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Course | Fluid Mechanics

1 $V_1 = 5ms^{-1}$

$V_2 = 2ms^{-1}$

Head smaller end = 2.5m

$h = \frac{0.35(v_1 - v_2)^2}{2g}$ $h = 2.0m$

Head Lower end =

$Z = Z_1 - Z_2 = 2$

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

$\frac{P_2}{w} = \frac{P_1}{w} + \frac{1}{2g}(v_1^2 + v_2^2) + (Z_1 - Z_2)_{hf}$

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

$= 2.5 + 1.09 + 2 - 0.16055$

$P_2 = 5.4096 bar$

Pressure at lower end

$= 5.4096 bar$

2 Inlet diameter = 20cm = 0.2m

outlet diameter = 10cm = 0.1m

$P_1 = 17.658m$

$y = 30cm$ of mercury

$Cd = 0.98$

$A_1 = \frac{\pi d^2}{4} = \frac{(0.2)^2 \times \pi}{4} = 0.0314$

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

$y = 30cm$ (0.3m of mercury)

$P_1 = \frac{17.658}{1000} = 1.7658 \times 10^{-3} N/m$

$\frac{P_1}{w} = \frac{1.7658 \times 10^{-3}}{9.81} = 1.80 \times 10^{-4} m$

$\frac{P_2}{w} = 0.3 \times 13.6 = 4.08$ of H_2O

$h = \frac{P_1}{w} - \frac{P_2}{w} = 1.8 \times 10^{-4} - 4.08$

$h = 4.08018 m$

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

$= 0.98 \times \frac{0.0314 \times 7.85 \times 10^{-3}}{\sqrt{(0.0314)^2 - (7.85 \times 10^{-3})^2}} \times \sqrt{2 \times 9.81 \times 4.08}$

$Q = \frac{0.000241}{0.0304} \times 8.947$

$Q = 0.0709 m^3/s$

3. $D_1 = 15cm = 0.15m$ $D_2 = 30cm = 0.3$

50cm of Hg = 0.5m, $Q = ?$

S.g = 0.9 $Cd = 0.64$

$A_1 = \frac{\pi d^2}{4} = \frac{(0.15)^2 \times \pi}{4} = 0.0176m$

$A_2 = \frac{\pi d}{4} = \frac{(0.30)^2 \times \pi}{4} = 0.0706m$

$h = y\left[\frac{13.6}{0.9} - 1\right]$

h = 0.5 (... - 1)
= 2.05
Q = Cd a1 a2 √(2gh) / √(a1² - a2²)   √(2 × 9.81 × 2.05)

Q =

= 6.35 × 10⁻³ m³/s

(8) ... = ...
... of mercury = 0.2
S.G. of Hg = 13.6
S.G. of water = 1.026
h = y (S_Hg / S_w - 1)
= 0.2 (13.6 / 1.026 - 1)

h = 2.083 m
v = √(2gh)
v = √(2 × 9.81 × 2.085)
v = 6.39 m s⁻¹

(9) Volumetric efficiency = Volume of water out (Va) / Volume of engine (pump) (Vd)

Va = 0.05 m³/min = 0.05 m³ × 60 sec = 3
Vd = 10 cm³/sec = 10 × 100 = 0.1 m³

= Va / Vd = 3 / 0.1 = 80

10 cm³/sec = 10/100 = 0.1 m³/sec = 0.1 %

Fluid power = ρ g Q H / η

= 16 × 10⁻³ × 9.81 × 0.05 m³/s × 15 / 0.1

= 110 watts

iii Shaft Power = $\frac{\text{Hydraulic Power}}{\text{Efficiency}} = \frac{1.10}{0.1}$

$= 11 \text{ watts}$

iv Overall efficiency = $\frac{0.110}{2}$