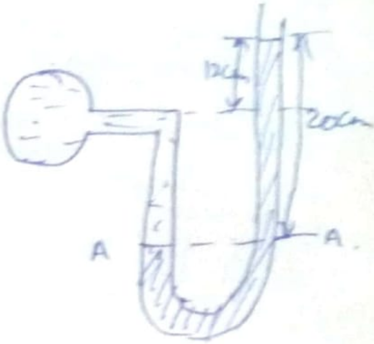
UO-I Dec. 2017 Solution (SE Biotech)

QP code : 24542



Q.2 b) ρ_{fluid} = sp. gr. × 1000 = 0.9×1000

ρ_1 = 900 kg/m³.

$\rho_2 = \rho_{mercury}$ = 13.6 ×1000 = 13600 kg/m³

h_2 = 20 cm = 0.2 m

h_1 = 20 − 12 = 8 cm = 0.08 m

Let P : press. of fluid in pipe

∴ $P + \rho_1 g h_1 = \rho_2 g h_2$

$P + 900 * 9.81 \times 0.08 = 13600 \times 9.81 \times 0.2$

∴ P = 25977 N/m²

= 2.5977 N/cm².

Q.2a) Major losses :

- Due to friction.
- found by Darcy weisbach formula.
  → loss of head in pipe due to friction

$h_f = \frac{4fLV^2}{D(2g)}$

h_f : loss of head due to fric^n.

f : coeff. of friction

D,L : Dia. and length of pipe.

V : vel. of fluid.

- By Chezy's formula.
  → calculated when vel. of flow through pipe and value of Chezy's coeff. C is known.

$V = C\sqrt{mi}$, m for pipe = D/4

$i = h_f/L$; i : loss of head for unit length of pipe.

Minor losses

Due to

i) Sudden expansion in pipe

ii) sudden contracⁿ.

iii) Bend in pipe.

iv) Pipe fittings

v) Obstruction in pipe

loss of head due to sudden expansion

$$h_e = \frac{(2V_2^2 + V_1^2 - 2V_2V_1 - V_2^2)}{2g} = \frac{(V_1 - V_2)^2}{2g}.$$

V_1, V_2 : vel. at entrance and exit.

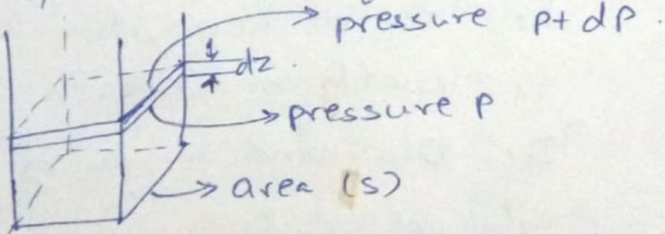
Sudden contracⁿ

$$h_c = \frac{kV_2^2}{2g}. \quad k = \left(\frac{1}{C_c} - 1\right)^2 ; \quad C_c = \frac{A_c}{A_2}$$

A_c : area of flow at contracⁿ.

A_2 : area of flow at exit.

Q.3 a) Hydrostatic equilibrium



- Stationary mass of single static fluid.
- const. P in any c/s parallel to earth's surface but varies ht. to ht.,
- ht. z above base of column.
- density ρ
- small element of thickness dz & area s.
- all forces on it must be zero.

Forces acting on column.

i) press. P acting upwards = Ps

ii) Press. P+dP acting downwards = (P+dP) s

iii) Gravity in downwards = ρgsdz

$Q_1 = V_{CE} \times$ area of CE

$\because \Sigma F = 0$

$$Ps - (P+dP)s - \rho g s\, dz = 0$$

$$\boxed{dP + \rho g\, dz = 0}$$ Hydrostatic eqn

for incompressible fluids only

- For compressible fluids.

$$\int dP + \rho g \int dz = 0.$$

$$P + \rho g z = \text{const}.$$

or $$\int_{P_1}^{P_2} dP = -\rho g \int_{z_1}^{z_2} dz$$

$$(P_2 - P_1) = \rho g (z_1 - z_2)$$

Q.3b) Bernoulli's eqn.

