A **Reg. No. :** | | | | | | | | | | |

Question Paper Code: 55902

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2018

Fifth Semester

Chemical Engineering

15UCH502 - MASS TRANSFER - I

(Use of Humidity Chart is permitted)

(Regulation 2015)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The units of diffusivity are CO1- R

   (a) m/s (b) m^2/s (c) $kmol/(m^2s)$ (d) None of these

2. Diffusivity in concentrated solutions differs from that in dilute solutions, because of the changes in CO1-R

   (a) Viscosity with concentration. (b) Degree of ideality of the solution.

   (c) Both (a) and (b) (d) Neither (a) nor (b)

3. The individual mass transfer co-efficients ($moles/m^2$. s) for absorption of a solute from a gas mixture into a liquid solvent are, K_L = 4.5 and K_G = 1.5. The slope of the equilibrium line is 3. Which of the following resistance (s) is (are) controlling ? CO2- R

   (a) Liquid side (b) Gas side

   (c) Interfacial (d) Both liquid and gas side

4. Pick out the wrong statement pertaining to the analogy between equations of heat and mass transfer operations. CO2- R

   (a) Sherwood number in mass transfer is analogous to Nusselt number in heat transfer.

   (b) Prandtl number in heat transfer is analogous to Schmidt number in mass transfer.

   (c) Reynolds number in mass transfer is analogous to Grashoff number in heat transfer.

   (d) Reynolds number remains the same in both heat and mass transfer.

5. The percentage humidity is less than the relative humidity only at _____ percent humidity. CO3- R

(a) Zero (b) Hundred

(c) Both zero and hundred (d) None of these

6. The dew point of an unsaturated gas-vapor mixture does not depend upon the _____ of the mixture. CO3- R

(a) Composition (b) Temperature

(c) Total pressure (d) All (a), (b) and (c)

7. Occurrence of 'case hardening' during drying of a high moisture solid cake _____ the drying rate. CO4- R

(a) Increases (b) Decreases

(c) Does not affect (d) Exponentially increases

8. Milk is dried usually in a _____ dryer. CO4- R

(a) Freeze (b) Spray (c) Tray (d) Rotary

9. Swenson-Walker crystalliser is a _____ unit CO5- R

(a) Continuous (b) Batch

(c) Semi-batch (d) Cooling cum evaporation

10. The caking of crystals can be prevented by CO5- R

(a) Maintaining high critical humidity (b) Maintaining low critical humidity

(c) Coating the product with inert material (d) Both (a) and (c)

PART – B (5 x 2= 10Marks)

11. Define molar flux. Provide its units in SI system. CO1- R

12. Distinguish molecular and eddy diffusion. CO2- R

13. State Lewis relationship. CO3- R

14. Suggest a suitable drier for drying milk powder and ceramics. CO4- R

15. List out the factors influencing nucleation. CO5- R

PART – C (5 x 16= 80Marks)

16. (a) Derive flux equation for steady state diffusion of an ideal gas A through a stagnant gas B. CO1- Ana (16)

Or

(b) An ethanol (A) water (B) solution in the form of a stagnant gas film 2.5mm thick at 30^0C is in contact with each other at one surface. The concentrations of ethanol on both the ends are 15.0 wt% and 3.0 wt% respectively and the corresponding densities are 963 kg/m^3 and 981 kg/m^3 respectively. The diffusivity of ethanol is 0.725 x 10^{-9} m^2/s. Calculate the flux assuming steady state operation and concentration of ethanol in the middle of water film. CO1- App (16)

17. (a) Discuss in detail on mass transfer theories stating their assumptions and limitations. CO2- U (16)

Or

(b) (i) Differentiate between differential and stage wise contact operations. CO2- Ana (8)

(ii) Derive the relationship between individual and overall mass transfer coefficient for a gas liquid system, when is the system said to be gas film or liquid film controlled? CO2- Ana (8)

18. (a) Air is entering into a cooling tower with characteristics as follows: CO3- App (16)
Dry bulb temperature=25^{o}C
We bulb temperature=22^{o}C
Pressure=1 atm
Average molecular weight of air=28.84
Find
(i) Humidity
(ii) % Humidity
(iii) % relative Humidity
(iv) Dew point
(v) Enthalpy

Or

(b) Elaborate the steps involved in designing of a counter current packed cooling tower. CO3- Ana (16)

19. (a) Explain the working principle of rotary drier with a neat sketch. Mention any four applications. CO4-U (16)

Or

(b) (i) Sketch the drying rate curve and explain its features. CO4-U (8)

(ii) A slab with a wet weight of 5 kg originally contains 50% moisture (wet basis).The slab is 600 x 900 x 75 mm thick. The equilibrium moisture content is 5% of total weight when in contact with air at 20^0C and 20% humidity. The drying rate is given below for contact of air of the above quality at a definite velocity. Drying is from one face. How long will it take to dry the slab to 15% moisture content (wet basis). CO4- App (8)

Wet slab weight,kg	9.1	7.2	5.3	4.2	3.3	2.9	2.7
Drying rate, kg/m^2hr	4.9	4.9	4.4	3.9	3.4	2.0	1.0

20. (a) A hot solution containing 2000 kg of $MgSO_4$ and water at 300K with a concentration of 30 wt % $MgSO_4$ is cooled to 293K and $MgSO_4.7H_2O$ crystals are removed. The solubility at 293K is 35 kg $MgSO_4$ per 100 kg water. The average heat capacity of the feed solution is 2.93 kJ/kgK. Heat of solution at 293K is -13.31kJ/kmol $MgSO_4.7H_2O$.Calculate the yield of crystals and make a heat balance assuming no water is lost by evaporation. CO5- Ana (16)

Or

(b) How crystallizers are classified? Explain the operation of any one continuous crystallizer focus to an industrial application. CO5-U (16)