B.Tech. (Chemical Engineering) Fifth Semester (C.B.S.)

Fluid Mechanics

P. Pages : 2 | **NIR/KW/18/3784**

Time : Three Hours | Max. Marks : 80

* 1 8 7 4 *

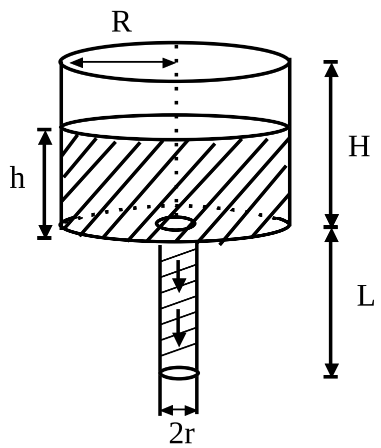
Notes :
1. All questions carry marks as indicated.
2. Solve **any five** questions.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data whenever necessary.
5. Diagrams and chemical equations should be given whenever necessary.
6. Illustrate your answers whenever necessary with the help of neat sketches.

1. a) Based on the rheology classify the different type of fluid and explain each of them in detail with an example; and rheological equation. **8**

b) Show that the rate of increase of pressure or the pressure intensity for the fluid in vertically downward direction is equal to the specific weight of the fluid at a point. **8**

2. The tank and pipe shown in figure are initially filled with a liquid of viscosity (μ) and density (ρ). Assuming laminar flow, taking pipe friction to be only resistance and ignoring exit kinetic energy effects, prove that the time taken to drain just the tank is **16**

$$t = \frac{8\mu L_R{}^2}{\rho g\, r^4}\,\ell n\left[1 + \frac{H}{L}\right].$$



3. a) Discuss the Baker diagram for the flow pattern in two phase flow in pipe. Discuss how the erosion in two phase can be avoided. **8**

b) Water is flowing at velocity of 1.5 m/s through a pipe of 60 cm diameter and 50 m long. The pipe is connected in series to pipe of 30 cm diameter and 60m long. Determine the equivalent length of pipe for 60 cm diameter pipe. density of water is $1000\,kg/m^3$ and viscosity of water is $1\frac{mN-S}{m^2}$. **8**

4. Discuss the working principle of variable area flow meter. Discuss the variation of coefficient of discharge (Cd) with the shape of float. Show that theoretical volumetric flowrate through rotameter is given by **16**

$$Q_{theo} = a\sqrt{\frac{2Mg}{\rho_A}}$$

Where

$M \rightarrow$ Mass of float (kg)

$\rho \rightarrow$ Density of fluid (kg/m^3)

$A \rightarrow$ Area of Tapered tube of float position. (m^2)

$a \rightarrow$ Area available for flow around the float position (m^2).

5. A centrifugal pump is used to deliver a liquid at a rate of $0.003 m^3/s$ from a reservoir at atmospheric pressure. The gauge pressure at the end of delivery pipe is $300 kN/m^2$. The delivery in 3.5 m and the pump suction in 1.5 m above the level in the reservoirs. The delivery pipe is 40 mm diameter. The friction in suction pipe is $3.5 kN/m^2$ and the friction in the delivery pipe in $41 kN/m^2$. The overall efficiency of the pump is 60%. The vapour pressure of liquid is $26 kN/m^2$. $\rho_f = 900 kg/m^3$. Determine : **16**

i) Head developed by the pump.

ii) Work done per second by the pump.

iii) Net Positive Suction Head (NPSH) of the pump.

6. A liquid reactant is pumped through the catalytic reactor which consist of a cylinder packed with catalyst sphere of diameter $d_1 = 2.0 mm$. Test summarized show the pressure drop $(-\Delta p)$ across the reactor are 0.66 bar, 1.66 bar at volumetric flowrate $9.33 \times 10^{-5} m^3/s$, $1.86 \times 10^{-4} m^3/s$, respectively. If the maximum pressure drop is limited by the pump to 3.45 bar. What is the upper limit on the flow rate? After the existing catalyst is spent, a similar batch is unfortunately unavailable and the reactor has to be packed with second batch of catalyst whose diameter is now $d_2 = 1.00 mm$. What is the new maximum allowable flowrate if the pump is still limited to 3.45 bar. **16**

7. Drive Hagen – Poiseuille equation and show that fanning friction (f) is given by $f = \frac{16}{Re}$ for flow of fluid through the pipe. **16**
(where Re-Reynolds Number)

8. a) A pitot tube placed in the centre of pipe of 30 cm diameter. The difference between the pressure head across the pitot tube is 5 cm of water. Determine the average velocity of water and volumetric flow rate of water. Assume suitable data $Cd = 0.98$. **8**

b) A fluid is passed vertically upward through a bed of catalyst consist of approximately spherical particle of diameter 0.3 mm and density $2600 kg/m^3$. The density of fluid is 900 kg/m^3 and viscosity of fluid is $9 mN-S/m^2$. The fractional voidage of fluidized bed at minimum fluidization is 0.50 and length of fluidised bed is 1.8 m. Determine (i) minimum fluidization velocity (ii) Entrainment velocity (iii) Pressure drop across fluidised column. **8**

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