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18/ENG07/004
PETROLEUM ENGINEERING
FLUID MECHANICS

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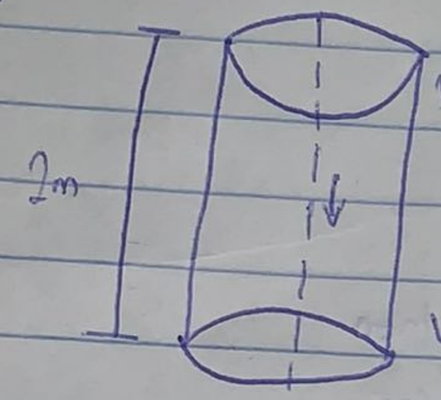

$$P = \frac{P_1}{w} = 2 - 5$$

$$h_2 = \frac{0.35(V_1 - V_2)^2}{2g}$$

$$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2}{2g} + Z_2 + h_2$$

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

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

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

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

3) $A_0 = \frac{\pi(0.15)^2}{4} = 0.0177 \times 10^2$, $A_1 = \frac{\pi(0.30)^2}{4} = 0.0707 m^2$

$y = 50cm\,Hg = 0.5m\,Hg$,

$h = y\left[\frac{S.g\,Hg}{S.g\,oil}\right] = 0.5\left[\frac{10.6}{0.9} - 1\right]$

$h = 7.05m$

$$Q = \frac{cd A_0 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.64 \times 0.0177 \times 0.0707 \times \sqrt{2 \times 9.81 \times 7.05}}{\sqrt{0.0707^2 - 0.0177^2}}$$

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

4) $y = 170mm\,Hg = 0.17m\,Hg$, $S.g\,Hg = 13.6$ $S.g\,oil = 1026$

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

$\Delta h = 2.08m.$

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

$V = 6.388 m/s$

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

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

ideal flow rate = Nominal displacement x Speed of rotation

$= 10^{-8} \times 28.3 = 2.83 \times 10^{-4} m^3/sec$

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

$$= \frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100 = 29.45\%$$

b) Fluid power, $P_i = Q \times \Delta p$

$= 8.33 \times 10^{-5} \times 15 \times 10^5 = 124.95$ 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 $= \frac{\text{Fluid power}}{\text{shaft power}} \times 100$

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

$= 4.68\%$