**Printed Pages : 2** **Roll No.** | | | | | | | | | | | **NCH403**

**B. TECH.**
**THEORY EXAMINATION (SEM–IV) 2016-17**
**MASS TRANSFER - I**

***Time : 3 Hours*** ***Max. Marks : 100***

***Note :*** *Be precise in your answer. In case of numerical problem assume data wherever not provided.*

## SECTION – A

**1. Attempt all parts of the following questions: 10 x 2 = 20**

**(a)** Explain mass transfer and mass transfer operation.
**(b)** Knudsen diffusion and eddy diffusion.
**(c)** Write the criteria for selection of solvent
**(d)** Explain operating line and equilibrium curve.
**(e)** Define the Humid Heat and Humid Volume.
**(f)** Write the application of cooling tower
**(g)** Explain continuous drying
**(h)** Write the difference between bound moisture and unbound moisture.
**(i)** Define the Solubility curve.
**(j)** Define the metastable region in crystallization.

## SECTION – B

**2. Attempt any five of the following questions: 5 x 10 = 50**

**(a)** A batch of solid for which the following table of data applies is to be dried from 25% to 6 % moisture under condition identical to those for which the data were tabulated. The initial weight of the weight of the wet solid is 300 kg and the drying surface is 1 $m^2$/ 8 kg dry weight. Determine the time for drying.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **X** | 0.35 | 0.25 | 0.2 | 0.18 | 0.16 | 0.14 | 0.12 | 0.1 | 0.09 | 0.08 | 0.064 |
| **N** | 0.3 | 0.3 | 0.3 | 0.266 | 0.239 | 0.208 | 0.18 | 0.15 | 0.097 | 0.07 | 0.025 |

X = kg moisture / kg dry air , n kg moisture evaporated / hr $m^2$

**(b)** Determine the diffusivity of $CO_2$ $O_2$ and $N_2$ in a gas mixture having the composition: $CO_2$ = 28.5 % , $O_2$ = 15 %, $N_2$ = 56.5 %. The gas mixture is at 273 K and 1.2 x $10^5$ Pa. the binary diffusivity value are given as $D_{12}$ P = 1.874 $m^2$ Pa / sec$D_{13}$ = 1.945 $m^2$ Pa /sec$D_{23}$ P = 1.834 $m^2$ Pa / sec.

**(c)** Air flows through a cylindrical tube made of naphthalene at a velocity of 5 m/s. the tube diameter is 0.1m, and the air temperature is 20 $^oC$. Estimate the mass transfer coefficient. Given: $D_{naph\text{-}air}$ = 4.24 x $10^{-6}$ $m^2$/s, $\mu_{air}$ = 1.8 x $10^{-6}$ Pa – sec and $\rho_{air}$= 1.2 kg/ $m^3$.

**(d)** 5000 kg/ hr of a $SO_2$ – mixture containing 5 % by volume of $SO_2$ is to be scrubbed with 2,00,000 kg/ hr of water in a packed tower. The exit concentration of $SO_2$ is reduced to 0.15 % the tower operates at 1 atm. The equilibrium relation is given by: Y = 30 X where Y = mole $SO_2$/ mole air , X = mole $SO_2$/ mole water . if the packed height of tower is 0.42 m , calculate the height of transfer unit.

**(e)** Fresh air at 21.2 $^oC$in which partial pressure of water vapour is 0.0118 atmosphere is blown at the rate of 214 $m^3$/ hr first through a pre heater and then adiabatically saturated in a spray chamber to 100 %saturation and again reheated. This reheated air

and the air leaving the reheater have the same percentage humidity. Determine heat requirements for pre-heating and reheating.

**(f)** What are the different types of packing used in packed tower?

**(g)** Derive Adiabatic saturation equation :

$$T_{G1} - t_{as} = ( Y'_{as} - Y'_1 ) \frac{\lambda_{as}}{C_{S1}}$$

**(h)** What is purpose of drying? Explain fluidized bed Dryer with application.

## SECTION – C

**Attempt any two parts of the following questions: 2 x 15 = 30**

**3.** Discuss the rate of crystal growth. 10 mg of solution containing 0.3 kg $Na_2CO_3$ / kg solution is cooled slowly to 293 K to from crystals of $Na_2CO_3$ 10 $H_2O$, the solubility at 293K is 0.215 kg/kg water. If 3 % of the original solution is lost by evaporation during cooling, what is the crystal yield?

**4.** What do you understand by draft? Give the classification of cooling tower used in industry. Explain Mechanical draft cooling tower.

5. Fresh air at 21.2 $^oC$ in which the partial pressure of water vapor is 0.0118 atmosphere is blown at the rate of 214 $m^3$/hr first through a pre-heater and then adiabatically saturated in a spray chamber to 100 % saturation and again reheated. This reheated air has a humidity of 0.024 kg water vapor per kg dry air. It is assumed that the fresh air and the air leaving the reheated have same percentage humidity.

(i) Determine the temperature of pre-heater, spray chamber and reheated.

(ii) Heat requirement for pre-heating and reheating.