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Dept: Mechanical Eng

Course: ENGT 214

Online Assignment

1.

$$l = 2 \text{ m}$$

$$V_1 = 5 \text{ m/s}$$

$$V_2 = 2 \text{ m/s}$$

$$\frac{P_1}{W} = 2.5 \text{ m}$$

$$h_L = \frac{0.35 (V_1 - V_2)^2}{2g} = \frac{0.35 (5 - 2)^2}{2 \times 9.81} = 0.161 \text{ m}$$

To get $\frac{P_2}{W}$; comparing:

$$\frac{P_1}{W} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{W} + \frac{V_2^2}{2g} + Z_2 + h_L$$

$$Z_2 = 0$$

$$Z_1 = 2 \text{ m}$$

$$2.5 + \frac{5^2}{2 \times 9.81} + 2 = \frac{P_2}{W} + \frac{2^2}{2 \times 9.81} + 0 + 0.161$$

$$5.77 = \frac{P_2}{W} + 0.365$$

$$\frac{P_2}{W} = 5.77 - 0.365$$

$$= \underline{\underline{5.405 \text{ m}}}$$

2. $d_1 = 0.2 \text{ m}$; $d_2 = 0.1 \text{ m}$; $P_1 = 17.658 \text{ N/cm}^2$; $P_2 = -30 \text{ mmHg}$; $C_d = 0.98$

$$A_1 = \frac{\pi \times 0.2^2}{4} = 3.14 \times 10^{-3} \text{ m}^2$$

$$A_2 = \frac{\pi \times 0.1^2}{4} = 7.85 \times 10^{-4} \text{ m}^2$$

$$h = \frac{P_1 - P_2}{W}$$

$$P_1 = \frac{17.658}{10^{-4}} = 176.58 \times 10^3 \text{ N/m}^2$$

$$\frac{P_1}{W} = \frac{176.58 \times 10^3}{1000 \times 9.81} = 18 \text{ m}$$

$$\frac{P_2}{W} = -0.30 \times 13.6$$

$$= -0.408 \text{ m} \quad -0.408 \text{ m} \quad -4.08$$

$$h = 18 - (-0.408) = 18 + 4.08 = 18 + 4.08$$

$$= 18.408 \text{ m}$$

$$Q_{act} = C_d \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$$

$$= 0.98 \times \frac{3.14 \times 10^{-3} \times 7.85 \times 10^{-4}}{\sqrt{(3.14 \times 10^{-3})^2 - (7.85 \times 10^{-4})^2}} \times \sqrt{2 \times 9.81 \times 18.408}$$

$$= 0.98 \times 8.12 \times 10^{-5} \times 19.2081$$

$$= \underline{1.512 \times 10^{-3} \text{ m}^3/\text{s}} \quad \underline{1.656 \times 10^{-2} \text{ m}^3/\text{s}}$$

3. $D_o = 15 \text{ cm} = 0.15 \text{ m}$

$D_1 = 30 \text{ cm} = 0.3 \text{ m}$

$y = 50 \text{ cm Hg} = 0.5 \text{ m Hg}$

$S_g \text{ of oil} = 0.9$; $S_g \text{ of mercury} = 13.6$

$C_d = 0.64$

Area of pipe (A_1) = $\frac{\pi \times 0.3^2}{4} = 0.0707 \text{ m}^2$

Area of orifice meter (A_o) = $\frac{\pi \times 0.15^2}{4} = 0.0177 \text{ m}^2$

$$h = y \left[\frac{S_{gh}}{S_o} - 1 \right]$$

S_{gh} = specific gravity of heavier liquid

$$h = 0.5 \left[\frac{13.6}{0.9} - 1 \right]$$

$$= 7.056 \text{ m of oil}$$

$$Q = C_d \frac{A_o A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_o^2}}$$

$$= \frac{0.64 \times 0.0177 \times 0.071 \times \sqrt{2 \times 9.81 \times 7.056}}{\sqrt{0.011^2 - 0.0177^2}}$$

$$= \underline{0.138 \text{ m}^3/\text{s}}$$

4.

manometer reading (y) = 170 mm Hg = 0.17 m Hg

$$S_{gh} = 13.6$$

$$S_g \text{ of sea water (sw)} = 1.026$$

$$h = 0.17 \left[\frac{13.6}{1.026} - 1 \right]$$

$$= 2.08$$

Velocity of the submarine:

$$V = \sqrt{2gh}$$

$$= \sqrt{2 \times 9.81 \times 2.08}$$

$$= \underline{6.39 \text{ m/s}}$$

5.

$$Q = 5 \text{ cm}^3/\text{min}$$

$$= \left[\frac{5}{1000} \times \frac{1}{60} \right] \text{ m}^3/\text{s}$$

$$= 8.3 \times 10^{-5} \text{ m}^3/\text{s}$$

$$V = 1700 \text{ rev/min} = \frac{1700}{60}$$

$$= 28.33 \text{ revs/sec}$$

$$Q_p = 10 \text{ cm}^3/\text{rev} = 10 \times 10^{-6} \text{ m}^3/\text{rev}$$

Ideal flow rate = speed \times displacement

$$1 \times 10^{-5} \times 28.33$$

$$= 2.833 \times 10^{-4} \text{ m}^3/\text{sec}$$

$$\text{i) Vol. efficiency} = \frac{\text{actual } Q}{\text{Ideal } Q} \times 100$$

$$= \frac{8.3 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100$$

$$= \underline{29.33\%}$$

$$\begin{aligned} \text{ii.) Fluid power} &= \text{flow rate} \times \text{pressure} \\ &= 8.3 \times 10^{-5} \times (15 \times 10^5) \\ &= \underline{124.5 \text{ W}} \end{aligned}$$

$$\begin{aligned} \text{iii.) Shaft power} &= \text{torque} \times \text{angular velocity} \\ \omega &= 2\pi N \\ &= 2\pi \times 28.33 = 178 \text{ rads}^{-1} \\ \text{Shaft power} &= 15 \times 178 \\ &= \underline{2670 \text{ W}} \end{aligned}$$

$$\begin{aligned} \text{iv.) Overall efficiency} &= \frac{\text{fluid power}}{\text{shaft power}} \times 100 \\ &= \frac{124.5}{2670} \times 100 \\ &= \underline{4.66\%} \end{aligned}$$