[Time- 3 Hours] **[Total Marks: 80]**

Note:

1. Question No 1 is compulsory
2. Attempt any three questions from the remaining five questions
3. Assume suitable data wherever necessary
4. The figures to the right indicate full marks

Q. No. 1 Solve the following:

a. What do you mean by an azeotrope? Discuss the minimum boiling azeotrope. **[05]**

b. Compare Van der Waals adsorption with chemisorption **[05]**

c. 250 $kmole/hr$ of a liquid solution of benzene (more volatile) and toluene containing 20 $mole$ % of benzene is distilled to get the top product containing 95 $mole$ % of benzene and a bottom product containing 95 $mole$ % of toluene Find the flow rates of distillate and bottom product. **[05]**

d. Discuss various methods for making a solution supersaturated **[05]**

Q. No. 2

a. The feed to a fractionating column is a binary mixture of 40 % benzene and 60 % toluene and it is admitted at a rate of 14320 kg/hr. An overhead product containing 98 % benzene and a bottom product containing 98 % toluene is to be obtained. A reflux ratio of 3.5: 1 is to be used. The molar latent heat of vaporization of benzene is 8085.97 cal/gmole and that of toluene is 9090.91 cal/gmole. Calculate the flow rates of overhead and bottom products in kmole/hr. The boiling points of benzene and toluene at 1 atm are 80.09^{O}Cand 110.6^{O}C respectively. Also, find the ideal number of stages. The specific heats of benzene and toluene are 82.44 $J/(gmole)(K)$ and 116.1 $J/(gmole)(K)$ respectively. The feed temperature is 295 K. Assume relative volatility to be 2.51 **[15]**

b. Discuss the selection of solvent for liquid-liquid extraction. **[05]**

Q. No. 3

a. Acetic acid [C] can be separated from water [A] by using benzene [B] as a liquid-liquid extraction solvent. The distribution coefficient for this system is 1.35, independent of composition at 25 ^{O}C and 101 KPa, the process conditions. Water and benzene may be assumed to be completely immiscible. 10000 kg/hr of a 20 wt % solution of C in water is to be extracted with 14000 kg/hr of B. What per cent extraction is achieved in-

i. One single stage

ii. In two cross-flow stages with 7000 kg/hr of solvent used in each stage **[12]**

a. Discuss the various adsorption isotherms. **[08]**

Q. No. 4

a. 300 kg/hr of halibut liver is to be extracted in a counter-current cascade with ether to recover oil. The ether which has been partially purified contains 1.5 % oil. The fresh liver contains 22 % oil and is to be extracted to a composition of 1 % oil [on a solvent-free basis]. 300 kg of a solvent is to be used

i. What % of oil entering the liver is recovered in the extract?

ii. How many equilibrium stages are required?

iii. Calculate the mass and direction of the total and component net flow

The given data is- **[20]**

Kg oil/kg solution	0	0.1	0.2	0.3	0.4	0.5	0.6
Kg solution/kg exhausted liver	0.288	0.368	0.44	0.51	0.60	0.71	0.87

Q. No. 5

a. Explain the break-through curve for unsteady state fixed bed adsorption. **[10]**

b. A salt solution weighing $12000\ kg$ with 30 % Na_2CO_3 is cooled to $293\ K$. The salt crystallizes as $Na_2CO_3.10H_2O$. Find the yield of crystals if there is loss of water by evaporation is 8 %. The solubility of Na_2CO_3 at $293\ K$ is $21.5\ kg$ of Na_2CO_3 in $100\ kg$ of water **[10]**

Q. No.6 Write short notes on the following (Any four)- **[20]**

a. Azeotropic distillation
b. Applications of adsorption
c. Ultrafiltration
d. Ballman extractor
e. Mier's supersaturation theory
