ASSIGNMENT 4

PART (A):

Prob. 3.4

Data

Section A

$\gamma = 6.3\ N/m^3$

$G = 4.5\ N/s$

$A = 0.6 \times 0.6 = 0.36\ m^2$

$V_a = ?$

Section B

$\gamma = 10\ N/m^3$

$V_B = ?$

Sol:

$Q = AV$

$V_a = \frac{Q}{A} = \frac{V/t}{A}$

$= \frac{4.5 t/\gamma}{tA}$

$V_a = \frac{4.5}{A\gamma}$

$= \frac{4.5}{0.36 \times 6.3}$

$\boxed{V_a = 1.984\ m/s}$

$G = \frac{W}{t}$

$4.5 = \frac{W}{t}$

$4.5 = \frac{\gamma V}{t}$

$V = \frac{4.5t}{\gamma}$

$V_B = \frac{4.5}{0.36 \times 10}$

$\boxed{V_B = 1.25\ m/s}$

Prob 3.5

Data:

$V = 0.5\ m\,s^{-1}$ $\quad Q = ?$

$S = 1.26$ $\quad M = ?$

$\gamma = 12360.6\ N/m^3 \Rightarrow \gamma = \rho g \Rightarrow \rho = 1260\ kg/m^3$ $\quad G = ?$

$d = 10\ cm = 0.1\ m \Rightarrow A = 7.85 \times 10^{-3}\ m^2$

Sol:

$$Q = \frac{V}{t} = \frac{AL}{t} = AV$$

$$\therefore Q = 7.85 \times 10^{-3} \times 0.5$$

$$\boxed{Q = 3.92 \times 10^{-3}\ m^3/s}$$

$$\because 1L = 10^{-3}\ m^3$$

$$\boxed{Q = 3.92\ L/s}$$

$$M = \rho AV$$

$$= 1260 \times 7.85 \times 10^{-3} \times 0.5$$

$$\boxed{M = 4.9455\ kg/s}$$

$$G = \gamma Q$$

$$= 12360.6 \times 3.92 \times 10^{-3}$$

$$G = 48.45\ N/s$$

$$\boxed{G = 0.04845\ KN/s}$$

Prob 3.6

Data:

Oxygen

$A = 5\ cm$ by $5\ cm = 25\ cm^2 = 2.5 \times 10^{-3}\ m^2$

$P = 275\ KPa$

$T = 40^\circ C = 40 + 273 = 313K$

$P_{atm} = 100\ KPa$, abs

$V = 5.5\ m/s$

$G = ?$

$P_{abs} = P + P_{atm}$

$= 275 + 100$

$P_{abs} = 375\ KPa$

Sol:

$$\gamma = \frac{Pg}{RT}$$

$\therefore RM = 8312$

$$R = \frac{8312}{32} = 259.75\ Nm/kg \cdot K$$

$$\gamma = \frac{375 \times 10^3 \times 9.81}{259.75 \times 313} = 45.248 \text{ N/m}^3$$

$\Rightarrow G = \gamma A V$

$= 45.248 \times 0.0025 \times 5.5$

$G = 0.62216 \text{ N/s}$

Prob 3.7

Data:

Air

$T = 40^\circ C = 40 + 273 = 313K$

$P_{abs} = 3000 \text{ mbar} = 3 \times 10^5 \text{ N/m}^2$

$d = 250 \text{ mm} = 0.25 \text{ m} \Rightarrow A = 49.08 \times 10^{-3} \text{ m}^2$

$V = 10 \text{ ms}^{-1}$

$M = ?$

Sol:

~~$PV = RT$~~

~~$\frac{P}{\rho} = RT$~~

$\rho = \frac{P_{abs}}{RT}$

For air

$R = 287 \text{ Nm/kgK}$

$\rho = \frac{m}{V}$

$V = \frac{m}{\rho}$

$\rho = \frac{3 \times 10^5}{287 \times 313}$

$\rho = 3.339 \text{ kg/m}^3$

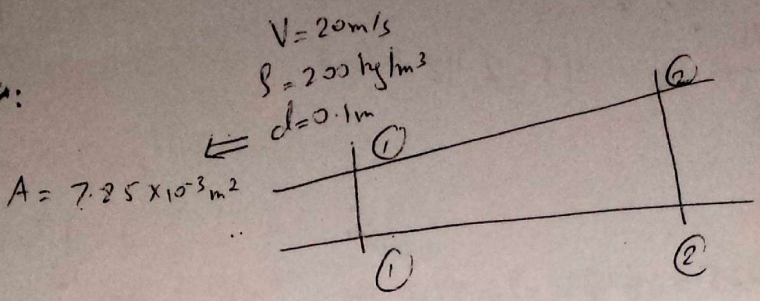
$\Rightarrow M = \rho A V$

$= 3.339 \times 49.08 \times 10^{-3} \times 10$

$M = 1.639 \text{ kg/s}$

Prob 3.9

Data:



Sol:

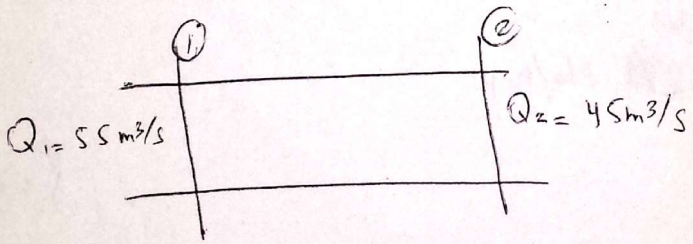
i) $\rho_1 A_1 V_1 = \rho_2 A_2 V_2$

$$\rho_2 = \frac{\rho_1 A_1 V_1}{A_2 V_2} = \frac{200 \times 7.85 \times 10^{-3} \times 20}{17.67 \times 10^{-3} \times 14} = 126.93 \text{ kg/s}$$

b) If the flow were unsteady, the problem could not be solved because no information is given on $\partial\rho/\partial t$. Also the vol. b/w two sections is unknown.

