Sarah Odekwo
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1) Ideal flow rate = normal displacement x speed
= 10 x 1500
= 15 dm³/mm

(i) Volumetric efficiency = $\frac{\text{Actual flow}}{\text{Idea flow}}$
= $\frac{10}{15} \times 100$
= 66.7%

(ii) Fluid power = $\Delta P \cdot Q$
= $(1.2 \times 10^5)(1.67 \times 10^{-3})$
= 200.4 W

$\Delta P = 1.2 \times 10^5$
$Q = \frac{10 \times 10^{-3}}{60}$
$= 1.67 \times 10^{-3}$

(iii) Shaft power = $\frac{2\pi NT}{60}$
= $\frac{2 \times \pi \times 1500 \times 12.5}{60}$
= 1963.5 Nm

$N = 1500$ rev/min
$T = 12.5$ Nm

(iv) Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft Power}}$
= $\frac{200.4}{1963.5} \times 100$
= 10.2%

2) Fluid power = ΔPQ
= $(100 \times 10^5)(5.83 \times 10^{-4})$
= 5830

$P = 100 \times 10^5 N/m^2$
$Q = 5.83 \times 10^{-4}$
Overall efficiency = 87%
= 0.87

Overall efficiency = $\frac{\text{Fluid power}}{\text{Shaft power}}$

$0.87 = \frac{5830}{S.P}$

$S.P = \frac{5830}{0.87} = 6701.15$ Nm

3) Ideal flow rate = normal displacement x speed
= 50 x 850
= 42·5 dm³/mm

(i) Volumetric efficiency = $\frac{\text{Actual flow}}{\text{Ideal flow}}$
= $\frac{35}{42.5} \times 100$
= 82·4%

(ii) Fluid power = ΔPQ
= $(100 \times 10^5)(8.33 \times 10^{-4})$
= 8330W

$\Delta P = 100 \times 10^5$
$Q = \frac{50 \times 10^{-3}}{60}$
$= 8.33 \times 10^{-4}$

6) $V_F^2 = V_I^2 - 2gh$
$V_I = \sqrt{V_F^2 + 2gh}$
$= \sqrt{0 + 2(9.81)(20)}$
$= 19.81 m/s$

$h = 20m$
$d = 10cm = 0.1m$
$A = \frac{\pi}{4} \times 0.1^2$
$= 0.00785 m^2$
$W = ?$

Then;
$Q = VA$
$= 19.81 \times 0.00785$
$= 0.156 m^3/s$
$W = \rho g Q h$
$= 1000 \times 9.81 \times 0.156 \times 20$
$= 30607.2 Kgm^2/s^3$
$= 3.06 \times 10^4 W$

7) $P_1 + \rho_g q \pm P_2 + \rho_{1g}(Z_2 - Z_1) + P_w g P$
$P_1 - P_2 = 19.62(Z_2 - Z_1) + 587.423$ ——— (1)

$P_{1g} = 19.62 N/m^2$
$C_d = 0.96$
$d_1 = 0.3m$
$d_2 = 0.2m$
$U_1 =$

Venturimeter:
$\frac{P_1}{\rho g} + \frac{U_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{U_2^2}{2g} + Z_2$
$P_1 - P_2 = 19.62(Z_2 - Z_1) + 0.803 U_2^2$ ——— (2)

8) Using Bernoulli's equation

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

$d_1 = 0.152m$
$d_2 = 0.076m$
$\rho = 800 kg/m^3$
$C_d = 0.97$
$A_1 = 0.01815 m^2$
$A_2 = 0.00454 m^2$

a) $P_1 = P_2$

$$\therefore \frac{V_1^2}{2g} + Z_1 = \frac{V_2^2}{2g} + Z_2$$

$$Q = V_1 A_1 = V_2 A_2$$

$$V_2 = \frac{V_1 A_1}{A_2}$$

$$= 0.4$$

$$V_1 = \sqrt{\frac{0.914 \times 2 \times 9.81}{15}}$$

$$= 1.0934 m/s$$

$$Q = C_d A_1 V_1$$
$$= 0.96 \times 0.01815 \times 1.0934$$
$$= 0.019 m^3/s$$

b) $P_1 - P_2 = 15170$

$$\frac{P_1 - P_2}{\rho g} = \frac{V_2^2 - V_1^2}{2g} - 0.914$$

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

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

9) $A_1 V_1 = A_2 V_2 = 40 L/sec$
$= 40 \times 10^{-3} m/sec$

$$V_1 = \frac{40 \times 10^{-3}}{0.0707} = 0.566 m/s$$

$$V_2 = \frac{40 \times 10^{-3}}{0.0177} = 2.260 m/s$$

$d_1 = 0.3m$
$A_1 = \frac{\pi}{4} \times 0.3^2 = 0.0707 m^2$
$Z_1 = 10m$
$P_1 = 400 \times 10^3 N/m^2$
$V_1 = ?$
$d_2 = 0.15m$
$A_2 = \frac{\pi}{4} \times (0.15)^2 = 0.0177 m^2$
$V_2 = ?$
$P_2 = ?$
$Z_2 = 6m$

Applying Bernoulli's method

$$\frac{400 \times 10^3}{9800} + \frac{(0.566)^2}{2 \times 9.8} + 10 = \frac{P_2}{w} + \frac{(2.264)^2}{2 \times 9.8} + 6$$

$$\frac{P_2}{w} = 44.57 N/m^2$$

10) $h = y\left[\frac{S_{hl}}{S_l} - 1\right]$

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

$= 2.08$

$V = \sqrt{2gh}$

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

$= 6.388239194$

$\simeq 6.39 m/s$

$y = 170mm = 0.17m$

$Hg, S_{hl} = 13.6$

$Seawater, S_l = 1.026$