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18/ENG06/005
Mechanical Engineering.

1) Ideal flow rate = normal displacement x speed
$= 10 \times 1500 = 15\ dm^3/min$

i) volumetric efficiency = $\frac{\text{actual flow}}{\text{ideal flow}} = \frac{10}{15} = 0.67 = 67\%$

ii) Fluid power = $\Delta P Q$
$\Delta P = 1.2 \times 10^5 = 1,2000000$
$Q = \frac{10 \times 10^{-3}}{60} = 1.67 \times 10^{-4}$
$\Delta P Q = 2000.4$ watts

iii) shaft power = $\frac{2\pi NT}{60} = (2\pi \times 1500 \times 12.5) \div 60$
$= 1964.3\ Nm$

iv) overall efficiency = $\frac{\text{fluid power}}{\text{shaft power}} = \frac{2000.4}{1964.3}$
$= 0.102 = 10.2\%$

2) 87% = F.P / S.P
Fluid Power = $\Delta P Q$
$P = 100 \times 10^5\ N/m^2$
$Q = 35 \times 10^{-3} = 5.83 \times 10^{-4} = 5833.3$ watts
$87\% = \frac{5833.3}{x}$
$= x = 6705\ Nm$

3) idea flow rate = normal displacement x speed
$= 50 \times 850 = 42.5\ dm^3/min$
volumetric efficiency = $\frac{\text{actual flow}}{\text{idea flow}}$
$= \frac{35}{42.5} = 82\%$

Fluid Power = $\Delta P Q$
= 8300

- Shaft = 15 kwatts

Overall Efficiency = Fluid Power / Shaft power = 8300 / 15000 = 33.3%

i) h = 20m $A = \frac{\pi d^2}{4} = 0.7854$

d = 10cm = 0.1m w = ? $V_f = 0$

$V_f^2 = V_i^2 - 2gh$

$V_i = \sqrt{V_f^2 + 2gh} = \sqrt{0^2 + 2(9.8)(20)}$

$= 19.80 \text{ m/s}$

$Q = V_A = (19.8)(7.854 \times 10^{-3})$

$= 1.55 \times 10^{-3} \text{ m}^3/\text{s}$

$w = \rho g Q h = 1000 \times 9.8 \times 0.155 \times 20$

$= 30478 \text{ kg m}^2/\text{s}^3$

$= 30 \times 10^3 \text{ w}$

ii) $P_{1g} = 19.62 \text{ N/m}^2$ $C_d = 0.96$ $d_1 = 0.3m$ $d_2 = 0.2m$

$P_1 + \rho_g g z_2 = P_2 + \rho_g (z_2 - z_1) + \rho_{wg} g z_1$

$P_1 - P_2 = (z_2 - z_1) 19.62 + 587.432$ ... ①

Bernoulli $\frac{P_1}{\rho_g g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho_g g} + \frac{V_2^2}{2g} + z_2$

$P_1 - P_2 = (z_2 - z_1) 19.62 + 0.803 V^2$ ... ②

Combin eqn I & II

$0.803 V_2^2 = 587.423$

$V_2 \text{ ideal} = 27.047 \text{ m/s}$

$Q \text{ ideal} = 27.047 \times \pi (\frac{0.2}{2})^2$

$= 0.85 \text{ m}^3/\text{s}$

$Q = C_d Q_{ideal} = 0.96 \times 0.85 = 0.816 \text{ m}^3/\text{s}$

8) $d_1 = 0.152\,m$ $d_2 = 0.076\,m$ $P = 800\,kg/m^3$ $C_d = 0.97$

$A_1 = 0.01814\,m$ $A_2 = 0.00454\,m$

Using Bernoulli method

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P^2}{\rho g} + \frac{v_2^2}{2g} + z_2$$

a) $P_1 = P_2 =$ $\frac{v_1^2}{2g} + z_1 = \frac{v^2}{2g} + z_2$

$Q = v_1 A_1 = v_2 A_2$

$v_2 = v_1 A_1 / A_2 = v_1 4$

$v_1 = \sqrt{(0.914 \times 2 \times 9.81)}\,/15$

$v_1 = 1.0934\,m/s$

$Q = C_d v_1 A_1$

$Q = 0.96 \times 0.01814 \times 1.0934$

$= 0.019\,m^3/s$

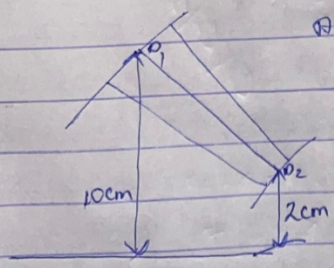
$P_1 - P_2 = 15170$

$$\frac{P_1 - P_2}{\rho g} = \frac{v_2^2 - v_1^2}{2g} = 0.914$$

$$\frac{15170}{\rho g} = Q_2 (220.43^2 - 55.11^2) - 0.914$$

$Q = 0.035\,m^3/s$

9)



At section 1

$D_1 = 0.3m$ $A = \frac{\pi}{4}(0.3)^2 = 0.707\,m^2$

$z_1 = 10\,m$ $v_1 = ?$ $P_1 = 400 \times 10^3\,N/m^2$

At section 2

$D_2 = 0.15m$ $A = \frac{\pi}{4}(0.15)^2 = 0.1767\,m^2$

$A_1 v_1 = A_2 v_2 = 40\,litre/s = 40 \times 10^{-3}\,m/s$

$v_1 = \frac{40 \times 10^{-3}}{0.707} = 0.566\,m/s$

$v_2 = \frac{40 \times 10^{-3}}{0.01767} = 2.264\,m/s$

Using bernoulli method

$$\frac{500\times10^3}{9800} + \frac{(0.856)^2}{2\times9.8} + 10 = \frac{P_2}{\omega} + \frac{(1.274)^2}{2\times9.8} + 6$$

$$P_2 = 436.8 \text{ kn/m}^2$$

ii) mercury level = 170mm = 0.17m

sg of mercury = 13.6

sg of water = 1.026

$$h = Y\left[\frac{S_{hi}}{S_{hi}} - 1\right]$$

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

$$h = 2.683$$

velocity of submarine

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

$$= \sqrt{2\times9.81\times2.683}$$

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

5.914