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

But, $Q = A_1 V_1$

$$\therefore V_1 = \frac{Q}{A_1} = \frac{0.04}{0.07059}$$

$$V_1 = 0.5658 \simeq 0.57 \, m/s$$

Then $V_2 = \frac{Q}{A_2} = \frac{0.04}{0.0177}$

$$V_2 = 2.2598 \simeq 2.26 \, m/s.$$

$$\frac{P_1}{\rho g} (Z_1 - Z_2) + \left(\frac{V_1^2}{2g} - \frac{V_2^2}{2g}\right) = \frac{P_2}{\rho g}.$$

$$\frac{400KN}{9.81KN} + (10-6) + \left(\frac{0.57^2 - 2.26^2}{2 \times 9.81}\right) = \frac{P_2}{9.81 KN}.$$

$$40.77 + 4 + (-0.2438) = \frac{P_2}{9.81 KN}.$$

$$44.52 \times 9.81 = P_2.$$

$$P_2 = 436.74 \, KN.$$

10. Reading of manometer = 170mm
= 0.17m

Specific gravity of mercury = 13.6.
" " seawater = 1.026.

$y = 0.17m$

For $h = y\left(\frac{S_{hl}}{S_L} - 1\right)$

$$= 0.17\left(\frac{13.6}{1.026} - 1\right)$$

$$= 0.17 \times 12.255$$

$$= 2.0834 \, m.$$

Recall $V = \sqrt{2gh}$

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

$$V = \sqrt{40.87}$$

$$V = 6.393 \, m/s.$$

ii) Then $P_1 - P_2 = 15170$

$$\left(\frac{P_1}{\rho g} + Z_1\right) - \left(\frac{P_2}{\rho g} + Z_2\right) = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}.$$

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

Recall, $Z_1 - Z_2 = 0.914$.

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

Recall, $Q = VA$, $V = \frac{Q}{A}$,

$\rho = 800$, $g = 9.81$,

$$\frac{15170}{800 \times 9.81} = \frac{\left(\left(\frac{Q}{A_2}\right)^2 - \left(\frac{Q}{A_1}\right)^2\right)}{2g} - 0.914.$$

$$\frac{15170}{7848} = Q^2\frac{\left(\left(\frac{1}{A_2}\right)^2 - \left(\frac{1}{A_1}\right)^2\right)}{2g} - 0.914$$

$$1.932 = Q^2\frac{(48516.36 - 3052.41)}{2g} - 0.914$$

$$(1.932 + 0.914)2g = Q^2(48516.36 - 3052.41).$$

$$\frac{56.3678}{45463.95} = \frac{Q^2 \, 45463.95}{45463.95}$$

$Q^2 = 1.24 \times 10^{-3}$

$Q = \sqrt{1.24 \times 10^{-3}}$

$Q = 0.0352 \, m^3/s.$

9.) $d_1 = 300mm = 0.3m$

$d_2 = 150mm = 0.15m.$

$\therefore A_1 = 0.07069 m^2$

$A_2 = 0.0177 m^2.$

$Q = 40 lit/sec = 0.04 m^3/sec$

$Z_1 = 10m$, $Z_2 = 6m.$

$P_1 = 400 KN/m^2$, $P_2 = ?$

equating equi & equii

$$19.62(Z_2 - Z_1) + 587.423 = 19.62(Z_2 - Z_1) + 0.803V_2^2$$

$$0.803V_2^2 = 587.423$$

$$V_2^2 = \frac{587.423}{0.803}$$

$$V_2^2 = 731.535$$

$$V_2 = \sqrt{731.535}$$

$$V_2 = 27.0469$$

$$\simeq 27.047 \text{ m/s}$$

$Q_{ideal} = A_2V_2$

$\therefore 27.047 \times 0.0314$

$Q_{ideal} = 0.8492$

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

$Q_{real} = C_d \times Q_{ideal}$

$= 0.96 \times 0.85$

$= 0.816 \text{ m}^3/\text{s}$

8.) Throat diameter $= 0.076\text{m}$ (d_2)

vertical diameter $= 0.152\text{m}$ (d_1)

Relative density $= 0.8$

Throat being $= 0.914\text{m}$

$C_d = 0.91$.

Bernoulli's equ.

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

Recall that

$Q = V_1A_1$, $Q = V_2A_2$.

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi \times 0.076^2}{4}$$

$$= 4.64 \times 10^{-3} \text{ m}^2$$

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi \times 0.152^2}{4}$$

$$= 0.0181 \text{ m}^2$$

7.) $d_1 = 0.3m$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi \times 0.3^2}{4}$

$= 0.07068 m^2 \simeq 0.0707 m^2$

$d_2 = 0.2m$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi \times 0.2^2}{4}$

$= 0.031415 m^2 \simeq 0.0314 m^2$

$C_d = 0.96$

specific weight of gas $= 19.62 N/m^2$.

