m^3/s$

$Area = \frac{\pi D^2}{4} = \frac{3.142 \times 0.06^2}{4} = 0.00283\,m^2$

$Q = AV, \quad V = \frac{Q}{A} = \frac{8.5 \times 10^{-3}}{0.00283} = 3\,m/s$

$\therefore Re = \frac{\rho V D}{\mu} = \frac{VD}{\gamma} = \frac{3 \times 0.06}{0.015 \times 10^{-4}} = 120{,}000$

$Re = 120{,}000$

Since $Re > 4000$, The flow is Turbulent.

$f = \frac{0.0791}{Re^{1/4}} = \frac{0.0791}{120{,}000^{1/4}} = 4.25 \times 10^{-3}$

$h_f = \frac{4 f L V^2}{2gD} = \frac{4 \times 4.25 \times 10^{-3} \times 850 \times 3^2}{2 \times 9.81 \times 0.06}$

$h_f = 110.47\,m$ of water

(b) $\tau_0 = \frac{f V^2 \rho}{2} = \frac{4.25 \times 3^2 \times 1000}{2}$

$= 19.13\,N/m^2$

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

(d) since $Re > 4000$, the flow is TURBULENT.