BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: BE **SEMESTER: V**
BRANCH: CHEMICAL/CHEMICAL P&P **SESSION : MO/2019**

SUBJECT : CL5001 MASS TRANSFER OPERATIONS

TIME: 1.5 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 (a) Derive the relationship between molar flux (N_A) and molar diffusion flux (J_A) for a binary system. [2]

(b) The diffusivity of carbon dioxide in helium is reported to be 5.31×10^{-5} m^2/s at 1 std atm and at 32°C. Estimate the diffusivity at 10 std atm and at 70°C. [3]

Q2 Calculate the amount of oxygen (A) diffused in one hour under steady state conditions through a non-diffusing gas mixture of methane (B) and hydrogen (C) in the volume ratio of 2:1. The diffusivities in are estimated to be $D_{AB} = 1.86\times10^{-5}$ m^2/s and $D_{AC} = 6.99\times10^{-5}$ m^2/s. The total pressure is 1 bar, and temperature is 0°C. The partial pressure of oxygen at two planes 2 mm apart are respectively 13000 and 6500 Pa. [5]

Q3 (a) Define Raoult's law. Write the assumptions of an ideal solution [2]

(b) For a stripping column, the number of plates can be calculated using following equation: [3]

$$\frac{X_0 - X_{N_P}}{X_0 - \frac{Y_{N_P+1}}{m}} = \frac{\left(\frac{1}{A}\right)^{N_P+1} - \frac{1}{A}}{\left(\frac{1}{A}\right)^{N_P+1} - 1}$$

For the absorption factor A=1, derive the relationship for calculating number of plates. Notations are of their usual meaning as per the textbook.

Q4 Classify the packing types. What should be the properties of the packing materials? [5]

Q5 Derive the material balances for absorbers operating under cocurrent and countercurrent modes. Plot the material balance equations on equilibrium diagram for both the cases. (Note: Write proper and clearly defined notations) [5]

Q6 An air-ammonia mixture containing 5% ammonia by volume is absorbed in water in a packed column operated at 20°C and 1 atm pressure to recover 98% of ammonia. The inert gas flow rate in the column is 1200 kg/(m^2.h), and the water flow rate is 1.25 times of the minimum water required. If overall mass transfer coefficient $K_G a$ to be 128 kmol/(h m^3.atm). Calculate the height of the column. Equilibrium relation is given as y = 1.154 x, where, x and y are the liquid and gas phase mole fractions of ammonia, respectively. [5]

:::::: 19/09/2019 ::::::E