$\gamma = \frac{mg}{V} = \rho g$.

$= \frac{19.62}{9.81} = \frac{\rho \times 9.81}{9.81}$ so, $\rho g = 19.62$

$\therefore \rho = 2 kg/m^2$

calculating $Q_1 = A_1 V_1$, $Q_2 = A_2 V_2$, $Q_1 = Q_2$.

$\therefore V_1 = \frac{Q_1}{A_1}$, $V_2 = \frac{Q_2}{A_2}$

$V_1 = \frac{Q}{0.0707}$ $V_2 = \frac{Q}{0.0314}$.

For the manometer.

$P_1 + \rho_g g Z_1 = P_2 + \rho_g g (Z_2 - R_P) + \rho_w g R_P$

$P_1 - P_2 = \rho_g g (Z_2 - R_P) + \rho_w g R_P - \rho_g g Z$.

$P_1 - P_2 = 19.62 (Z_2 - Z_1) + 587.423$. — i

For the venturimeter,

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

$P_1 - P_2 = 19.62 (Z_2 - Z_1) + 0.803 V_2^2$ — ii

& $Z_2 - Z_1 = 0.06m$.

iv) Efficiency = $\frac{\text{Power of Jet}}{\text{Power of Reservoir}} \times 100\%$.

$= \frac{4797.1}{571442.3} \times 100\%$

$= 0.83\%$.

6.) $P = \rho g Q z$.

$z = 20m = h$

$\rho = 1000$

$g = 9.81$.

$Q = vA$.

$d = 10cm = 10 \times 10^{-2} m$.

$A = \frac{\pi d^2}{4} = 7.85 \times 10^{-3} m^2$

But we need the velocity at height of initial velocity using one of the equation of motion,

$v = 0$.

$v^2 = u^2 - 2gh$.

$u = \sqrt{v^2 + 2gh}$.

$u = \sqrt{0^2 + 2 \times 9.81 \times 20}$.

$u = \sqrt{392.4}$

$u = 19.809 \simeq 19.81 m/s$.

The velocity $= 19.81$.

$\therefore Q = VA$

$= 19.81 \times 7.85 \times 10^{-3}$

$= 0.15558 m^3/s$

$\simeq 0.156 m^3/s$

Then;

$P = \rho g Q z$

$= 1000 \times 9.81 \times 0.156 \times 20$.

$P = 30510.7677$ watts.

$\simeq 30.5$ kilowatts.

5 Sg of oil = 0.89

$z = 30{,}000\,cm = 300\,m$

$Q = 220\,L/sec = 0.22\,m^3/sec.$

$V = 7\,m/sec.$

introducing, $z = 0$, Pressure = 0.

i) $P = \frac{\rho Q V^2}{2}$

but, Sg = 0.89.

$Sg = \frac{x}{1000}$

$\therefore x = 0.89 \times 1000$

$x = 890.$

$\therefore \rho = x = 890.$

$P = \frac{890 \times 0.22 \times (7)^2}{2}$

$P = 4797.1$ watts

ii Power supplied from reservoir.

$P = \rho g Q z$

$P = 890 \times 9.81 \times 0.22 \times 300.$

$P = 576239.4$ watts.

$\simeq 576.2394$ kilowatts

iii Power loss in transmission

= Power reservoir − Power of Jet.

$= (576.2394 - 4.7971)$ kilowatt

$= 571442.3$ watts

$= 571.4423$ kilowatt

Head used to overcome losses

$= \frac{571442.3}{890 \times 9.81 \times 0.22}$

$= 297.51\,m.$

$$P = \frac{1000 \times 0.013 \times (66)^2}{2}$$

$P = 28314$ watts $= 28.314$ Kilowatts

ii) Power supplied from reservoir.

At atmospheric pressure; $P = 0$ and $V = 0$.

$\therefore$

$P = \rho g Q z$.

$= 1000 \times 9.81 \times 0.013 \times 240$

$= 30607.2$ watts.

$\simeq 30.607$ Kilowatts.

iii) Power loss in transmission,

= Power of reservoir − Power of Jet.

$= (30607.2 - 28314)$.

$= 2293.2$ watts.

