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18/EN/904/047
Elect/Elect

① $L = 2m$
Velocity flow at smaller end $= V_1 = 5m/s$
Velocity flow at lower end $= V_2 = 2m/s$
Pressure head at smaller end $= P_s = 2.5m$ of liquid
Loss of Head $= \frac{0.35(V_1 - V_2)^2}{2g}$

$$= \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161m$$

Pressure head at lower end $= P_L$

Berwlli's eqn

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

$$P_S = \frac{P_1}{\rho g} \qquad P_L = \frac{P_2}{\rho g}$$

$$Z_1 = 2 \; ; \; Z_2 = 0$$

$$2.5 + \frac{5^2}{2 \times 9.81} + 2 = P_L + \frac{2^2}{2 \times 9.81} + 0 + 0.161$$

$$P_L = 5.409m \text{ of fluid}$$

② Inlet Diameter = $D_1 = 20cm$

Throat Diameter = $D_2 = 10cm$

Inlet Area = $A_1 = \frac{\pi D_1^2}{4} = 314.16 m^2$

Throat Area = $A_2 = \frac{\pi D_2^2}{4} = 78.54 cm^2$

Density of water $\rho = 1000 kg/m^3$

Pressure at inlet = $17.658 N/cm^2 = 17.656 \times 10^4 N/m^2$

Pressure at inlet = $\frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{1000 \times 9.81} = 18m$

$\frac{P_2}{\rho g} = -30 cm$ of Hg   S.G = 13.6

$\frac{P_2}{\rho g} = -30 \times 10^{-2} m$ of Hg $\times 13.6$

$= -4.08m$

Differential Head = $\frac{P_1 - P_2}{\rho g}$

$= 18 - (-4.08)$

$= 22.08m = 2208cm$

Using $Q = \frac{C_d \sqrt{2gh} \cdot A_1 A_2}{\sqrt{A_1^2 - A_2^2}}$

$$= \frac{0.98 \times \sqrt{2 \times 981 \times 2208} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$$

$= 165455.3 cm^3/s$

$= 165.455 l/s$

③ Diameter of Pipe = 30cm

$$A_1 = \frac{\pi d_1^2}{4} = 706.86\text{cm}^2$$

Diameter of Orifice = 15cm

$$A_2 = \frac{\pi d_2^2}{4} = 176.72\text{cm}^2$$

Specific Gravity of Oil = 0.9

Specific Gravity of Hg = 13.6

Differential ~~mano~~ Manometer reading X = 50cm of Mercury

C_d = 0.64

Differential Head, ~~$h = x(\rho$~~

$$h = x\left(\frac{\rho_{Hg}}{\rho_o} - 1\right)$$

$$= 50\left(\frac{13.6}{0.9} - 1\right)$$

h = 705.56cm of oil

$$Q = \frac{C_d\sqrt{2gh} \cdot A_1 A_2}{\sqrt{A_1^2 - A_2^2}}$$

$$= \frac{0.64 \times \sqrt{2 \times 9.81 \times 705.56} \times 706.86 \times 176.72}{\sqrt{(706.86)^2 - (176.72)^2}}$$

Q = 137443.29 Cm³/s

$$Q = \frac{137443.29}{1000} = 137.44 \text{ l/s}$$

④ Distance of Mercury head $x = 170mm = 0.17m$

S.G of Mercury $= 13.6$

S.G of Seawater $= 1.026$

$V = \sqrt{2gh}$ $\quad h = x\left(\frac{\rho_g}{\rho} - 1\right)$

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

$$= 2.0834m$$

$V = \sqrt{2 \times 9.81 \times 2.0834} = 6.395 m/s$

$= \frac{6.395 \times 3600}{1000} = 23.01 km/h$

⑤ $Q = 0.05 m^3/min = 50 dm^3/min$

$P = 15 bar = 15 \times 10^6 N/m^2$

Speed $= 1700$ rev/min

$T = 15 Nm$ $\quad ND = 10 cm^3/rev$

Volumetric efficiency $= \frac{\text{Actual flow rate}}{\text{ideal flow rate}}$

ideal flow rate $=$ Nominal flow rate $\times$ Speed

$= 10 cm^3/rev \times 1700 rev/min$

$= 17000 cm^3/min$

ideal flow rate $=$ ~~17000~~ $\frac{17000}{1000000} =$ $0.017 m^3/min$

Actual flow rate $= 0.05 m^3/min$

Volumetric efficiency $= \frac{0.05}{0.017} =$ 2.94%

Fluid power $= P \times Q$

$= 15 \times 10^5 \, N/m^2 \times \frac{0.05}{60} \, m/s$

$= 1249.5W$

Shaft power $= \frac{2\pi N T}{60} = \frac{2\pi \times 1700 \times 15}{60}$

$= 2670.35W$

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

$= \frac{1249.5}{2670.35} = 0.468 = 46.8\%$