Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–II EXAMINATION – SUMMER 2015

Subject Code: 2723001 **Date: 30/05/2015**

Subject Name: Advanced Mass Transfer

Time: 02:30 PM to 05:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Figures to the right indicate full marks.**
3. **Make suitable assumptions wherever necessary**

Q.1 State the detail algorithm for calculation of no. of stages in multi-component distillation by Thiele Geddes method along with the list of basic variables to be specified as input data. 14

Q.2 a) Discuss in brief about pressure swing distillation and short path distillation. 07

b) State the various types of solid diffusion and explain any one of them in details. 07

OR

b) Write a short note on unsteady state diffusion from a slab with sealed edges. 07

Q.3 a) A 5% agar gel containing a uniform urea concentration of 5 g/100 cm^3 is molded in the form of a 3 cm cube. One face of the cube is exposed to a running supply of fresh water, into which the urea diffuses. The other faces are protected by the mold. The temperature is 5^oC. At the end of 68 h, the average urea concentration in the gel has fallen to 3 g/100 cm^3. The resistance to diffusion may be considered as residing wholly within the gel. i) Calculate the diffusivity of the urea in the gel, ii) How long would it have taken for the average concentration to fall to 1 g/100 cm^3? iii) Repeat part (ii) for the case where two opposite faces of the cube is exposed. Data given 07

E	$D\theta/a^2$
0.2	0.568
0.4	0.291
0.6	0.128
0.8	0.04

b) State the criteria of selection for packed tower, venturi scrubber and spray towers 07

OR

Q.3 Design the horizontal and vertical spray chamber for the following duty 14

Volumetric flow rate of boiler flue gas = 24000 Sm^3/h, Pressure of gas = 150 mm WC (gauge), temperature = 90^oC, SO_2 concentration in flue gas inlet 4000×10^{-6} kmol/kmol gas, desired concentration at the outlet = 200×10^{-6} kmol/kmol gas, solvent 1% lime solution. Max. permissible gas velocity in vertical tower = 2.3 m/s and horizontal tower = 7 m/s. Calculate i) tower diameter ii) number of gas phase transfer unit iii) circulation rate of lime solution iv) height of tower v) pressure drop across the tower.

Typical data for existing vertical spray tower of one of the large scale industry is given below for information.

Volumetric flow rate of boiler flue gas = 12 000 Sm^3/h, temperature = 90^oC, SO_2 concentration for inlet flue gas 2500 to 4000 ppm, desired concentration at the outlet less than 400 ppm, solvent 1% lime solution circulation rate = 30 m^3/h, tower diameter = 1.7 m, height of spray zone = 3.5 m, pressure drop = 100 mm WC. Assume overall volumetric M.T. coefficient for horizontal tower = 0.1 $kmol/m^3.s$. Use the following equation to calculate pressure drop. $\Delta P = 100 \times G^{1.84} \times d^{-4.84} \times L$

Q.4 a) The irreversible reaction $A_{(g)} + B_{(s)} \rightarrow R_{(g)}$, first order reaction with respect to A takes place on flat solid surface as shown in Fig.1. Develop the overall rate expression for this gas-solid reaction where dilute A diffuses through a stagnant gas film on to a plain solid surface B. On the surface, A reacts with B to give gaseous R, which diffuses back into main gas stream. 07

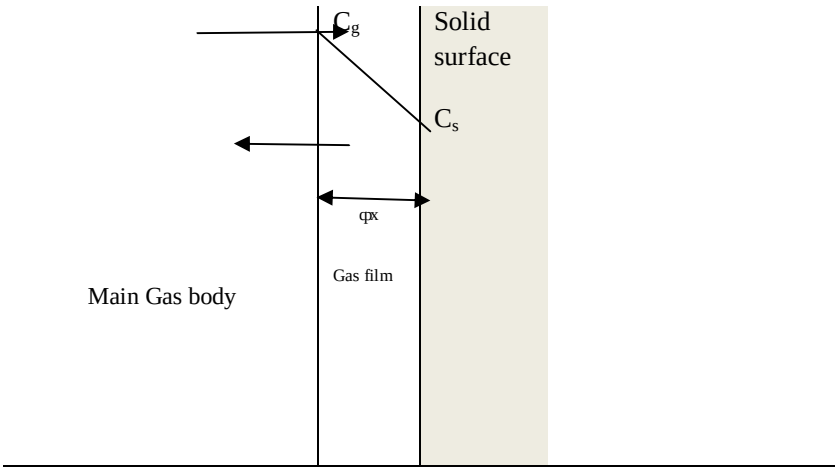

Fig.1

b) Derive the rate equation for a second order fast reaction $A_{(g)} + bB_{(l)} \rightarrow R_{(l)}$ for Low C_B and high C_B 07

OR

Q.4 Discuss about stream variables with suitable argument along with the degree of freedom proposed by Kwauk. Determine the degree of freedom with the help of design variables and design equations for i) adiabatic equilibrium stage, ii) equilibrium stage with heat addition, feed stream and side stream, iii) Condenser and boiler 14

Q.5 a) Discuss the advantages and disadvantages of membrane processes. 07

b) Explain the basic working principle of pervaporation and state its advantages 07

OR

Q.5 a) Compare the super heated steam drying with conventional hot air drying 07

b) Discuss the Concept, principle and working of super heated steam drying 07