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CM-6002-CBGS

B.E. VI Semester

Examination, June 2020

Choice Based Grading System (CBGS)

Mass Transfer - II

Time : Three Hours

Maximum Marks : 70

Note: i) Attempt any five questions.

ii) All questions carry equal marks.

1. a) Discuss break through curves in adsorption.

b) A solution of washed, raw cane sugar, 48% sucrose by weight, is colored by the presence of small quantities of impurities. It is to be decolorized at 80°C by treatment with an adsorptive carbon in a contact filtration plant. The data for an equilibrium adsorption isotherm were obtained by adding various amounts of the carbon to separate batches of the original solution and observing the equilibrium color reached in each case.

The data, with the quantity of carbon expressed on the basis of the sugar content of the solution, are as follows:

kg carbon/kg dry sugar :	0	0.005	0.01	0.015	0.02	0.03
Color removed, % :	0	47	70	83	90	95

The original solution has a color concentration of 20, measured on an arbitrary scale and it is desired to reduce the color to 2.5% of its original value.

i) Calculate the necessary dosage of fresh carbon, per 1000 kg. of solution for a single-stage process.

ii) Calculate the necessary carbon dosage per 1000 kg. of solution for a two-stage crosscurrent treatment, using the minimum total amount of fresh carbon.

iii) Calculate the necessary carbon dosage per 1000 kg. of solution for a two-stage countercurrent treatment.

2. a) Discuss the concepts of humidification and dehumidification with its industrial significance and utility.

b) A continuous dryer is being designed to handle 10 tons/day of wet feed containing 20% water and to produce product containing 5% water. Air is fed into the dryer at 70°F and 40% Relative Humidity will be preheated to 250°F before entering and is to be exhausted at 65% Relative Humidity. Assuming adiabatic drying, calculate the input air required in ft^3/min.

3. a) Discuss the drying rate curve with detail explanation.

b) A batch of solid is dried from 28% to 6% moisture, wet basis. The initial weight of the solid is 380 kg and the drying surface is 0.15 m^2/40 kg dry weight. The critical moisture content is 28% dry basis and the constant drying rate is 0.32 kg/hr.m^2. For the falling rate period, the following data are available.

Moisture content, % dry basis	25	21.9	19.0	16.0	13.6	11.0	8.2	7.5	6.4
Rate of Drying, kg/hr.m^2	0.3	0.27	0.24	0.21	0.18	0.15	0.07	0.044	0.025

Calculate the time of drying.

4. a) Discuss the selection criteria of solvent used in leaching.

b) It is desired to extract the oil from halibut livers by continuous counter-current extraction with ethyl ether. The quantity of solution retained by the granulated livers is given in the table:

kg oil/kg solution	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.65	0.7	0.72
kg solution/ kg oil-free liver	0.205	0.242	0.286	0.339	0.405	0.489	0.6	0.672	0.765	0.81

The halibut livers contain 0.257 mass fraction oil. If 95% of the oil is to be extracted and the strong solution obtained from the system is to contain 0.7 mass fraction oil. determine:

i) The quantity and the composition of discharged solids.

ii) Kilogram of oil-free ether required for 1000 kg charge of fresh livers.

iii) The number of ideal stage required.

5. a) Do you consider crystallization as a mass transfer operation? Why?

b) 2000 kg/hour of $FeSO_4.7H_2O$ crystals are to be produced in a Swenson-Walker crystallizer by cooling a saturated solution from 50°C to 18°C. Cooling water enters the jacket at 15°C and leaves at 20°C. The overall heat transfer co-efficient has been estimated to be 180 kcal/hr.m^2 °C. There are 3 m^2 of cooling surface per meter length.

i) Estimate the cooling water requirement in kg/hr.

ii) Determine the number of crystallizer sections if each section is 3.5 meter long.

Data: Saturated solutions of $FeSO_4$ contains 140 parts and 74 parts of $FeSO_4.7H_2O$ per 100 parts of excess water at 50°C and 18°C respectively. The specific heat of solution is 0.70 15.8 kcal/kg.°C and the heat of crystallization is 75.8 kcal/kg.

6. A 2500 kg of pyridine-water solution, 50% pyridine, is to be extracted with chlorobenzene three times and each time 2200 kg of solvent is to be used. Determine the concentration of pyridine in the final raffinate.
   Equilibrium tie-line data for the system water-chlorobenzene-pyridine at 25°C are given below:

Pyridine	Chlorobenzene	Water	Pyridine	Chlorobenzene	Water
0	99.95	0.05	0	0.08	99.92
11.05	88.28	0.67	5.02	0.16	94.82
18.95	79.90	1.15	11.05	0.24	88.71
24.10	74.28	1.62	18.90	0,38	80.72
28.60	69.15	2.25	25.50	0.58	73.92
31.55	65.58	2.87	36.10	1.85	62.05
35.05	61.00	3.95	44.95	4.18	50.87
40.60	53.00	6.40	53.20	8.90	37.90
49.00	37.8	13.2	49.00	37.80	13.20

7. Write detailed notes on:
   a) Rotary Dryer
   b) Cross-flow induced draft cooling tower
   c) Tie lines

8. Write detailed notes on:
   a) Spray Column
   b) Super saturation in crystallization
   c) Adiabatic saturation temperature

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