BRAIDE SOGBETE STEVEN

18/ENG06/016

MECHANICAL ENGINEERING

Braide Sogbere Steven
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Mechanical

1) $L = 20m$
$V_1 = 5m/s$ $\qquad P_2/\rho g = ?$
$P_1/\rho g = 2.5m$ 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 bernoulli's equ

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

$$\therefore 2.5 \times \frac{5^2}{2 \times 9.81} + 20 = \frac{P_2}{\rho g} + \frac{2^2}{2 \times 9.81} + 0 + 0.16$$

$$2.5 \times 1.27 + 20 = \frac{P_2}{\rho g} + 0.204 + 0.16$$

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

$$\therefore \frac{P_2}{\rho g} = 5.77 - 0.304 = 5.406m \text{ of Liquid}$$

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

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

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

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

water $= 1000 Kgm^3$

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

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

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

$= -0.3m$ of mecury

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

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

$= 22.08m$ of water

Using discharge equation

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

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

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

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

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)

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

$= 705.556cm$ of oil

$$Q = \frac{Cd \times A_O A_P}{\sqrt{A_P^2 - A_O^2}} \times \sqrt{2gh}$$

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

$$= 0.64 \times 182.5094 \times 117.656$$

$$= 13742.96 cm^3/sec$$

$$= 74296 \, lt^3/sec$$

4) $h = x\left[\frac{S_g}{S_m} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.0834\,m$

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

$10\,dm = 1\,m$

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

$1000\,dm^3 = 1\,m^3$

$5\,dm^3 = ?$

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

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

$\delta P = 15 = 15 \times 10^3\,N/m^2$

Normal displacement $= 10\,cm^3/rev$

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

$10\,cm^3 = x$

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

Ideal flowrate = Normal ~~10~~ 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 $= Q\,dp$

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

$= 124.95$ Nm/sec

c) Shaft Power $= T \cdot N$

$T = 15$ Nm

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

$\therefore$ Shaft power $= 15 \times 178.07 = 2071.05$ watt

d) ~~Qe~~ Overall Efficiency = $\frac{\text{Fluid power}}{\text{shaft power}} \times 100\%$

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