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Mechatronics
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1 $L = 2.0m$ $(L = \Delta z)$

$V_1 = 5m/s$ $V_2 = 2m/s$ $\frac{P_1}{\omega} = 2.5m$ $hl = \frac{0.35(v_1 - v_2)^2}{2g}$

Substituting values for hl

$hl = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.16$

Applying Bernoulli's theorem

$\left(\frac{P_1}{\omega} - \frac{P_2}{\omega}\right) + \left(\frac{V_1^2}{2g} - \frac{V_2^2}{2g}\right) + (Z_1 - Z_2) = hl$

$\left(2.5 - \frac{P_2}{\omega}\right) + \left(\frac{5^2}{2 \times 9.81} - \frac{2^2}{2 \times 9.81}\right) + (2) = 0.16$

$2.5 - \frac{P_2}{\omega} + (1.274 - 0.204) + 2 = 0.16$

$2.5 - \frac{P_2}{\omega} = 0.16 - 2 - 1.07$

$\frac{P_2}{\omega} = -2.91 + 2.5$

$\frac{P_2}{\omega} = 5.41m$

2 $d_1 = 20cm$ $d_2 = 10cm$ $P_1 = 17.658 N/cm^2$ $P_2 = -30cmHg$ $Cd = 0.98$ $A = \frac{\pi d^2}{4}$

$A_1 = \frac{\pi \times 0.2^2}{4} = 0.0314$ $A_2 = \frac{\pi \times 0.1^2}{4} = 0.00785$ $\frac{P_1}{\omega} = \frac{~~1765~~ 176.58}{9.81} = 18$ $P_2 = -0.3mHg \times 13.6 = -4.08$ $h = \frac{P_1}{\omega} - \frac{P_2}{\omega} = 18 - -4.08 = 22.08$

$Q = cd \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$

$= 0.98 \times \frac{0.0314 \times 0.00785}{\sqrt{0.0314^2 - 0.00785^2}} \times \sqrt{2 \times 9.81 \times 22.08}$

$Q = 0.1654 m^3/s = 165.4 lit/s$

(3) $d_o = 15cm$ $d_1 = 30cm$ $y = 50cm\,Hg$ $s.g = 0.9$ $C.d = 0.64$ $mercs.g = 13.6$

$A = \frac{\pi d^2}{4}$ $A_o = \frac{\pi \times 0.15^2}{4}$ $A_1 = \frac{\pi \times 0.3^2}{4}$ $h = y\left(\frac{S_{hg}}{S_l} - 1\right)$

$= 0.018$ $= 0.071$ $h = 50\left(\frac{13.6}{0.9} - 1\right)$

$= 705.6$

$$Q = \frac{cd \times A_o \times A_1}{\sqrt{A_1^2 - A_o^2}} = \frac{0.64 \times 0.018 \times 0.071 \times \sqrt{2 \times 9.81 \times 705.6}}{\sqrt{0.071^2 - 0.018^2}}$$

$= \underline{136.8\,Lt/s}$

(4) speed/velocity $= \sqrt{2gh}$

$h = y\left(\frac{sg}{sl} - 1\right) = 0.17\left(\frac{13.6}{1.026} - 1\right)$ $h = 2.0834$

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

$= \underline{6.39\,m/s}$

(5) i VE $= \frac{\text{Actual flowrate}}{\text{Ideal flowrate}} \times 100$

Ideal Flow Rate = nominal spd × displacement

$= 10\,\frac{cm^3}{rev} \times 1700\,\frac{rev}{min} = 17000\,cm^3/min = 2.83 \times 10^{-4}\,m^3/s$

actual flowrate $= 0.05\,m^3/min = 8.33 \times 10^{-4}\,m^3/s$

$VE = \frac{8.33 \times 10^{-4}}{2.83 \times 10^{-4}} \times 100$

$= 2.93 \times 100$

$= \underline{293\%}$

ii Fluid Power $= Q \cdot P$

$= 8.3 \times 10^{-4} \times (15 \times 10^5) = \underline{1249.5\,watts}$

iii Shaft power $= T \cdot \omega$

$= 15 \times (2\pi N)$

$= 15 \times 2 \times \pi \times \frac{1700}{60} = \underline{2667\,watts}$

iv O.E $= \frac{\text{Fluid Power}}{\text{Shaft Power}} \times 100$

$= \frac{1249.5}{2667} \times 100$

$= \underline{46.8\%}$