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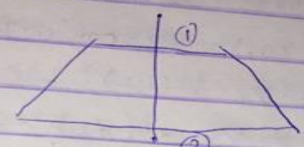
18/ENG06/024
Mechanical Engineering



let the smaller end be represented by ①
The larger end be represented by ②

Solution

$l = 2.0m \quad P_1/\rho g = 2.5m$

$V_1 = 5m/s \quad V_2 = 2m/s$

Loss of head $= hl = \frac{0.35(V_1 - V_2)^2}{2g} = \frac{0.35(5-2)^2}{2g} = \frac{0.35(\times 3)^2}{2 \times 9.81}$

$= \frac{0.35(a)}{2 \times 9.81}$

pressure head $= P_2/\rho g = ?cm$

Applying Bernoulli's eq at ① & ②

$P_1/\rho g + V_1^2/2g + Z_1 = P/\rho g + V_2^2/2g + Z_2 + Lh$

$Z_2 = 0, Z_1 = 2.0$

$\therefore 2.5 + (5)^2 + 2.0 = P_2/\rho g + \frac{(3)^2}{2 \times 7.81} + 0.016$

$2.5 + 1.27 + 2.0 = P^2/\rho g + 0.203 + 0.16$

$P^2/\rho g = (2.5 + 1.27 + 2.0)$

$= 5.77 - 0.363 = 5.407$

$= 5.4m$ of fluid.

2 Inlet Diameter (D_1) = 20 cm = 0.2 m

throat Diameter (D_2) = 10 cm = 0.1 m 3

Area of Inlet = $\pi/4 \times (0.2)^2 = 0.03146 m^2$

Area of throat = $\pi/4 \times (d_2)^2 = \pi/4 (0.1)^2$ = 0

= $0.07854 m^2$

$C_d = 0.98$, pressure $(P_1) = 17.685 \times 10^4 N m^2$, $\rho_2 = 1000 kg$

$$P_1 / \rho_w \cdot g = \frac{17.653 \times 10^4}{9.81 \times 1000} = 18 m$$

$P_2/\rho_w \cdot g$ = 30 cm of mercury = $-0.3 \times 13.4 = -4$

differential head.

$$h = P_1/\rho_w \cdot P_2/\rho_w = 18 - (-4)$$

$$= 22.08 m \text{ water}$$

$$Q_1 = \frac{C_d \times a_1 a_2 \sqrt{2gh}}{\sqrt{(a_1)^2 - (a_2)^2}}$$

$$= \frac{0.98 \times 314.16 \times 0.007854}{\sqrt{(314.16)^2 - (0.001854)^2}} \times \sqrt{2} \times 9.81 \times 22.08$$

$$= \frac{5032\,8837.21 \times 165555}{304} = 0.165 m$$

= 165.56 lit/s

3 Orifice Diameter = 15cm

Pipe Diameter = 30 cm.

Coefficient of discharge of the metro is 0.64

flow of oil of specific gravity = 0.9

Soln

$A_o = \pi/4 \, (15)^3 = 176.714 \, cm^2$ (A_o, Area of the orifice)

$A_p = P_A \, (30^2) = 706.838 \, cm^2$ (Area of the pipe)

$$H = \left[\frac{13.6}{0.9} - 1 \right] + 50cm \text{ of oil}$$

$$= [15.1 - 1] \times 50 \, cm = 14.1 \times 50$$

$$= 705.56$$

$$Q_1 = \frac{Cd \, A_o A_p \sqrt{2gh}}{\sqrt{(A_p^2) - (A_o)^2}}$$

$$Q = \frac{0.64 \times 176.71 \times 706.86 \times \sqrt{2 \times 9.81 \times 7.05 \times 100}}{\sqrt{(706.85)^2 - (176.74)^2}}$$

$Q = 137414.25 \, cm^3/sec$

Litres = 137.41425 lit/sec

Rate of flow of oil = 137.414 Lit/sec

Diff of Mercury level $x = 170mm = 0.17m$

Sp gr of mercury = 13.6

Specific gravity (sp) = 1.026

Soln

$$H = x\left[\frac{sg}{sp} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$$

$$= 2.0834m$$

$$V = \sqrt{2gh}$$

$$= 2 \times 9.81 \times 2.08$$

$$= 6.39 m/s$$

$$= \frac{6.39 \times 60 \times 60}{1000}$$

$$= 23004/1000 = 23.004$$

Speed of Submarine = 23.004 km/hr

= 23.004 km/hr

5 Rate of Pump - $0.05 m^3/min = 500 m^3/mm$

Pressure charge - 15bar

Speed rotation - 1700

normal displacement - $15 cm^3/rev$

tongue input = 15N/m

Soln

Ideal flow rate = Normal displacement * speed

$= 15 \times 1700 = 25,500 cm^3/min$

$= 25.500 dm^3/min$

Volumetric efficiency

$= \frac{\text{Actual flow}}{\text{Ideal flow}} = \frac{500}{25.5} = 19.60$

$Q = \frac{(500 \times 10^{-3})}{60 m^3/s} = 83.3 \times 10^{-4} m^3/s$

Fluid Power

$\Delta P = 100 \times 10^5 N/m^2$

Fluid Power = $Q\Delta P = 83.3 \times 10^{-4} \times 100 \times 10^5$

Fluid Power = 83300W

Shaft Power =

$= 2\pi N / 60 = \frac{2\pi \times 1700 \times 25.5}{60} = 4541.4 N/m$

Overall Efficiency

$= \frac{\text{Fluid Power}}{\text{Shaft Power}} = \frac{83300}{4541.4} = 18.342$

O.E = 18.342 or 1834.2 %