P P SAVANI UNIVERSITY

Fourth Semester of B. Tech. Examination

May 2022

SECH2080 MASSS TRANSFER OPERATION I

27.05.2022, Friday **Time: 10:30 a.m. To 1:00 p.m.** **Maximum Marks: 60**

Instructions:

1. The question paper comprises two sections.
2. Section I and II must be attempted in same answer sheet.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1 Answer any five of the Following: (MCQ/Short Question/Fill in the Blanks) **[05]**

(i) Fick's law is given by the formula

a) $N_b = - D_b c \, dC_b/d x$ b) $N_b = - 2 D_b c \, dC_b/d x$

c) $N_b = - 3 D_b c \, dC_b/d x$ d) $N_b = - 4 D_b c \, dC_b/d x$

(ii) Consider loss of ethanol vapor by diffusion from a half-filled open test tube. At what point in the diffusion path will the contribution of the bulk flow term to the molar flux be maximum?

a) At the liquid-gas interface b) In the bulk liquid

c) In the bulk gas d) None of the mentioned

(iii) Prandtl number is given by

a) V/α b) $2 V/\alpha$ c) $3 V/\alpha$ d) $4 V/\alpha$

(iv) Sherwood number is given by

a) 3/2 h m L/D b) ½ h m L/D c) 3 h m L/D d) h m L/D

(v) Sherwood number is a function of

a) Lewis number and Reynolds number

b) Prandtl number and Lewis number

c) Reynolds number and Schmidt number

d) Schmidt number and Lewis number

(vi) The real driving force of the mass transfer is

a) Chemical potential b) Physical potential c) Pressure gradient d) Concentration gradient

(vii) In which of the following conditions mass transfer will occur spontaneously? C and z is concentration and distance respectively.

a) $dC/dz>0$ b) $dC/dz<0$ c) $dC/dz=0$ d) None of the Mentioned

Q - 2 (a) Name methods of conducting mass transfer operations. and Define molecular diffusion **[05]**

Q - 2 (b) Starting from Fick's first law of diffusion for unidirectional binary gas phase, derive the equation to calculate N_A for steady state molecular diffusion of A through non-diffusing B **[05]**

OR

Q - 2 (a) State the unit of diffusivity and State the unit of diffusivity **[05]**

Q - 2 (b) State and discuss the types of diffusion with suitable example. **[05]**

Q - 3 (a) Define J factors for heat and mass transfer. State its applications and limitations **[05]**

Q - 3 (b) Describe a method to estimate the diffusivity of a volatile solvent into air. **[05]**

OR

Q - 3 (a) The molar composition of a gas mixture at 273 K and $1.5 * 10^5$ Pa is: **[05]**

O_2 7%, CO 10%, CO_2 15%, N_2 68%

Determine

a) the composition in weight percent

b) average molecular weight of the gas mixture

c) density of gas mixture
d) partial pressure of O_2

Q - 3 (b) Explain Ficks First law and What is eddy diffusion? **[05]**

Q - 4 Attempt any one/two. **[05]**

(i) Explain Reynolds Analogy and Chilton – Colburn Analogy

(ii) A stream of air at 100 kPa pressure and 300 K is flowing on the top surface of a thin flat sheet of solid naphthalene of length 0.2 m with a velocity of 20 m/sec. The other data are:
Mass diffusivity of naphthalene vapor in air = $6 * 10^{-6}$ m^2 /sec
Kinematic viscosity of air = $1.5 * 10^{-5}$ m^2 .sec
Concentration of naphthalene at the air-solid naphthalene interface = $1 * 10^{-5}$ $kmol/m^3$
Calculate
(a) the overage mass transfer coefficient over the flat plate
(b) the rate of loss of naphthalene from the surface per unit width
Note: For heat transfer over a flat plate, convective heat transfer coefficient for laminar flow can be calculated by the equation you may use analogy between mass and heat transfer.

SECTION – II

Q - 1 Answer any five of the Following: (MCQ/Short Question/Fill in the Blanks) **[05]**

(i) Tray driers are direct driers.
a) True b) False

(ii) For estimating the drier size it is necessary to know _____
a) Time of drying b) Heat of drying c) Speed of drying d) All of the mentioned

(iii) In humidification the gas is _____ in the liquid for the mass transfer to take part.
a) Soluble b) Insoluble c) Partially soluble d) Inert

(iv) Mass absolute humidity is
a) Absolute humidity b) Grosvenor humidity
c) Relative humidity d) All of the mentioned

(v) The humidity is represented in
a) Humidity chart b) Psychometric chart
c) Psychometric chart or humidity chart d) All of the mentioned

(vi) De-humidification is done in
a) Adiabatic temperature b) Adiabatic saturated temperature
c) Adiabatic unsaturated temperature d) None of the mentioned

(vii) Partial pressure equals vapour pressure if it is_____
a) Saturated b) Unsaturated c) Isothermal d) None of the mentioned

Q - 2 (a) Explain The Psychrometric chart construction and its use **[05]**

Q - 2 (b) Explain Natural Draft Towers **[05]**

OR

Q - 2 (a) Explain Fluidized bed Dryer in detail with appropriate diagrams **[05]**

Q - 2 (b) Classify cooling tower on their design **[05]**

Q - 3 (a) Discuss the concept with principle of crystallization **[05]**

Q - 3 (b) Explain construction and working of Swenson-Walker Crystallizer with the help of a neat sketch **[05]**

OR

Q - 3 (a) Define nucleation and growth of Crystal **[05]**

Q - 3 (b) Discuss agitated batch crystallizer with neat sketch **[05]**

Q - 4 Attempt any one/two. **[05]**

(i) Explain construction and working of Swenson-Walker Crystallizer with the help of a neat sketch.

(ii) Explain analogies between Mass and Heat transfer operations

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