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18/ENG02/016
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(1) $h = 2.0m$

$V_1 = 5m/s$

$P_1/\rho g = 2.5m$ of liquid

$V_2 = 2m/s$

loss of head $= h_L = \frac{0.35(V_1 - V_2)^2}{2g}$

$= \frac{0.35(5-2)^2}{2g} = \frac{0.35 \times 9}{2 \times 9.81} = 0.16m$

pressure head $\frac{P_2}{\rho g} = ?$

Applying ~~equation~~ Bernoulli's equation at section (1) and (2), we get

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + h_L$$

Let the datum line passes through section (2). Then $Z_2 = 0$, $Z_1 = 2.0$

$$\therefore 2.5 + \frac{5^2}{2 \times 9.81} + 2.0 = \frac{P_2}{\rho g} + \frac{2^2}{2 \times 9.81} + 0 + 0.16$$

$$2.5 + 1.27 + 2.0 = \frac{P_2}{\rho g} + 0.203 + 1.6$$

$$\frac{P_2}{\rho g} = (2.5 + 1.27 + 2.0) - (.203 + 1.6)$$

$= 5.77 - 363 = 5.407$ m of fluid

(2) $d_1 = 20cm$

$a_1 = \frac{\pi}{4} \times (20)^2 = 314.16cm^2$

$d_2 = 10cm$

$a_2 = \frac{\pi}{4} \times 10^2 = 78.74cm^2$

$P_1 = 17.658 N/cm^2 = 17.658 \times 10^4 N/m^2$

$= 1000 \frac{kg}{m^3}$ and $\therefore \frac{P_1}{\rho g} = \frac{17.658 \times 10^4}{9.81 \times 1000} = 18m$ of water

$= 1000\ kg/m^3$ and $\therefore P_1/\rho g = 17.658 \times 10^4 / 9.81 \times 1000 = 18$ m of water

$\frac{P_2}{\rho g} = -30$ cm of mercury

$= -0.30$ m of mercury $= -0.30 \times 13.6 = -4.08$ m of water

$\therefore$ Differential head

$$= h = \frac{P_1}{\rho g} - \frac{P_2}{\rho g} = 18 - (-4.08)$$

$$= 18 + 4.08 = 22.08 \text{ m of water} = 2208 \text{ cm of water}$$

The discharge Q is given by equation (6.8)

$$Q = \frac{C_d\, a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$$

$$= 0.98 \times \frac{314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.74)^2}} \times \sqrt{2 \times 981 \times 2208}$$

$$= \frac{5032887.21}{304} \times 1.65555\ cm^3/s = 165.555\ l/s \text{ ans}$$

(3) $d_0 = 15$ cm

$$a_0 = \frac{\pi}{4}(15)^2 = 176.7\ cm^2$$

$d_1 = 30$ m

$$a_1 = \frac{\pi}{4}(30)^2 = 706.85\ cm^2$$

$S_0 = 0.9$

$x = 50$ cm of mercury

$$h = x\left[\frac{S_g}{S_0} - 1\right] = 50\left[\frac{13.6}{0.9} - 1\right] \text{cm of oil}$$

$$= 50 \times 14.11 = 705.5 \text{ cm of oil}$$

$C_d = 0.64$

$\therefore$ The rate of the flow Q is given equation (6.13)

$$Q = C_d \frac{a_0 a_1}{\sqrt{a_1^2 - a_0^2}} \times \sqrt{2gh}$$

$$= \frac{0.64 \times 176.7 \times 706.85}{\sqrt{(706.85)^2 - (176.7)^2}} \times \sqrt{2 \times 981 \times 705.5}$$

$$= \frac{940463147.78}{6844} = 137414.26\ cm^3/s = 137.414\ litres/s$$

(4) $V = \sqrt{2g\,x\left(\frac{S_m}{S} - 1\right)}$

$$x = \frac{170}{1000}$$

$$= 0.17m$$

$S = 1.025$, $C = 1$

$S_m = 136$

$S = 1028$

$$V = \sqrt{2 \times 9.81 \times \left(\frac{13.6}{1.025} - \right)}$$

$V = 6.4$

(5)