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18/ENG07/051
ELECT/ELECT ENG.
ENG 214 ASSIGNMENT.

1. Let Smaller end be (1) and lower end (2).

$L = 2.0m$

$v_1 = 5m/s$

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

$v_2 = 2m/s$

$P_2/\rho g = ?$

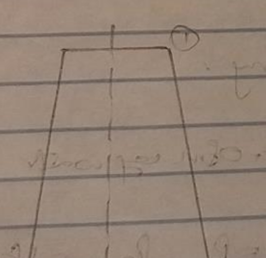
loss of head $(h_L) = \frac{0.35(v_1 - v_2)^2}{2g}$

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

$= 0.16m$

Using bernoulli's equation.

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + h_L$$




letting the line pass through the section, then $z_1 = 2.0$, $z_2 = 0$

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

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

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

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

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

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

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

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

$\rho$ for water $= 1000 kg/m^3$

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

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

$= 18m$ of water

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

$= -0.3m$ of mercury

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

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

$= 22.08 m$ of water.

Using discharge equation.

$\frac{0.98 \times 0.0314 \times 7.85 \times 10^{-3}}{\sqrt{0.0314^2 - (7.85 \times 10^{-3})^2}} \times \sqrt{2 \times 9.81 \times 22.08}$

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

$= 0.1653 m^3/s = 165.3 litres/s.$

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

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

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

$= 705.556$ cm of oil.

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

$$= \frac{0.64 \times 176.714 \times 706.858}{\sqrt{706.858^2 - 176.714^2}} \times \sqrt{2 \times 981 \times 705.556}$$

$= 0.64 \times 182.5094 \times 117.656$

$= 13742.76\,cm^3/sec$

$= 13.74276$ lts/sec

Difference of mercury level $x = 170$ mm $= 0.17$ m

Sp. gr of mercury $S_g = 13.6$

Sp. gr of sea water $S_{sw} = 1.026$

$$\therefore h = x\left[\frac{S_g}{S_{sw}} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right] = 2.0834\text{m}$$

Using $V = \sqrt{2gh}$

$$V = \sqrt{2 \times 9.81 \times 2.0834}$$

$$= 6.393\text{m/s}$$

Convert to km/hr

$$\frac{6.393 \times 60 \times 60}{1000}$$

$$= 23\text{km/hr}.$$

5. Volumetric flow rate:

Changing from $dm^3/min$ to $m^3/min$.

$10 dm = 1m$

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

$1000 dm^3 = 1m^3$

$5 dm^3 = ?$

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

$\therefore$ 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

Changing to rps.

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

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

Nominal displacement $= 10cm^3/rev$

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

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

$= 2.833 \times 10^{-4}$

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$f)$ Volume Efficiency = $\frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100\%$

$= \frac{8.83 \times 10^{-5}}{2.883 \times 10^{-4}} \times 100$

$= 29.4\%$.

$g)$ Fluid power = $Q.\Delta P$

$= 8.83 \times 10^{-5} \times 15 \times 10^{5}$

$= 124.95$ Nm/sec

$h)$ Shaft power = $T.\omega$

$T = 15$ Nm

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

Shaft power $= 15 \times 178.07 = 2671.05$ watts.

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

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

$= 4.67\%$.