$\simeq 2.2932$ Kilowatts

Head loss in pipeline $= 2.2932$ Kwatts

$$h = \frac{\text{Power lost in transmission}}{\rho g Q}$$

$$= \frac{2293.2}{1000 \times 9.81 \times 0.013}$$

$$= \frac{2293.2}{127.53}$$

$h = 17.98$ m

$$\text{Efficiency} = \frac{\text{Power of Jet}}{\text{Power of reservoir}} \times 100\%$$

$$= \frac{28314}{30607.2} \times 100.$$

$= 92.51\%$.

Ideal flowrate = Nominal displacement × speed

$= 50 \times 10^{-6}\ m^3/rev \times 14.17\ rev/s$

$= 7.085 \times 10^{-4}\ m^3/s.$

i volumetric efficiency $= \frac{\text{Real Flowrate}}{\text{Ideal Flowrate}} \times 100\%.$

$= \frac{5.83 \times 10^{-4}}{7.085 \times 10^{-4}} \times 100\%$

$= 82.29\%.$

ii Fluid power $= Q \cdot dp.$

$= 5.83 \times 10^{-4} \times 100 \times 10^5$

$= 5830$ watts.

Overall Efficiency $= \frac{5830}{15000} \times 100.$

$= 38.867\%$

4. $Z = 2400\ cm = 24\ m$

Volumetric flowrate, $Q = 13$ litres/sec

$= 0.013\ m^3/sec$

Velocity $= 66\ m/sec$

The general formula,

$$P = \rho g Q \left(\frac{P}{\rho g} + \frac{V^2}{2g} + Z \right)$$

$$P = QP + \frac{\rho Q V^2}{2} + \rho g Q Z$$

But introducing here (Power of jet)

pressure head = 0.

$Z = 0$

$\therefore P = \frac{\rho Q V^2}{2}.$

and, $Q = 0.013$, $\rho = 1000$, $V = 66\ m/s.$

iv) Overall Efficiency.;

$$\frac{\text{Fluid power}}{\text{Shaft power}} \times 100\%.$$

$$\frac{200.4}{1963.5} \times 100\% = 10.206 \simeq 10.21\%$$

2.) pump delivery = $35 dm^3/min$

$$\frac{35 \times 10^{-3}}{60} = 5.83 \times 10^{-4}$$

$P = 100 bar = 100 \times 10^5 Nm^{-2}$

Overall Efficiency = 87%.

Fluid power = $Q \cdot dP$.

$$= 5.83 \times 10^{-4} \times 100 \times 10^5$$

= 5830 watts

Recall,

$$\text{Overall Efficiency} = \frac{\text{Fluid power}}{\text{Shaft power}} \times 100\%.$$

$$\therefore \text{Shaft power} = \frac{\text{Fluid Power} \times 100.}{\text{Overall. Efficiency}}$$

$$= \frac{5830 \times 100}{87.}$$

= 6701.149 watts

3 Nominal displacement of $50 cm^3/rev$.

$$= 50 \times 10^{-5} m^3/rev.$$

Pressure = $100 bar = 100 \times 10^5 N/m^2$

Shaft power = 15 KW = 15000 watts.

Actual flowrate = $35 dm^3/min = \frac{35 \times 10^{-3}}{60} m^3$

$$= 5.83 \times 10^{-4} m^3/s.$$

Speed = $850 rev/min = \frac{850}{60}$

$$= 14.166 \simeq 14.17 rev/s$$

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$V_1 = 5ms^{-1}$; $V_2 = 2ms^{-1}$

$P_1 = 2.5m$, $P_2 = ?$

$P_{1} - P_{2} = \frac{0.35(V_1 - V_2)^2}{2g} = \frac{0.35 \times 3^2}{2 \times 9.81} = 0.161$

$\therefore P_1 - P_2 = 0.161$

$2.5 - P_2 = 0.161$

$P_2 = 2.5 - 0.161$

$P_{T_2} = 2.67m$

2) 200mm

$= 0.20m$, $A = \frac{\pi d^2}{4}$; $A = \frac{\pi (0.20)^2}{4} = 0.051KM$

$P_1 = 17.658\ N/cm^2 = \frac{17.658}{10^{-6}} = 17658000$

Specific gravity of mercury $= 13.6$

$h_w = \frac{P_1}{g} = \frac{17.658 \times 10^{-6}}{1000 \times 9.81} = 1.8 \times 10^{-9}$

Vacuum pressure $= \frac{P_2}{\omega}$

$= 300mmHg$

$d_2 = 100mm = 0.1$

$\therefore 0.30 \times 13.0$ $A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.10)^2}{4} = 7.85 \times 10^{-1}$

$P_{12} = -4.08$

$h = 1.8 \times 10^{-9} + 4.08 = 4.0800000m$