Prob 3.12

Data:



Rate of storage $= Q_1 - Q_2$

$= 55 - 45$

$= 10 \text{ m}^3/\text{s}$

PART B

Q=1

Data:

$d = 100\,mm = 0.1\,m \Rightarrow A = \frac{\pi d^2}{4} = 7.85 \times 10^{-3}\,m^2$

$V = 3\,ms^{-1}$

$Q = ?$

$M = ?$

$G = ?$

Benzene at 20°C

$\rho = 895\,kg/m^3$

$S = 0.9$

$\gamma = \rho g = 8779.95\,N/m^3$

Sol:

$Q = AV$

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

$= 23.56 \times 10^{-3}\,m^3/s$

$M = \rho Q$

$= 895 \times 23.56 \times 10^{-3}$

$= 21.0862\,kg/s$

$G = \gamma Q$

$= 8779.95 \times 23.56 \times 10^{-3}$

$G = 206.85\,N/s$

Q=2

Data:

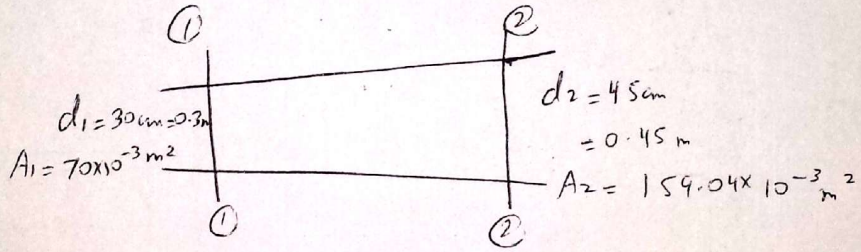
a) $V_1 = ?$

b) $Q_1 = ?$

c) $Q_2 = ?$

d) $G = ?$

e) $M = ?$



Sol:

$A_1V_1 = A_2V_2$

a) $V_1 = \frac{A_2V_2}{A_1} = \frac{159.04 \times 10^{-3} \times 5}{70 \times 10^{-3}} = 11.36\,m/s$

b) $Q_1 = A_1V_1$

$Q_1 = 70 \times 10^{-3} \times 11.36 = 0.7952\,m^3/s$

$Q_2 = A_2V_2$

$Q_2 = 159.04 \times 10^{-3} \times 5 = 0.7952\,m^3/s$

d) $G = \gamma Q$

$G = 9810 \times 0.7952 = 7800.9121$

N

e) $M = \rho Q$

$= 1000 \times 0.7952$

$M = 795.2\,kg/s$

Q=3

$1L = 10^{-3} m^3$

Data:

ρ = constant $V_{BD} = 4 m/s$

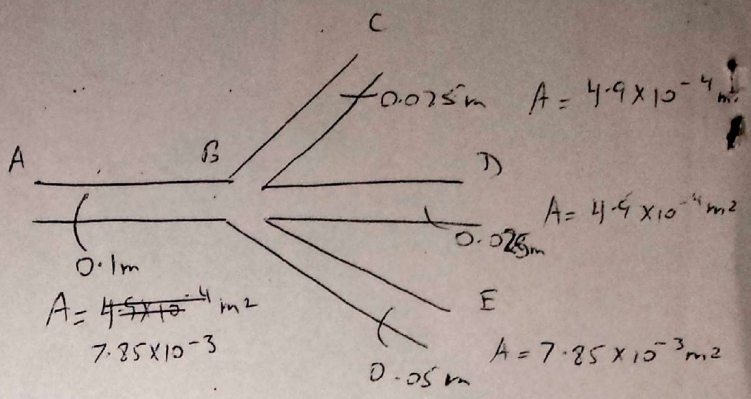
$Q_{AB} = 15 L/s = 15 \times 10^{-3} m^3/s$

$d_{AB} = 100mm = 0.1m$

$Q_{BC} = 3 Q_{BE}$

$Q_{BC}, Q_{BD}, Q_{BE} = ?$

$V_{AB}, V_{BC}, V_{BE} = ?$



Sol:

$Q_{AB} = A V_{AB}$

$V_{AB} = \frac{15 \times 10^{-3}}{7.85 \times 10^{-3}}$

$\boxed{V_{AB} = 1.91 m/s}$

$Q_{BD} = A V_{BD}$

$= 4.9 \times 10^{-4} \times 4$

$\boxed{Q_{BD} = 1.96 \times 10^{-3} m^3/s}$

$Q_{AB} = Q_{BC} + Q_{BD} + Q_{BE}$

$\Rightarrow Q_{AB} = 3Q_{BE} + Q_{BD} + Q_{BE}$

$0.015 = 4 Q_{BE} + (1.96 \times 10^{-3})$

$\boxed{Q_{BE} = 3.26 \times 10^{-3} m^3/s}$

$Q_{BC} = 3Q_{BE}$

$Q_{BC} = 3 \times (3.26 \times 10^{-3})$

$\boxed{Q_{BC} = 9.78 \times 10^{-3} m^3/s}$

$V_{BE} = \frac{Q_{BE}}{A_{BE}} = \frac{3.26 \times 10^{-3}}{1.96 \times 10^{-3}} = 1.66 m/s$

$\boxed{V_{BE} = 1.66 m/s}$

$V_{BC} = \frac{Q_{BC}}{A_{BC}} = \frac{9.78 \times 10^{-3}}{4.9 \times 10^{-4}} = 19.95 m/s$

$\boxed{V_{BC} = 19.95 m/s}$