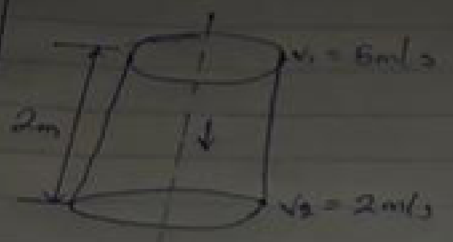
Archibong David David
18/ENG04/017
Electrical Electronics Engineering
ENG 214

1.



$P_1 = \frac{P_1}{w} = 2.5m$

$H_2 = \frac{0.55(v_1 - v_2)^2}{2g}$

$$\frac{P_1}{w} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{v_2^2}{2g} + z_2 + H_2$$

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{v_1^2 - v_2^2}{2g} + (z_1 - z_2) - \frac{0.55(v_1 - v_2)^2}{2g}$$

$$\frac{P_2}{w} = 2.5 + \frac{5^2 - 2^2}{2(9.81)} + 2 - \frac{0.55(5-2)^2}{2(9.81)}$$

$$\frac{P_2}{w} = 2.5 + 1.07 + 2 - 0.161$$

$$\frac{P_2}{w} = 5.409m \text{ of liquid}$$

2. $d_1 = 20cm = 0.2m$, $d_2 = 10cm = 0.1m$

$P_1 = 17.658N/cm^2 = 176580 N/m^2$, $P_2 = -0.30cmHg = -0.3mHg$

$$A_1 = \frac{\pi(0.2)^2}{4} = 0.031m^2$$

$$A_2 = \frac{\pi(0.1)^2}{4} = 7.85 \times 10^{-3} m^2$$

$$h = \frac{P_1}{w} - \frac{P_2}{w} = \frac{176580}{(1000 \times 9.81)} - (-0.3 \times 13.6)$$

$h = 18 + 4.08 = 22.08m$

$C_d = 0.98$

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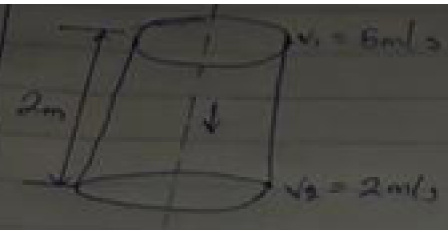

$P_1 = \frac{P_1}{w} = 2.5m$

$H_L = \frac{0.35(V_1 - V_2)^2}{2g}$

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

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{v_1^2 - v_2^2}{2g} + (z_1 - z_2) - \frac{0.35(V_1 - V_2)^2}{2g}$$

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$h = 18 + 4.08 = 22.08m$

$Cd = 0.98$

$$Q = \frac{Cd \cdot A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.98 \times 0.031 \times 7.85 \times 10^{-3} \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{0.031^2 - (7.85 \times 10^{-3})^2}}$$

$Q = 8.03\times10^{-3}\times 20.81$

$Q = 0.167\,m^3/sec$

3. $A_0 = \frac{\pi(0.15)^2}{4} = 0.0177\,m^2$, $A_1 = \frac{\pi(0.30)^2}{4} = 0.0707\,m^2$

$y = 50cmHg = 0.5mHg$, $S_o = 0.7$, $C_d = 0.64$

$h = y\left[\frac{S.g_{Hg}}{S.g_{oil}} - 1\right] = 0.5\left[\frac{13.6}{0.7} - 1\right]$

$h = 7.05m$

$Q = \frac{C_d A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.64\times0.0177\times0.0707\times\sqrt{2\times9.81\times7.05}}{\sqrt{0.0707^2 - 0.0177^2}}$

$= \frac{9.4195\times10^{-3}}{0.0685} = 0.1376\,m^3/sec$

4. $y = 170mmHg = 0.17mHg$, $S.g_{Hg} = 13.6$ $S.g_{oil} = 1.026$

$\Delta h = y\left[\frac{S.g_{Hg}}{S.g_{oil}} - 1\right] = 0.17\left[\frac{13.6}{1.026} - 1\right]$

$\Delta h = 2.08m$

$v = \sqrt{2g\Delta h} = \sqrt{2\times9.81\times2.08}$

$v = 6.388m/s$

5. $Q = 0.05dm/min = 8.33\times10^{-5}m/sec$

Speed of rotation = 1700 Rev/min = 28.3rev/sec

Nominal displacement = $10cm^3/rev = 10^{-5}m^3/rev$

Torque input = 15Nm

Pressure change = 15bar = $15\times10^5 N/m^2$

Ideal flow rate = Nominal displacement × Speed of rotation

$= 10^{-5}\times28.3 = 2.83\times10^{-4}m^3/sec$

a. Volumetric Efficiency = $\frac{\text{Actual flowrate}}{\text{~~Total~~ flowrate}}\times100$

$= \frac{8.33\times10^{-5}}{2.83\times10^{-4}}\times100 = 29.45\%$

b Fluid Power, $P_F = Q \times \Delta P$

$= 8.33 \times 10^{-5} \times 15 \times 10^{5} = 124.95$ watts

c Shaft power = $T \times \omega$

$\omega = 2 \times \pi \times$ speed of rotation $= 2 \times \pi \times 28.3$

$= 177.81$ rad/sec

$\therefore$ Shaft power $= 15 \times 177.81 = 2667.2$ watts

d) Overall Efficiency $= \dfrac{\text{Fluid power}}{\text{Shaft power}} \times 100$

$= \dfrac{124.95}{2667.2} \times 100$

$= 4.68\%$