AIKU JOSHUA ADEBIYI
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ELECT/ELECT
FLUID MECHANICS

1 Real Flowrate = $10 dm^3/min$ $T = 12.5 Nm$

$= \frac{10 \times 10^{-3}}{60} = 1.67 \times 10^{-4} m^3/s$

Pressure = 12bar = $12 \times 10^5 N/m$

Speed = 1500rev/min = $\frac{1500 rev}{60}$ = 25 rev/sec

~~Normal~~ Nominal displacement = $\frac{10 cm^3}{rev} = 1 \times 10^{-5} m^3/rev$

Ideal Flowrate = Nominal displacement × Speed

$= 1 \times 10^{-5} \frac{m^3}{rev} \times 25 \frac{rev}{sec}$

$= 2.5 \times 10^{-4} m^3/sec$

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

$= \frac{1.67 \times 10^{-4}}{2.5 \times 10^{-4}} \times 100\%$

$= 66.8\%$

ii) Fluid power = Q . dp

$= 1.67 \times 10^{-4} \times 12 \times 10^5$

= 200.4 watts

iii) Shaft power = $T . W$

$W = 2\pi N = 2 \times \pi \times N$

$= 2 \times \pi \times 25 = 157.08$

iv) Overall Efficiency

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

$$\frac{2004}{19635} \times 100\% = 10.206 \simeq 10.2\%$$

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 $= Q.dp$

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

$= 5830$ watts

Recall

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

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

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

$= 6701.149$ watts

3) Normal displacement of $50 cm^3/rev$
$= 50 \times 10^{-6} m^3/rev$

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

Shaft power $= 15 kw = 15000$ watts

Actual Flowrate $= 35 dm^3/min = \frac{35 \times 10^{-3} m^3}{60}$
$= 5.83 \times 10^{-4} m^3/s$

Speed $= 850 rev/min = \frac{850}{60}$
$= 14.166 \simeq 14.17 rev/s$

Ideal Flowrate = Nominal displacement x Speed
$= 50 \times 10^{-6} m^3/rev \times 14.17 rev/s$
$= 7.085 \times 10^{-4} m^3/s$

i Volumetric efficency $= \frac{\text{Real flowrate}}{\text{Ideal flow rate}} \times 100\%$

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

$= 82.29\%$

ii Fluid power $= Q.dp$
$= 5.83 \times 10^{-4} \times 100 \times 10^5$
$= 5830$ watts

Overall Efficiency $= \frac{5830 \times 100}{15000}$
$= 38.867\%$

= 38.867 %

4 $Z = 2400cm = 24m$

Volumetric flowrate, $Q = 13$ litres /sec

$= 0.013 m^3$ /sec

Velocity $= 66$ m/sec

The general formual

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

$$P = ~~1000\times~~ QP + \rho\frac{QV^2}{2} + \rho g Q Z$$

But Introducing here (Power of Jet)

Pressure head = 0

$Z = 0$

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

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

$P = 28314$ watts $= 28.314$ Kilowatt.

ii) power supplied from reservar.

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

$= 0.0607$ Kilowatts

(ii) Power loss in ~~tran form~~ Transmission

= Power of reservoir - power of Jet

= (30607.2 - 28314)

= 2293.2 Watts

= 2.2932 Kilowatts

Headloss 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 = 17.98m

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

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

= 92.51%

g of oil = 0.89

$Z = 30,000 cm = 300 m$

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

$V = 7 m/sec$

ntroducing, $Z = 0$, Pressure $= 0$

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

it, $Sg = 0.89$

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

$x = 0.89 \times 1000$

$x = 890$

$\rho = x = 890$

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

$P = 4797.1$ watts

Power Supplied from reservoir

$P = \rho g Q z$

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

$P = 576239.4$ watts

$\Omega = 576.2394$ Kilowatts

Efficiency $= \frac{\text{Power of Jet} \times 100\%}{\text{Power of Reservoir}} = 0.83\%$

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

$v = 0$

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

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

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

$u = \sqrt{392.4}$

$u = 19.809 = 19.81 m/s$

The velocity = 19.81

$Q = VA$

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

$= 0.15558 m^3/s$

$= 0.156 m^3/s$

7) $d_1 = 0.3m$

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

$= 0.07068m^2 = 0.0707m^2$

$d^2 = 0.2m$

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

$= 0.031415m^2 = 0.0314m^2$

$Cd = 0.096$

Specific weight of gas = $19.62 N/m^2$

$\int = \frac{mg}{V} = \rho g,$

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

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

Calculating $Q_1 = A_1 V_1$. $Q_2 = A_2 V_2$, $Q_1 = Q$.

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

$V_1 = \frac{Q_1}{0.0707}$ $V_2 = \frac{Q}{0.0314}$

For the Manometer

$P_1 - P_2 - 19.62(z_1 - z_1) + 587.423$ — i

For the Venturimeter

$$\frac{P_1}{\rho_2 g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho_2 g} + \frac{V_2^2}{2g} + z_1$$

$\therefore z_2 - z_1 = 0.06m$

Q ideal = $A_2 V_2$

$\therefore 27.047 \times 0.0314$

Q ideal $= 0.8492$

$= 0.85 m^3 s$

Q real = Cd × Q ideal

$= 0.96 \times 0.85$

$= 0.816 m^3/s$

(8) Throat diameter = 0.676m (d_2)

Vertical diameter = 0.152m

Relative density = 0.8

Throat being = 0.914 m

Cd = 0.91

Bernoulis Eqn

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

$= 0.0181 m^2$

ii) Then $P_1 - P_2 = 15170$

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

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

$Q = 0.0352 m^3/s$

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

$d_2 = 150mm = 0.15m$

$A_1 = 0.07069 m^2$

$A_2 = 0.0177 m^2$

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

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

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

10. Reading of Manometer = 170mm
= 0.17m

Specific gravity of mercury = 13.6
" " seawater = 1.026

$y = 0.17\,m$

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

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

$= 0.17 \times 12.55$

$= 2.0834\,m$

Recall $v = \sqrt{2gh}$

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

$v = \sqrt{40.87}$

$v = 6.393\,m/s$