volumetric flowrate

AKINWANDE SIMISOLA
18/ENG03/012
CIVIL ENGINEERING

Assignment

(1)

$V_1 = 5ms^{-1}$ $V_2 = 2ms^{-1}$

Pressure at smaller end = 2.5m.

Loss of head.

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

$= \frac{0.35 (5 - 2)^2}{2g}$

$\frac{0.35 (3)^2}{2 \times 9.81} = \frac{0.35 \times 9}{19.62} = 0.161$

Pressure at lower end. $h = z_1 - z_2 = 2m$

$\frac{P_1}{w} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + z_2 + h_f$

$\frac{P_1}{w} + \frac{V_1^2}{2g} - \frac{V_2^2}{2g} + z_1 - z_2 - h_f = \frac{P_2}{w}$

$2.5 + \frac{5^2 - 2^2}{9.81} + 0.161 = \frac{P_2}{w}$

$2.5 + 1.070 - 0.161$

~~3.731~~ 5.409 bar

(2)

$d_1 = 20cm \rightarrow$ ~~200m~~ $0.2m$

$d_2 = 10cm \rightarrow$ ~~100m~~ $0.1m$

$P_1 = 17.683 N/cm^2$

~~300mm of mercury~~ 0.3m of mercury

$C_d = 0.98$

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

$= 0.0314 m^2$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi \times 0.1^2}{4} = 0.00785 m^2$

$P_1 = 17.683 N/cm^2$

$\frac{17.683}{1000} = 1.7658 \times 10^{-3} N/m$

$\frac{P_1}{w} = \frac{1.7658 \times 10^{-3}}{9.81} = 1.8 \times 10^{-4} N/m$

$P_2 = 0.3 \times 13.6$

$= 4.08$

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

$h = 4.08018 m$

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

$= 0.98 \times \frac{0.0314 \times 0.00785}{\sqrt{(0.0314)^2 - (0.00785)^2}} \times \sqrt{2 \times 9.81 \times 4.08018}$

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

$= 0.070 m^3/s$

3

$D_1 = 15cm$
$0.15m$

$D_2 = 30cm$
$0.3m$

$y = 50cm$ of Mercury
$= 0.5m$ of mercury

S.G - specific gravity = 0.9
coefficient of discharge of the meter = 0.64

$A_1 = \frac{\pi d^2}{4} = \frac{\pi \times 0.15^2}{4}$

$= 0.018 m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi \times 0.3^2}{4} = 0.071 m^2$

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

$h = 0.5 \left[\frac{13.6 - 0.9}{0.9} \right]$

$h = 0.5 [14.1]$
$7.05m$

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

$= 0.64 \times \frac{0.018 \times 0.071}{\sqrt{0.071^2 - 0.018^2}} \times \sqrt{2 \times 9.81 \times 7.05}$

$Q = \frac{9.61 \times 10^{-3}}{40.12} = 2.33 \times 10^{-3} m^3/s$

$= 0.139 m^3/s$

(4)

[illegible] = 15
170mm of mercury
= 0.17m

specific gravity of mercury = 13.6
specific gravity of sea water = 1.026

$h = y \left[\frac{13.6}{1.026} - 1 \right]$

$h = 0.17 \left[\frac{13.26 - 1}{12.26} \right]$

$h = 2.1m$

$V = \sqrt{2gh}$

$\sqrt{2 \times 9.81 \times 2.1m}$

$\sqrt{41.202}$

$6.42 ms^{-1}$

(5)

Actual flow rate = 0.05 m³/min = $\frac{0.05}{60}$

$= 8.3 \times 10^{-4} m^3/s$

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

Speed of rotation = 1700 rev/min = $\frac{1700}{60}$

$= 28.3 rps$

Normal displacement
$= 100 cm^3/rev$
$= 1 \times 10^{-4} m^3/rev$

Torque - input = 15 N/m

Ideal flow rate = [illegible] displacement × speed of [illegible]

= [illegible] × 10 [illegible] × 28.5 × 10 [illegible]

(ii)

Volumetric efficiency = Actual flow rate / Ideal flow rate × 100%

= [illegible] × 10^-4 / [illegible] × 10^-4 × 100

= [illegible] %

(iii)

Fluid power = Q · ΔP

= [illegible] × 10^-4 × [illegible] × 10^5

= 1245 watt

(iv)

Shaft power = T · ω

ω = 2 × 22/7 × 28.5 = 179.57 rad/sec

= 15 × 179.57

= 2668.35 watt

(v)

Overall efficiency = Fluid power / Shaft power × 100

= 1245 / 2668.35 × 100

= 46.66 %