Aboubakar Abdullahi
Civil Engineering
18/ENG03/001

① $V_1 = 5ms^{-1}$, $V_2 = 2ms^{-1}$
$PT_1 = 2.5m$, $PT_2 = ?$
$PT_1 - PT_2 = 0.35 \frac{(V_1 - V_2)^2}{2g} = \frac{0.35 \times 3^2}{2 \times 9.81} = 0.161$

$\therefore PT_1 - PT_2 = 0.161$
$2.5 - PT_2 = 0.161$
$PT_2 = 2.5 - 0.161$
$PT_2 = 2.67m$

② $200 = 0.20m$
$A = \pi d^2 = PT = \frac{\pi (0.20)^2}{4} = 0.0314m^2$

$P_1 = 17.658 N/cm^2 = \frac{17.658}{10^{-6}} = 17658000$

Specific gravity of mecury = 13.6
$\frac{P_1}{w} = \frac{P_1}{\rho g} = \frac{17.658 \times 10^{-6}}{1000 \times 9.81} = 1.8 \times 10^{-9}$

Vaccum ~~Compressc~~ Pressure $= \frac{P_2}{w} = 300mmHg$

$d_2 = 100mm = 0.1$

$-0.30 \times 13.6$ $\quad A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.10)^2}{4}$

$= 7.85 \times 10^{-3}$

$P_1 = -4.08.$ $\quad h = 1.8 \times 10^{-4} - 4.08$

$= 4.08000000 m$

$h = \frac{P_1}{w} - \frac{P_2}{w}$

$actual = \frac{(d\, p_1 p_2 \sqrt{2gh})}{\sqrt{A_1^2 - A_2^2}}$

$= \frac{0.98 \times 0.0314 \times 7.815 \times 10^{-3} \sqrt{2 \times 9.81 \times 4.080000}}{(0.031)^2 - (7.85 \times 10^{-3})^2}$

$= 0.07108691665$

(3) $d_0 = 15 \times 10^{-2} m$ $\quad d_1 = 30 \times 10^{-2} m$

$A_0 = \frac{\pi \times (15 \times 10^{-2})^2}{4}$ $\quad y = 50 \times 10^{-2} mHg$

$= 0.01767 m^2$ $\quad$ Sg of oil = 0.9

$Cd = 0.64$, $Q = ?$, $S_w = 13.6$ $\quad S_0 = 0.7$

$A_1 = \frac{\pi \times (30 \times 10^{-2})^2}{4}$ $\quad H = y \left[\frac{S_{w}}{S_0} - 1\right]$

$= 0.0707 m^2$

$$H = 50 \times 10^{-2} \left[\frac{13.6}{0.9} - 1\right]$$

$H = 7.055\,m$

$$Q = \frac{C_d A_0 A_1 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$= \frac{0.64 \times 0.176 \times 0.0707 \sqrt{2 \times 9.81 \times 7.055}}{0.0707^2 - 0.0176^2}$$

$Q = 0.137\,m^3/s$

(4) $y = 170\,mmhg = 170 \times 10^{-3}\,mhg$.

sg of mecury = 13.6 hg.

sg of sea water = 1.026

$$H = \frac{y \times S_m}{S_0} - 1$$

$v = \sqrt{2gH}$

$$H = 120 \times 10^{-3} \times \left(\frac{13.6}{1.026} - 1\right)$$

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

$v = 6.39\,m/s$

$H = 2.08\,m$

(5) Actual flowrate $Q = 5\,dm^3/min = 8.33 \times 10^{-5}\,m^3/s$

$p = 15\,bar = 15 \times 10^5\,N/m^2$

$V = 1700\,rev/min = 28.33\,rev/sec$

$T = 15\,N/m$ Normal displacement

$= 100\,cm^3/rev$

$= 1 \times 10^{-5}\,m^3/rev$

Volumetric efficiency:

$$\frac{\text{Actual flowrate}}{\text{ideal flowrate}} \times 100\%$$

ideal flowrate = $\frac{\text{displacement}}{\text{speed}}$

$Q = 1 \times 10^{-5} \times 28.33 = 2.833 \times 10^{-4} \, m^3/sec$

Volumetric efficiency $= \frac{8.33 \times 10^{-5}}{2.833 \times 10^{-4}} \times 100$

$= 29.4\%$

fluid power $(Q \times \Delta P)$

$= 8.33 \times 10^{-5} \times 15 \times 10^{5} = 124.95$ watts

shaft power $= T \times \omega$

$\omega = 2 \times \pi \times N / t = 2 \times \pi \times 28.33 = 178$ rad/sec

$= T \times \omega = 15 \times 178 = 2640$ watts.

