MATRIC NUMBER: 17/MHS01/314

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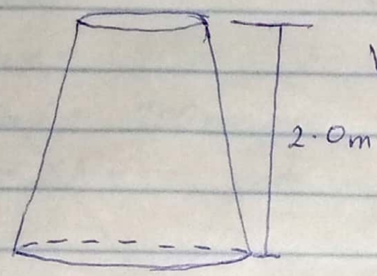
DEPARTMENT: Mechanical Engineering

COURSE: ENG 214

POWER

1. Given



$V_A = 5 m/s$ $\frac{P_A}{\rho g} = 2.5m$ of liquid

$\frac{P_B}{\rho g} = ?$ $Z_A = 2$ $Z_B = 0$

$V_B = 2 m/s$

$$h_L = \frac{0.35(V_A - V_B)^2}{2g} = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.16m$$

$$\frac{P_A}{\rho g} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\rho g} + \frac{V_B^2}{2g} + Z_B + h_L$$

$$\Rightarrow 2.5 + \frac{5^2}{2 \times 9.81} + 2 = \frac{P_B}{\rho g} + \frac{2^2}{2 \times 9.81} + 0 + 0.16$$

$$\frac{11329}{1962} = \frac{P_B}{\rho g} + \frac{26962}{122625}$$

$$\therefore \frac{P_B}{\rho g} = 3.58$$

2. Given a horizontal venturimeter,

$d_i = 20cm$; $A_i = \pi (d_i/2)^2 = 314.16 cm^2$

$d_t = 10cm$; $A_t = \pi (d_t/2)^2 = 78.54 cm^2$

Sp. gr. $= 0.8$ ~~$Q = 60 lit/s = 60 \times 1000 \, cm^3/s$~~ $C_d = 0.98$

~~$Q = C_d \frac{A_i \times A_t}{\sqrt{A_i^2 - A_t^2}} \times \sqrt{2gh}$~~

$P_i = 17.658 \, N/cm^2$

$= 17.658 \times 10^4 \, N/m^2$

~~$60 \times 1000 = 0.98$~~

$\frac{P_i}{\rho g} = \frac{17.658 \times 10^4}{9.81 \times 1000} = 18m$ of water

$\frac{P_t}{\rho g} = -30cm$ of mercury

$= -0.3 \times 13.6 = -4.08m$ of water

$$h = \frac{P_i}{\rho g} - \frac{P_t}{\rho g} = 18 - (-4.08) = 22.08 \text{ m of water}$$
$$= 2208 \text{ cm}$$

$$Q = C_d \frac{a_i a_t}{\sqrt{a_i^2 - a_t^2}} \times \sqrt{2gh}$$

$$= 0.98 \times \frac{314.16 \times 78.54}{\sqrt{314.16^2 - 78.54^3}} \times \sqrt{2 \times 9.81 \times 2208}$$

$$= 0.98 \times 81.116 \times 208.137$$

$$= 16545.58 \text{ cm}^3/s$$

$$= 16.55 \text{ ltr}/s$$

5.

3. Given,

$d_o = 15cm$; $A_o = \pi \left(\frac{d_o}{2}\right)^2 = 176.72 \text{ cm}^2$

$d_P = 30cm$; $A_P = \pi \left(\frac{d_P}{2}\right)^2 = 706.86 \text{cm}^2$

diff. manometer reading (x) = 50 cm of mercury   Sp. gr. oil = 0.9 $C_d = 0.64$

$$h = x \left[\frac{S_m}{S_o} - 1\right] = 50\left[\frac{13.6}{0.9} - 1\right] = 705.56 \text{ cm of oil}$$

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

$$= 0.64 \times \frac{176.72 \times 706.86}{\sqrt{706.86^2 - 176.72^2}} \times \sqrt{2 \times 9.81 \times 705.56}$$

5.

$$= 0.64 \times 182.52 \times 117.66$$

$$= 13744.19 \text{ cm}^3/s$$

$$= 13.74 \text{ ltr}/s$$

4. Given submarine horizontally,

$x = 170mm = 0.17m$

S_g mercury = 13.6 $V = ?$

S_g sea-water = 1.026

$$h = x\left[\frac{S_{gm}}{S_{gs}} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.083 \text{ m}$$

$V = \sqrt{2gh}$

$= \sqrt{2 \times 9.81 \times 2.0834}$

$V = 6.394 m/s$

$= \frac{6.394 \times 60 \times 60}{1000}$

$\therefore V = 23.02 km/hr$

5. Given pump,

speed = 1700 rev/min   displacement = $10 cm^3/rev$

torque = 15 Nm   rate of flow = $0.05 m^3/min$

i. Vol. Eff. = ?

$\text{Vol. Eff} = \frac{\text{actual flow}}{\text{theoritical flow}}$

th. flow = 10×1700

$= 17 \times 10^3 cm^3/min$

$= 17 \times 10^{-3} m^3/min$

$\Rightarrow$ Vol. Eff. = $\frac{0.05}{0.017}$

5. Given pump,

Speed = 1700 rev/min $\times \frac{1}{60s}$

$= 28.333 rev/s$

$p = 15 \times 10^5 N/m^2$

torque = 15 Nm

displacement = $10 cm^3/rev$

$= 1 \times 10^{-5} m^3/rev$

rate of flow = $0.05 m^3/min \times \frac{1}{60s}$

$= 8.333 \times 10^{-5} m^3/s$

i. Volumetric Efficiency = ?

$\text{Vol Eff} = \frac{\text{actual flow}}{\text{theoritical flow}}$

th. flow = $1 \times 10^{-5} \times 28.333$

$= 2.8333 \times 10^{-4} m^3/s$

$\Rightarrow \text{Vol Eff} = \frac{8.33 \times 10^{-5}}{2.8333 \times 10^{-4}} \times 100$

$= 29.41\%$

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ii. Fluid Power = ?

P_F = actual flow rate × Pressure

$= 8.333 \times 10^{-5} \times 15 \times 10^5$

$= 124.995 W$

iii. Shaft Power = ?

$P_S = \tau \times \omega$

$\Rightarrow P_S = 15 \times 178.02$

$= 2670.3 W$

speed = 28.333 rev/s

1 rev = 360°

& π rad = 180°

2π rad = 360°

$\Rightarrow$ 2π rad = 1 rev

Thus, speed = 28.333 × 2π

$\omega = 178.02$ rad/s

iv. Overall Efficiency = ?

$$\text{Ove Eff} = \frac{P_F}{P_S} \times 100$$

$$= \frac{124.995}{2670.3} \times 100$$

∴ Ove Eff = 4.68%