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18/ENG06/036
Mechanical engineering
ENG 214 assignment

1. $\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + H_2$

$\frac{P_2}{w} = \frac{P_1}{w} + \frac{V_1^2 - V_2^2}{2g} + (Z_1 - Z_2) - 0.35\frac{(V_1 - V_2)^2}{2g}$

$\frac{P_2}{w} = 2.5 + \frac{5^2 - 2}{2(9.81)} + 2 - \frac{0.35(5-2)^2}{2(9.81)}$

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

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

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

$P_1 = 17.658\,Nm^{-2} = 176580\,Nm^{-2}$, $P_2 = 0.30cmHg$

$= 0.3mHg$

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

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

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

$h = 18 + 4.08 = 22.08m$

$Cd = 0.98$

$Q = \frac{Cd \cdot A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = 0.98 \times 0.031 \times 7.$

$= \frac{0.98 \times 0.031 \times 7.85 \times 10^{-3} \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(0.031^2 - (7.85 \times 10^{-3})^2)}}$

Continuation of 2.

$Q = 8.85 \times 10^{-5} \times 20.81$

$Q = 0.67 m^3/s$

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

$y = 50 cmHg = 0.3 mHg$, $S_g = 0.9$, $Cd = 0.64$

$h = 7.05 m$

$$Q = \frac{Cd A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.64 \times 0.0177 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.05}}{\sqrt{0.0177^2 - 0.0707^2}}$$

$$= \frac{9.4193 \times 10^{-3}}{0.0685} = 0.1376 m^3/s$$

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

$$\Delta h = y\left[\frac{S.g_{Hg}}{S.g_{oil}} - 1\right] = 0.17\left[\frac{13.6}{9.026} - 1\right]$$

$\Delta h = 2.08 m$

$v = \sqrt{2g\Delta h} = \sqrt{2 \times 9.81 \times 2.08}$

$V = 6.388 ms^{-1}$

5. $Q = 0.05 dm^3/min = 8.33 \times 10^{-7} m^3/sec$

speed of rotation $= 1700 rev/min = 28.3 rev/sec$

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

Torque input $= 15 NM$

Pressure change $= 15 bar = 15 \times 10^5 NM^2$

Ideal flow rate = nominal displacement × Speed of rotation

$= 10^{-5} \times 28.3 = 2.83 \times 10^{-4} m^3/sec$

Volumetric efficiency $= \frac{\text{Actual flow rate}}{\text{Total flow rate}} \times 100$

$= \frac{33 \times 10^{-5}}{83 \times 10^{-4}} \times 100 = 29.45\%$

Continuation of 5.

b. fluid power, $P = Q \times \Delta r$

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

c. Shaft power $= T \times W$

$W = 2 \times \pi \times$ 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 $= \frac{\text{fluid power}}{\text{Shaft power}} \times 100$

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

$= 4.68\%$