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

But, $Q = A_1 V_1$

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

$$V_1 = 0.5658 \simeq 0.57 \text{ m/s}$$

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

$$V_2 = 2.2598 \simeq 2.26 \text{ m/s}.$$

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

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

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

$$44.52 \times 9.81 = P_2.$$

$$P_2 = 436.74 \text{ KN}.$$

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

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

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

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

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

$$(1.932 + 0.914)\,2g = Q^2 \cdot (48516.36 - 3052.41)$$

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

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

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

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

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

$d_2 = 150mm = 0.15m$.

$A_1 = 0.07069 m^2$

$A_2 = 0.0177 m^2$

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

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

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

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

$d_2 = 0.2m$

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

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

$C_d = 0.96$

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

& $Z_2 - Z_1 = 0.06m$

$$0.803 V_2^2 = 587.423$$

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

$$V_2^2 = 731.535$$

$$V_2 = \sqrt{731.535}$$

$$V_2 = 27.0469$$

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

$$Q_{ideal} = A_2 V_2$$

$$\therefore 27.047 \times 0.0314$$

$$Q_{ideal} = 0.8492$$

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

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

$$= 0.96 \times 0.85$$

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

Throat diameter = 0.076m (d_2)

Vertical diameter = 0.152m (d_1)

Relative density = 0.8

Throat being = 0.914m

$C_d = 0.91$.

Bernoulli's equ.

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

eall that

$Q = V_1 A_1$, $Q = V_2 A_2$

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

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

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi \times 0.0152^2}{4}$$

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

$$\frac{}{A_1} \quad 0.07059$$

$$V_1 = 0.5658 \simeq 0.57 \text{ m/s}$$

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

$$V_2 = 2.2598 \simeq 2.26 \text{ m/s.}$$

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

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

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

$$44.52 \times 9.81 = P_2.$$

$$P_2 = 436.74 \text{ KN}.$$

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

$P = 28314$ 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

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

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

$= 92.51\%$

5 Sg of oil = 0.89

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

$Q = 220L/sec = 0.22m^3/sec$

$V = 7m/sec$.

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.

$= (576239.4 - 4.7971)$ Kilowatt

$= 571442.3$ watts

$= 571.4423$ Kilowatt

Head used to overcome losses

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

$= 297.51m$.

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

$= 14.166 \simeq 14.17 rev/s$

Nominal displacement = $\frac{100\,cm^3}{rev}$

Ideal Flowrate = Nominal displacement × speed

$= 1\times10^{-5}\,m^3/rev \times 25\,rev/sec$

$= 2.5\times10^{-4}\,m^3/sec.$

i) Volumetric efficiency = $\frac{\text{Real Flowrate}}{\text{Ideal Flowrate}} \times 100\%$

$= \frac{1.67\times10^{-4}}{2.5\times10^{-4}} \times 100\%$

$= 66.8\%$

ii) Fluid Power = $Q \cdot dp$

$= 1.67\times10^{-4} \times 12\times10^{5}$

$= 200.4$ watts.

iii) Shaft Power = $\tau \cdot \omega$

$\omega = 2\pi N = 2\times\pi\times N$

$= 2\times\pi\times25$

$= 157.0796$

$\simeq 157.08$

shaft power = 12.5×157.08

$= 1963.5$ watts

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

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

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

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

$= 82.29\%.$

ii Fluid power $= Q \cdot dp$

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

$= 5830$ watts.

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

$= 38.867\%$

4. $z = 2400\,cm = 24\,m$

Volumetric flowrate, $Q = 13$ litres/sec

$= 0.013\,m^3/sec$

Velocity $= 66\,m/sec$

The general formula,

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

$$P = QP + \rho \frac{QV^2}{2} + \rho g Q z$$

But introducing here (Power of jet)

pressure head $= 0.$

$z = 0$

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

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

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Mat NO : 19/ENG01/060

Depart : Eletrical

Date :

$d_2 = 0.2m$

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