



(Following Paper ID and Roll No. to be filled in your Answer Book)

**PAPER ID : 151411**

Roll No.

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## B. Tech.

(SEM. IV) THEORY EXAMINATION, 2014-15  
MASS TRANSFER - I

Time : 3 Hours]

[Total Marks : 100

**Note :** Attempt all questions. All questions carry equal marks. In case of numerical problems assume data wherever not provided

- 1 Attempt any four parts of the following:  $5 \times 4 = 20$
- (a) Prove that for equimolecular counter diffusion from a sphere to a surrounding stationary, infinite medium, the Sherwood number based on the diameter of the sphere is equal to 2.
  - (b) What are the general principles underlying the two-film and penetration theories for mass transfer across the phase boundary? Give the basic difference equations with appropriate boundary conditions.
  - (c) The diffusivity of  $\text{CO}_2$  in  $\text{O}_2$  at  $0^\circ\text{C}$  is  $1.39 \times 10^{-5} \text{ m}^2/\text{s}$  at atmospheric pressure. Find the diffusivity at an elevated temperature and pressure of  $100^\circ\text{C}$  and 2 atm respectively.

- (d) Obtain the relationship between overall mass transfer coefficient and individual mass-transfer coefficient.
- (e) In many processes mass-transfer and heat transfer take place simultaneously. In what manner the governing equations, are related with each other? Comment on it.
- (f) What is the effective thickness of the gas film for the evaporation of water into air in a 50mm diameter wetted wall column at a Reynolds number of 20,000 and temperature of 40°C. Kinematics viscosity for air at 40°C is 0.165 cm<sup>2</sup>/s. diffusivity for water in air at 1 atm, is 0.288cm<sup>2</sup>/s.

2 Attempt any two parts of the following : 10×2=20

- (a) (i) Write all the requirements of the packing to be used in a gas absorption packed-bed.
- (ii) Write all the necessary requirement of a suitable solvent.
- (b) (i) What is meant by number of transfer unit? Differentiate between HTU and HETP.
- (ii) Derive the following relation with explanation of each term:--  

$$HTU_{OG} = HTU_g + (mG/L) (HTU_l)$$
- (c) (i) What are different types of gas-liquid contractors used for absorption?
- (ii) What do you understand by limiting gas-liquid ratio in absorption column?

3 Attempt any Two parts of the following : 10×2=20

- (a) The dry bulb temperature and the wet bulb temperature of an air-water vapor sample is 90°C and 30°C, respectively . With the help of a humidity chart, determine the following :
- (i) Absolute humidity
  - (ii) Saturation humidity
  - (iii) Dew point temperature
  - (iv) Humid volume.
- (b) In a process in which benzene is used as a solvent, it is evaporated into dry nitrogen. At 24°C and 1 bar, the resulting mixture has a percentage relative humidity of 60. It is required to recover 80% of benzene present by cooling to 10°C and compressing to a suitable pressure. What should this pressure be? Vapour pressure of benzene at 24°C and 10°C are 12.2 and 6.0 kN/m<sup>2</sup> respectively.
- (c) Give classification of different types of cooling towers with help of neat sketches. Explain the construction and operation of any one.

4 Attempt any Two parts of the following : 10×2=20

- (a) In certain batch drying operation we get the rate drying in constant drying period as 2.8 kg H<sub>2</sub>O/hr.m<sup>2</sup> at a air inlet temperature of 60°C with a wet bulb temperature of 35°C. What will be the rate if same air is used at a inlet temperature of 80°C.

- (b) Describe rate of drying curve. Mention the points at which it changes the shape.
- (c) With the help of neat sketch, explain the construction and operation of a continuous rotary dryer. Also discuss its application.

5 Attempt any two parts of the 10×2=20  
following :

- (a) What do you understand by individual and overall growth coefficient in crystal growth?
- (b) A saturation solution containing 1500 kg of KCl at 87°C is cooled in an open tank to 17°C. If the density of solution is 1200 kg/m<sup>3</sup>, solubility of KCl per 100 parts of water is 53.55 at 87°C and 34.5 at 17°C, calculate :
  - (i) the capacity of tank required
  - (ii) the weight of crystal obtained.
- (c) In some of the crystallizers the crystals are in fluidized state why? Describe the construction and operation of such crystallizer.

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