Overall efficiency

$$\frac{\text{fluid power}}{\text{shaft power}} \times 100\%$$

$$= \frac{124.95}{2620} \times 100$$

$= 4.68\%$

(6) power = $\frac{\text{work done}}{\text{time}}$

work done = $\frac{mgh}{\text{time}}$ · $v$ = Velocity of stream

$\rho$ = density of water (1000 kg/m³)

$m = \rho \times v$ ∴

$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 20} = 19.7989$ m/s

$\frac{p \pi r^2 v g h}{t}$

power = $\frac{1000\,kg}{m^3} \times \left(\frac{10 \times 10^{-2}}{2}\right) \times 19.4989\,m/s \times 9.8\,m/s^2 \times 20\,m$

$= 30478.03N$

power = 30478.03N

(7) Diameter ($D_1$) = 0.3m, $A_1 = \frac{\pi}{4} \times 0.3^2$

$A_1 = 0.070685\,m^2$

throat diameter ($D_2$) = 0.2m

∴ $A_2 = \frac{\pi}{4} \times (0.2)^2$

$A_2 = 0.031416\,m^2$, coefficient of dischar(ge) ($C_d$) = 0.96

Specific weight of gas ($r$) = $\frac{19.62}{9.81}$

$S_g = 2\,kg/m^3$

Piezometric head diff (h) = $x\left(\frac{S_w}{S_g}-1\right)$

$= 0.06 \times \left(\frac{1000}{2}-1\right)$ $h = 29.94\,m$

∴ Volume flow rate (Q) = $\frac{C_d \cdot A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$

$= 0.81599\,m^3/s$

(8) $A_1 = \frac{\pi}{4} D_1^2 = \frac{\pi}{4}(0.152)^2 = 0.018146\,m^2$

$A_2 = \frac{\pi}{4} D_2^2 = \frac{\pi}{4}(0.076)^2 = 4.5365 \times 10^{-3}\,m^2$

(i) $Q = \frac{C_d A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \sqrt{2gh}$

$Q = 0.01924\,m^3/s$

(ii) $h = \left(\frac{P_1 - P_2}{\rho g}\right) = \frac{15 \times 70}{0.8 \times 10^3 \times 9.81} = 1.933\,m$

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

$Q = 0.02798\,m^3/s$

(1) $d_1 = 300mm = 0.3m$ $A_1 = \pi d^2/4 = \pi(0.3)^2/4$

$d_2 = 150mm = 0.15m$ $= 0.0707 m^2$

$A_2 = \pi d^2/4 = \pi(0.15)^2/4 = 0.0177 m^2$

$Q = 40 l/s$

$= (40 \times 10^{-3}) m^3/s$

$Z_1 = 10m$, $Z_2 = 6m$, $P = ?$, $P_2 = 400 kN/m^2$

$Q = VA$ $V_1A_1 = Q$ - - - $(V_1)(0.0707) = (40 \times 10^{-3})$

$V_1 = (40 \times 10^{-3})/0.0707$ $V_1 = 0.3658 m/s$

$Q = V_2 A_2$. $V_2(0.0177) = 40 \times 10^{-3}$

$V_2 = 2.2599 m/s$

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

$$50.79 = \frac{P_2}{9.81 \times 1000} + 6.260303$$

$P_2 = (9.81 \times 1000)(44.53)$

$P_2 = 436.836 kN/m^2$

(vi) Calculate the head

$$h = y\left[\frac{\rho_m}{\rho_f} - 1\right]$$

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

$$h = 2.0834$$

Calculate the velocity of the substance

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

$$= \sqrt{2 \times 9.81 \times 2.0834}$$

$$= 6.393\ m/sec$$