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ENG 214

1) $Z_1 = 2m$ $L = 2m$ $V_1 = 5m/s$ $\frac{P_1}{w} = 2.5m$

$Z_2 = 0m$ $V_2 = 2m/s$

Head loss $= \frac{0.35(5.2)^2}{2 \times 9.81}$ $(h_1)$ head loss $= 0.1601m$

Applying Bernoullis Equation

$$\frac{P_1}{w} + \frac{V_1}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2}{2g} + Z_2 + h_1$$

$$2.5 + \frac{(5)^2}{2 \times 9.81} + 2 = \frac{P_2}{w} + \frac{(2)^2}{2 \times 9.81} + 0 + 0.1601$$

$$5.7742 = \frac{P_2}{w} + 0.3640$$

$$\frac{P_2}{w} = 5.7742 - 0.3640 = 5.4102m.$$

(2) $d_1 = 20cm = 0.2m$ $A_1 = \frac{\pi (d_1)^2}{4} = \frac{\pi \times (0.2)^2}{4} = 0.03142$

$Cd = 0.98$

$d_2 = 10cm = 0.1m$

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(4) depth - 15m

Manometer reading = 170mm = 0.17m

SGM - 13.6

SGS - 1.026

$h = y\left[\frac{S_{Hg}}{S_{water}} - 1\right]$

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

$h = 2.08335m$

Velocity $V = \sqrt{2 \times g \times h}$

$V = \sqrt{2 \times 9.81 \times 2.08335}$

$V = 6.3934 m/s$

(5) Actual Flow rate - $0.05 m^3/m = 8.33 \times 10^{-4} m^3/s$

Pressure - 15bar = $15 \times 10^5 N/m^2$

Speed = 1700 revolution = 28.33 revs/s

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

Torque Input - 15Nm

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Volumetric Efficiency = $\frac{\text{Actual flow rate}}{\text{Ideal " "}} \times 100\%$

Ideal flow rate = Nominal displacement x Speed

$= 1 \times 10^{-5} \times 28.33$

$= 2.833 \times 10^{-4} m/s$

Volumetric Efficiency - $\frac{8.33 \times 10^{-4}}{2.833 \times 10^{-4}} \times 100\%$

$= 2.94 \times 100\%$

$= 294\%$

Fluid Power = Actual rate x Pressure

$= 8.33 \times 10^{-4} \times 15 \times 10^{5}$

Fluid Power - 1249.5 watts

Shaft Power = Torque x angular Speed

Angular Speed - $2 \times \pi \times$ speed

$= 2 \times \pi \times 28.33$

angular speed = 178.0026 rad/s

Shaft Power = $15 \times 178.0026 = 2670.039$ watts

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

$= \frac{1249.5}{2670.039} \times 100\%$

$= 46.8\%$

$$A_2 = \frac{\pi (d_2)^2}{4} = \frac{\pi \times (0.1)^2}{4} = 0.007855\ m^2$$

$$P_1 = 17.658\ N/cm^2 = 17.6580\ N/m^2$$

$$\frac{P_1}{w} = \frac{P}{\rho g} = \frac{176580}{1000 \times 9.81} = 18\ m$$

Vaccum Pressure = 30cm of Mercury

= −0.3m Mercury

$$P_2 = -0.3 \times 13.6$$

$$\frac{P_2}{w} = -4.08$$

$$h = \frac{P_1 - P_2}{w}$$

$$h = 18 - (-4.08) = 22.08\ m$$

$$Q_{actual} = \frac{C_d A_1 A_2 \times \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$= \frac{0.98 \times 0.03142 \times 0.007855 \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.03142^2 - 0.007855^2}}$$

$$= \frac{5.03477 \times 10^{-3}}{0.03042} = 0.1655\ m^3/s$$

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(3) $d_o = 15\ cm = 0.15\ m$

$$A_o = \frac{\pi (d_o)^2}{4} = \frac{\pi \times (0.15)^2}{4} = 0.0177\ m^2$$

$$d_1 = 30\ cm = 0.3\ m$$

$$A_1 = \frac{\pi (d_1)^2}{4} = \frac{\pi \times (0.3)^2}{4} = 0.0707\ m^2$$

$C_d = 0.69$

differential reading (y) = 50cm = 0.5m

($S_{Hg}$) Specific Gravity of Mercury = 13.6

Specific gravity of Oil = 0.9

$$\text{Differential head } (h) = y\left[\frac{S_{Hg}}{S_{oil}} - 1\right]$$

$$= 0.5\left[\frac{13.6}{0.9} - 1\right]$$

$$= 0.5(14.11)$$

$$= 7.055\ m$$

$$Q = \frac{C_d \cdot A_o A_1 \times \sqrt{2gh}}{\sqrt{A_1^2 - A_o^2}}$$

$$Q = \frac{0.6 \times 0.0177 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.055}}{\sqrt{0.0707^2 - 0.0177^2}}$$

$$Q = 0.1378\ m^3/s$$