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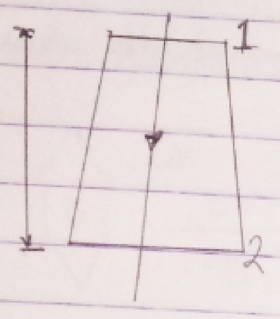
Mat No: 18/ENG04/044

Answers.

1).



Length = 2.0m
$V_1 = 5m/s$
$V_2 = 2m/s$
$P_s = 2.5m$
$H_2 = \frac{0.35(V1 - V2)^2}{2g}$
$= \frac{0.35(5-2)^2}{2 \times 9.81} = 0.101m$

$P_2 = ?$

Bernoulli's equation =
$$P_1/\rho g + V_1^2/2g + Z_1 = P_2/\rho g + \frac{V_2^2}{2g} + Z_2 + H_L.$$

Where $P_s = P_1/\rho g$ and $P_2 = P_2/\rho g$
$Z_1 = 2.0$ and $Z_2 = 0$ (datum line passes through section 2).

$$2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = P_2 + 2^2/2g \times 9.81 + 0 + 0.1$$

$2.5 + \frac{25}{19.62} + 2 = P_2 + \frac{4}{19.62} + 0.161$

$2.5 + \frac{25}{19.62} + 2 - \left(\frac{4}{19.62} + 0.161\right.$

$5.774 - 0.365 = P_2.$

$P_2 = 5.409\,m$ of the fluid.

2). $D_1 = 20cm$

$D_2 = 10cm$

$A_1 = \frac{\pi D_2^2}{4} = \frac{\pi (20)^2}{4} = 314.16cm^2$

$A_2 = \frac{\pi D_2^2}{4} = \frac{\pi (10)^2}{4} = 78.54cm^2$

$P = 1000\,kg/m^3$

Pressure $= 17.658\,N/cm^2 = 17.658 \times 10^4 N/m^2$

$\frac{P_1}{Pg} = \frac{17.658 \times 10^4}{1000 \times 9.81} = 18m$

~~$P_2/Pg = 17.658 \times 10$~~

$\frac{P_2}{Pg} = -30cm$ of mercury, $= 30 \times 10^{-2} m$ of mercury $\times 13.6 = 4.08m$

Let the differential head $= \frac{P_1}{Pg} - \frac{P_2}{Pg}$

$= 18 - (-4.08)$

$= 18 + 4.08 = 22.08m \times 100$

$H = 2208cm$

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

$= \frac{0.98 \times \sqrt{2 \times 981 \times 2208} \times 314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}}$

1).

$= \frac{0.98 \times 2081.37 \times 24674.1264}{304.184112}$

$= 165455.3 \text{ cm}^3/s$

$= \frac{165455.3}{1000} = 165.455 \text{ lit/sec}$

3). Diameter of the pipe $= A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (30)^2}{4} = 706.86 \text{cm}^3$

Diameter of orifice $= d_2 = 15$cm

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (15)^2}{4} = 176.72$cm

i Specific gravity of oil = 0.9

ii Specific gravity of mercury = 13.6

Differential manometer reading, x = 50cm of mercury

Coefficient of discharge, $Cd = 0.64$

Differential head, $h = x\left(\frac{S_m}{S} - 1\right)$

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

$h = 705.56$cm of oil

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Answ

The rate of flow of oil is

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

$$Q = \frac{0.64 \times \sqrt{2 \times 981 \times 705.56} \times 706.86 \times 176.72}{\sqrt{(706.86)^2 - (176.72)}}$$

1).

$Q = 137443.29 \ cm^3/s$

$Q = \frac{137443.29}{1000} = 137.44 \ lit/s$

4). $x = 170mm = 170 \times 10^{-3} = 0.17m$

$S_g = 13.6$

$S_o = 1.026$

Speed (v) = ?

$V = \sqrt{2gh}$, $h = ?$

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

$= 2.0834m$

$v = \sqrt{2 \times 9.81 \times 2.0834} = 6.393 \ m/s$

$$V = \frac{6.393 \times 60^2}{1000}$$

$v = 23.01 \ Km/hr$

5. $Q = 0.05 m^3/min = 50 dm^3/min$

$P_0 = 15 bar = 15 \times 100000 = 15 \times 10^5 N/m^2$

Speed = 1700 rev/min.

$T = 15 Nm$, $ND = 10 cm^3/rev$

i. Volumetric Efficiency = $\frac{\text{Actual flowrate}}{\text{Ideal flow rate}}$

Ideal flow rate = Nominal flow rate X Speed

$= 10 cm^3/rev \times 1700 rev/min$

$= 17000 cm^3/min$

Ideal flow rate = $\frac{17000}{1000000} = 0.017 m^3/min$.

Actual flow rate = $0.05 m^3/min$.

Volumetric Efficiency = $\frac{0.05}{0.017} = 2.94\%$

ii) Fluid Power = $P \times Q$

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

$Q = 0.05 m^3/min = \frac{0.005}{60} = 8.33 \times 10^{-4} m/s$

Fluid Power = $15 \times 10^5 \times 8.33 \times 10^{-4}$

$= 15 \times 10^5 \times 83.3 \times 10^{-5}$

$= 12495 \times 10^{5-5}$

$= 1249.5 watts$.

iii) Shaft Power = $2\pi NT = \frac{2\pi \times 1700 \times 15}{60} = 2670.35 watts$