

B.E./B.TECH. Degree Examination, December 2020

Fifth Semester

CH18501 - MASS TRANSFER I

(Regulation 2016)

Time: Three hours

Maximum : 80 Marks

Answer **ALL** questions**PART A - (8 X 2 = 16 marks)**

1. Which number relates Schmidt number and Prandtl number:
(a) Nusselt number (b) Sherwood Number (c) Lewis Number (d) Peclet Number
2. Pick the odd one out with respect to NTU
(a) $\int dy/(y-y^*)$ (b) $\int dx/(y^*-x)$ (c) $\int dx/(x_i-x)$ (d) $\int dy/(y-y_i)$
3. Psychrometric chart is not possible for system containing Water Vapour and
(a) Air (b) Natural gas (c) Petroleum gas (d) Butanol
4. As per Ostwald ripening, small crystals and large crystals are favored respectively by
(a) kinetics and thermodynamics (b) thermodynamics and kinetics
(c) kinetics and fluid dynamics (d) thermodynamics and fluid dynamics
5. How permeability and solubility of a solute gas in solid are related?
6. Compare and contrast Prandtl analogy with Von Karman analogy.
7. Based on humidity and climate condition at a particular location compare the utility of air cooler and air conditioner.
8. With respect to crystal growth imperfections distinguish needle breeding and veiled growth.

PART B - (4 X16 = 64 marks)

09. (a) Water has spilled out through the accidental opening of the valve of a pipe line on the floor of a chemical plant. The water layer is **1 mm** thick and is at **298 K**. The air is at **298 K** and **1 atm** pressure. The water vapor content of air is **2 g per kg** of dry air. Determine the time required for complete evaporation of the water assuming water molecular diffusion is taking place through air film of **5 mm** thickness. The diffusivity of water vapour in air is **0.256 cm² sec⁻¹** and the vapor pressure of water at **298 K** is **24.56 mm Hg**. **(16)**

(OR)

- (b) A vertical glass tube of **3 mm** diameter was filled with liquid gold to a depth of **2 cm** from the top open end. The liquid gold has diffusivity in air of **1.18 x 10⁻⁵ m²sec⁻¹**, density of **820 kg m⁻³** and vapor pressure at **303 K** of **57 mm Hg**. The top end of the tube was accidentally opened and the level has dropped now to **8 cm** for the top open end. Estimate the time required for the drop in level at **303K**, assuming no air diffuses into liquid gold. **(16)**

10. (a) (i) Derive the analogous relationship between mass, momentum and heat transfer in turbulent condition and what correction needs to be included for the relationship to hold good for even in laminar condition. (12)

(ii) Draw the representative equilibrium curve for liquid phase controlled mass transfer and gas phase controlled mass transfer (4)

(OR)

(b) (i) Derive the relationship between K_x , k_x , k_y and m for a liquid-gas system. (8)

(ii) Utilizing Whitman theory, derive the relationship between mass transfer coefficient and diffusivity for a liquid-gas system. (8)

11. (a) (i) Air at **298 K** and **70%** relative humidity is cooled to **288 K** and reheated to **293 K**. Find (8)

(i) The weight of water removed per unit weight of dry air

(ii) The WBT of original and final air and

(iii) The percentage humidity, relative humidity and partial pressure of water vapour in the final air.

(ii) Compare the operation, performance and cost of the mechanical draft cooling towers to Natural draft cooling towers. (8)

(OR)

(b) (i) Conditioned air at **298 K** and **50% saturation** is to be supplied for a laboratory of size **4m x 20m x 6m** with no facilities for recirculation. The air conditioner takes the outside air at **308K** and **90%** saturation, refrigerate and separates out the condensed water and reheats the air using steam at **1 atm**. Find the volume of air needed at the entry conditions and compute the weight of water condensed in the conditioner. (10)

(ii) Derive an expression for wet bulb depression. (6)

12. (a) (i) A wet solid is dried from **32%** to **8%** moisture in **5 hours** under constant drying conditions. The critical moisture content is **12%** and the equilibrium moisture content is **5%** and all moisture contents are reported on a wet basis. How long will it take under the same drying conditions to dry it to a final water content of **6%**. (10)

(ii) Considering yourself as a dryer consultant, elaborate on the selection of dryers for a particular application. (6)

(OR)

- (b) (i) Solubility of **FeSO₄·7H₂O** in **100 kg** of water at **318 K** and **305 K** is **47.5 kg** (10) and **33.8 kg** respectively. Estimate
- (i) Theoretical weight of saturated solution at **318 K** to be charged to get **1000 kg** of crystals by cooling to **305 K**
- (ii) The yield of crystals, if **5%** of the total water entering the system is lost by evaporation in addition to cooling as stated in (i)
- (ii) Elaborate on the selection of crystallizer based on the temperature dependence of (6) solute solubility.