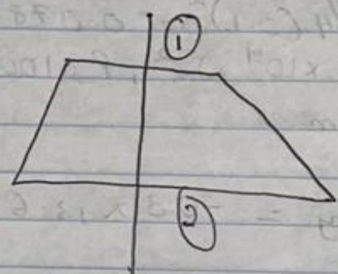
Goodhead Ibigomie
18/6Na06/024
Mechanical Engineering
Eng 2

(1)



Let smaller end be represented by ①
lower end be represented by ②
Solution

$l = 2.0m$ $P_1/\rho g = 2.5m$
$V_1 = 5m/s$ $V_2 = 2m/s$

loss of head $= hl = 0.35 \frac{(v_1 - v_2)^2}{2g} = \frac{0.35(5-2)^2}{2g} = \frac{0.35(x3)^2}{2 \times 9.81}$

$= \frac{0.35(9)}{2 \times 9.81}$

pressure Head $= P_2/\rho g = 7 (m)$

Applying Bernoulli's eq at ① and ②

$P/\rho g + v_1^2/2g + Z_1 = P/\rho g + V_2^2/2g + Z_2 + hL$

$Z_2 = 0$, $Z_1 = 2.0$

$\therefore 2.5 + \frac{(5)^2}{2 \times 9.81} + 2.0 = P_2/\rho g + \frac{(3)^2}{2 \times 9.81} + 0.016$

$2.5 + 1.27 + 2.0 = P_2/\rho g + 0.203 + 0.16$

$P_2/\rho g = (2.5 + 1.27 + 2.0) - (0.203 + 0.16)$
$= 5.77 - 0.363 = 5.407$
$= 5.4m$ of fluid.

(2) DATA

Inlet Diameter $(D_1) = 20cm = 0.2m$

throat Diameter $(D_2) = 100 = 0.10m$

Area of Inlet $= \pi/4 \times (0.2)^2 = 0.03146m^2$

Area of throat $= \pi/4 \times (d_2)^2 = \pi/4 (0.1)^2 = 0.07854m^2$

$Cd = 0.98$, pressure $(P_1) = 17.685 \times 10^4 \, N/m^2$, $P = 10000 \, kg/m^3$

$$P_1/P_4 \, eg = \frac{17.653 \times 10^4}{9.81 \times 1000} = 18m$$

$P_2/P_4 \, e.g = 30cm$ of mercury $= -0.3 \times 13.6 = -4$

differential head.

$$h = P_1/P_4 - P_2/P_4 = 18 - (-4)$$

$$= 22.08 \, m \, C_{water}$$

$$Q = \frac{Cd \times a_1 a_2 \sqrt{2gh}}{\sqrt{(a_1)^2 - (a_2)^2}}$$

$$= \frac{0.98 \times 314.16 \times 0.007854 \times \sqrt{2 \times 9.81 \times 22.08m}}{\sqrt{(314.16)^2 - (0.001854)^2}}$$

$$= \frac{50328837.21}{304} \times 165555 = 0.165m$$

$$= 165.561 \, lt/s$$

(3) DATA

Orifice Diameter - 15cm

Pipe Diameter - 30cm

Co-efficient of discharge of the meter is 0.64

flow of oil of specific gravity - 0.9.

Solution

$\ldots)^2 = 176.714 cm^2$ (A_0, area of the orifice)

$$Q_1 = \frac{C_d A_0 A_p}{\sqrt{(A_p^2) - (A_0)^2}} \sqrt{2gh}$$

$$Q = \frac{(0.64 \times 176.71 \times 706.86 \times \sqrt{2 \times 9.81 \times 7.05 \times 100}}{\sqrt{(706.85)^2 - (176.74)^2}}$$

$Q = 137414.25 \ cm^3/sec$

Litres $= 137.41425$ lit/sec

Rate of flow of oil $= 137.414$ lit/sec

(4) manometer reading (y) = 170 mmHg = 0.17 mHg

Sg h = 13.6

Sg of sea water (sw) = 1.026

$$h = 0.17\left[\frac{13.6}{1.026} - 1\right]$$

$$= 2.08$$

Velocity of the Submarine

$$v = \sqrt{2gh}$$

$$= \sqrt{2 \times 9.81 \times 2.08}$$

$$= 0.39 \, m/s$$

5. Q = Solution

$$= \left[\frac{5}{1000} \times \frac{1}{60}\right] m^3/s$$

$$= 8.3 \times 10^{-5} \, m^3/s$$

$$v = 1700 \text{ rev/min} = \frac{1700}{60}$$

$$= 28.33 \text{ revs/sec}$$

$Q_P = 10 \, cm^3/rev = 10 \times 10^{6} \, m^3/rev.$

Ideal flow rate = speed × displacement

$$1 \times 10^{-5} \times 28.33$$

$$= 2.833 \times 10^{-4} \, m^3/sec$$

i) Vol. efficiency = $\frac{\text{actual } Q}{\text{Ideal } Q} \times 100$

$= \frac{8.3 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100$

$= 29.33\%$

ii) fluid power = flow rate × pressure

$= 8.3 \times 10^{-5} \times (15 \times 10^{5})$

$= 124.5\,W$

iii) shaft power = torque × angular velocity

$\omega = 2\pi N$

$= 2\pi \times 28.33 = 178$ rad/s

shaft power

$= 15 \times 178$

$= 2670\,W$

Overall efficiency = $\frac{\text{fluid power}}{\text{shaft power}} \times 100$

$= \frac{124.5}{2670} \times 100$

$= 4.66\%$

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