$$\int \frac{dP}{\rho} + \int v\,dv + \int g\,dz = \text{const} \quad \text{—— (1)}$$

For isothermal process,

$$\frac{P}{\rho} = \text{constant} = C_1$$

$$\therefore \int \frac{dP}{\rho} = \int \frac{dP}{P/C_1} = \int \frac{C_1\, dP}{P} = C_1 \int \frac{dP}{P}$$

$$= C_1 \ln P = \frac{P}{\rho} \ln P$$

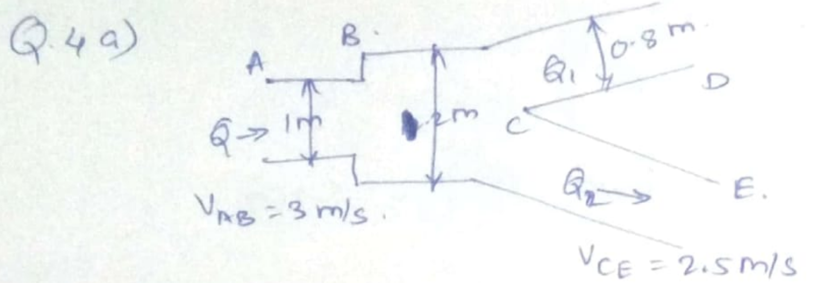
Substituting in (1).

$$\frac{P}{\rho} \ln P + \frac{V^2}{2} + gz = \text{constant}.$$

$$\therefore \boxed{\frac{P}{\rho g} \ln P + \frac{V^2}{2g} + z = \text{Const}.}$$

Bernaulli's eqn. for compressible flow undergoing isothermal process.

Q.4 a)



$D_{AB} = 1$ m

$V_{AB} = 3$ m/s

$D_{BC} = 1.2$ m

$D_{CD} = 0.8$ m

$V_{CE} = 2.5$ m/s

flow rate in AB = Q m^3/s

flow rate through CD = Q/3

flow rate through CE $= Q - \frac{Q}{3} = \frac{2Q}{3}$

i) vol. flow rate through AB = Q = V_{AB} x area

$= 3 \times \frac{\pi}{4}(D_{AB})^2$

$= 2.356$ m^3/s

ii) By continuity eqn.

V_{AB} x Area of AB = Q = V_{BC} x area of BC

$3\left(\frac{\pi}{4} \times 1^2\right) = V_{BC} \times \frac{\pi}{4} \times 1.2^2$

$V_{BC} = 2.083$ m/s

iii) flow through CD $= Q_1 = \frac{Q}{3} = \frac{2.356}{3} = 0.7853$ m^3/s

$V_{CD} = \frac{Q_1}{\text{area of CD}}$

$= \frac{0.7853}{\frac{\pi}{4} \times 0.8^2}$

$= 1.563$ m/s

iv) $Q_2 = Q - Q_1 = 1.5707$ m^3/s

~~$D_{CE} = \frac{Q_2 \times \frac{\pi}{4}}{\text{area of CE}} = \frac{1.5707}{\frac{\pi}{4} \times}$~~

Q_1 = V_{CE} x area of CE

$1.5707 = 2.5 \times \frac{\pi}{4} D_{CE}^2$

$\therefore D_{CE} = 0.894$ m.

Q.5 b) Critical speed of ball mill = n_c

$$n_c = \frac{1}{2\pi}\sqrt{\frac{g}{R-r}}$$

R : radius of ball mill.

r : radius of ball

n_{op} : op. speed of ball mill.

n_{op} = 50 % of ~~the~~ n_c.

$= 0.5$ ~~x~~ n_c

$$n_{op} = 0.5\left[\frac{1}{2\pi}\sqrt{\frac{9.81}{0.25-0.02}}\right]$$

$n_{op} = 6.53$ rpm