

INSTRUCTION: Answer ANY FOUR QUESTIONS

1. Discuss in detail the classification of mass transfer processes.
2. (a) State and discuss Fick's law of diffusion. What is the role of diffusion in mass transfer?  
(b) A binary mixture of Oxygen and Nitrogen with partial pressures in the ratio 0.21 and 0.79 is contained in a vessel at 300K. If the total pressure of the mixture is  $1 \times 10^5 \text{ N/m}^2$ , make calculations for the molar concentration, the mass density, the molar fraction, and the mass fraction of each of the species. Proceed to calculate the average molecular weight of the mixture.
3. (a) State and explain the phase rule. What is the usefulness of the knowledge of equilibria between phases?  
(b) Apply the phase rule to mass transfer operations of gas absorption, distillation and liquid extraction.
4. The vapour-liquid equilibrium data of a binary liquid mixture is given in Table 1. The operating lines of the rectifying and stripping sections are expressed by equations (1) and (2) respectively.

$$y = 0.69x + 0.3 \quad (1)$$

$$y = 3x - 0.2 \quad (2)$$

where: x and y are the mole fractions of the more volatile component of the mixture in the liquid and vapour phases respectively. Estimate the theoretical as well as the actual number of stages that will be required for the distillation process.

(Hint: Assume that the mole fraction of the low boiler is 0.07 and 0.99 in the bottom product and the overhead product respectively.)

Table 1. Vapour-liquid equilibrium data

x	0	0.04	0.1	0.2	0.4	0.6	0.8	1.0
y	0	0.2	0.4	0.58	0.73	0.83	0.93	1.0

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RESERVE

5. (a) With the aid of a well illustrated diagram of an equipment for continuous distillation, explain each of the following terms:

(a) Reboiler

(b) Low boiler

(c) Reflux

(d) Bottoms

(e) Rectifying section

(f) Stripping Section

(b) Explain the details of mass transfer between the two streams in the equipment above with the aid of a detailed schematic representation of a typical sieve plate in a fractionation column showing the downcomer and segmental weir.