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18/Eng02/004
Computer Engineering

1. $L = 2.0m$

$V_1 = 5m/s$ $\qquad$ $P_2/\rho g = ?$

$P_1/\rho g = 2.5m$ of liquid

$V_2 = 2m/s$

Loss of head $(h_L) = \frac{0.35(v_1 - v_2)^2}{2g}$

$$= \frac{0.35(5-2)^2}{2 \times 9.81} = 0.16m$$

Using bernoullis equ.

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_L$$

$$\therefore 2.5 \times \frac{5^2}{2 \times 9.81} + 2.0 = \frac{P_2}{\rho g} + \frac{2^2}{2 \times 9.81} + 0 + 0.16$$

$$2.5 \times 1.27 + 2.0 = \frac{P_2}{\rho g} + 0.204 + 0.16$$

$$5.77 = \frac{P_2}{\rho g} + 0.364$$

$$\therefore \frac{P_2}{\rho g} = 5.77 - 0.364 = 5.406m \text{ of liquid}$$

2.) $d_{inlet} = \frac{20cm}{100} = 0.2m$

$a_{inlet} = \frac{\pi}{4} \times (0.2)^2 = 0.0314 m^2$

$d_{throat} = \frac{10cm}{100} = 0.1m$

$a_{throat} = \frac{\pi}{4} \times (0.1)^2 = 7.85 \times 10^{-3} m^2$

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ρ for water = 1000 kg m^3

$P_1 = 17.658\ N/cm^2 = 17.658 \times 10^4\ N/m^2$

$\therefore \frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{1000 \times 9.81} = 18$ m of water

$\frac{P_2}{\rho g} = -30$ cm of meruy

$= -0.3$ m of meruy

$= -0.3 \times 13.6 = -4.08$ m of water

$\therefore$ Differential head $(h) = \frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 18 + 4.08$

$= 22.08$ m of water

Using discharge aquation

$Q = Cd \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$

$= 0.98 \times \frac{0.0314 \times 7.85 \times 10^{-3}}{\sqrt{0.0314^2 - (7.85 \times 10^{-3})^2}} \times \sqrt{2 \times 9.81 \times 22.8}$

$= 0.98 \times 8.107 \times 10^{-3} \times 20.81$

$= 0.1653\ m^3/s = 165.3$ lit/s

3.) $A_{orifice} = \frac{\pi}{4} \times (15)^2 = 176.714\ cm^2$ (Area of orifice)

$A_{pipe} = \frac{\pi}{4} \times (30)^2 = 706.858\ cm^2$ (Area of pipe)

$h = \left[\frac{13.6}{0.9} - 1\right] \times 50$ cm of oil

$= 705.556$ cm of oil

$Q = Cd \times \frac{A_o A_p}{\sqrt{A_p^2 - A_o^2}} \times \sqrt{2gh}$

$= 0.64 \times \frac{176.714 \times 706.858}{\sqrt{706.858^2 - 176.714^2}} \times \sqrt{2 \times 9.81 \times 705.556}$

$= 0.64 \times 182.5094 \times 117.656$

$= 13742.96\ cm^3/sec$

$= 44.296$ lits/sec

4.

5.

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4. $h = x\left[\frac{S_g}{S_{sm}} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.0834m$

Using $V = \sqrt{2gh}$

$V = \sqrt{2 \times 9.81 \times 2.0834} = 6.393 m/s$

converting to km/hr

$\frac{6.393 \times 60 \times 60}{1000} = 23 km/hr$

5. Volumetric flow rate

$10 dm = 1m$

$\therefore 10^3 dm^3 = 1m^3$

$1000 dm^3 = 1m^3$

$5 dm^3 = ?$

$? = \frac{5}{1000} = 0.005$

Volumetric flow rate $= 0.005 m^3/min$

Actual flow rate $= \frac{0.005}{60} = 8.33 \times 10^{-5} m^3/sec$

Speed $= 1700 rpm$

$\frac{1700}{60} = 28.33 rev/sec$

$dP = 15 bar \equiv 15 \times 10^5 N/m^2$

Norminal displacement $= 10 cm^3/rev$

Note that $100^3 cm^3 = 1m^3$

$10 cm^3 = x$

$x = \frac{10}{100^3} = 1 \times 10^{-5} m^3/rev$

$\therefore$ ideal flowrate = Norminal D x speed

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

$= 28.33 \times 10^{-4}$

a.) Volume efficiency = $\frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100\%$

$= \frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100$

$= 29.4\%$

b.) Fluid Power = $Q \cdot dP$

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

$= 124.95$ Nm/sec

c.) shaft Power = $T \cdot N$

$T = 15$ Nm

$W_0 = \frac{2 \times 22}{7} \times 28.33 = 178.07$ rad/sec

∴ shaft power = $15 \times 178.07 = 2671.05$ watts

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

$= \frac{124.95}{2671.05} \times 100 = 4.67\%$