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Question Paper Code: 55092

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2017

Fifth Semester

Chemical Engineering

15UCH502 - MASS TRANSFER - I

(Data book are may be permitted)

(Regulation 2015)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

- The driving force required for diffusion operation is _____ gradient.
 - pressure
 - thermal
 - velocity
 - concentration
- The SI unit of diffusivity is
 - m^2/sec
 - $\text{moles}/(\text{m}^2.\text{sec})$
 - moles m^{-1}
 - $\text{kg}/(\text{sec.m})$
- Eddy diffusion is characterized by motion of the fluid particles which is irregular with respect to
 - direction only
 - time only
 - both time and direction
 - neither time nor direction
- According to film theory, the relationship between mass transfer coefficient (K_c) and molecular diffusivity (D) is given by
 - $K_c \propto \frac{1}{D}$
 - $K_c \propto D$
 - $K_c \propto \frac{1}{\sqrt{D}}$
 - $K_c \propto \sqrt{D}$

5. The steady-state temperature reached by a small amount of liquid evaporating into a large amount of unsaturated vapor-gas mixture is called _____ temperature.
- (a) wet-bulb (b) dry bulb
(c) dew point (d) bubble point
6. The process in which cold water condenses some water vapor from warm air is
- (a) drying (b) humidification
(c) water cooling (d) dehumidification
7. _____ refers to the moisture contained by a substance which exerts an equilibrium vapor pressure less than that of the pure liquid at the same temperature.
- (a) equilibrium moisture (b) bound moisture
(c) free moisture (d) unbound moisture
8. Milk powder is prepared by _____ drier.
- (a) tray (b) fluidized bed
(c) spray (d) rotary
9. During crystallization, the correct sequence of stages in the evolution of a crystal is
- (a) embryo → cluster → nucleus → crystal
(b) nucleus → embryo → cluster → crystal
(c) cluster → embryo → nucleus → crystal
(d) nucleus → cluster → embryo → crystal
10. The most common type of nucleation in industrial crystallizers is _____ type nucleation.
- (a) contact (b) fluid-shear
(c) secondary (d) primary

PART - B (5 x 2 = 10 Marks)

11. State Fick's first law of diffusion.
12. Define Schmidt number. Mention its physical significance.
13. What is absolute humidity?
14. Classify driers based on method of operation and method of supplying the heat necessary for evaporation of the moisture.
15. What is meant by equilibrium solubility curve in crystallization?

PART - C (5 x 16 = 80 Marks)

16. (a) (i) Consider the absorption of ammonia (A) from air (B) into water. Derive an expression for molar flux of 'A' for the Steady state diffusion of 'A' through non diffusing 'B'. (10)
- (ii) Explain the determination of diffusivity of liquids by Wilke and Chang equation. (6)

Or

- (b) (i) Oxygen (A) is diffusing through carbon monoxide (B) under steady-state conditions with the carbon monoxide non-diffusing. The total pressure is 1×10^5 N/m², and the temperature 0 °C. The partial pressure of oxygen at two planes 2.0 mm apart is, respectively, 13000 and 6500 N/m². The diffusivity for the mixture is 1.87×10^{-5} m²/s. Calculate the rate of diffusion of oxygen in kmol/s through each square meter of the two planes. (10)
- (ii) Discuss the mechanism of diffusion taking place in porous solids. (6)
17. (a) Explain the determination of mass transfer coefficient using: penetration theory and surface-renewal theory. (16)

Or

- (b) Describe the following analogies among mass, heat and momentum transfer operations: Reynolds analogy and Chilton-Colburn analogy. (16)
18. (a) (i) The air in a room at 26.7°C and a pressure of 101.325 kPa and contains water vapor with a partial pressure $P_A = 2.76$ kPa. Calculate the following: humidity (H), saturation humidity (H_S), percentage humidity (H_P) and percentage relative humidity (H_R). At 26.7°C the vapor pressure of water is $P_{AS} = 3.5$ kPa. (10)
- (ii) What is humidity chart? Mention the various regions in the chart for mixture of air and water vapor at 1 atm. (6)

Or

- (b) (i) Explain the construction and working principle of forced – draft cooling tower with a sketch. (12)
- (ii) Write short notes about dehumidifiers. (4)
19. (a) (i) A wet solid is to be dried from 80 to 5% moisture, wet basis. Compute the moisture to be evaporated, per 1000 kg of dried product. (6)

- (ii) For cross circulation drying in the constant rate period, derive an expression for the rate of drying. (10)

Or

- (b) With a neat sketch, explain the construction, working principle and uses of rotary dryer. Discuss the major types of rotary driers based on the mode of operation. (16)

20. (a) Describe the construction and working principle of: Swenson-Walker crystallizer and circulating-magma vacuum crystallizer. (16)

Or

- (b) (i) Enumerate the factors affecting rate of crystal growth and growth coefficients during crystallization. (10)

- (ii) State and explain the importance of ΔL law of crystal growth. (6)
