Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. - SEMESTER – VI • EXAMINATION – WINTER 2012

Subject code: 161403 **Date: 04/01/2013**

Subject Name: Food Engineering Operations - II

Time: 02.30 pm - 05.00 pm **Total Marks: 70**

Instructions:

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

Q.1 **(a)** A continuous fractionating column is to be designed to separate 30,000 kg/h of a mixture of 40 percent benzene and 60 percent toluene into overhead product containing 97 percent benzene and bottom product containing 98 percent toluene. These percentages are by weight. A reflux ratio of 3.5 moles to 1 mole of product is to be used. The feed has boiling point of 95 ^{0}C at a pressure of 1 atm. **07**

(a) Calculate the moles of overhead product and bottom product per hour.

(b) Determine the number of ideal plates and the position of the feed plate if feed is liquid and at its boiling point.

Molecular Weight of benzene & toluene is 78 & 92 respectively.

The vapour liquid equilibrium data are given as follow.

Mole fraction of benzene in liquid, x	0.1	0.3	0.5	0.9	1.0
Mole fraction of benzene in vapour,y	0.217	0.517	0.714	0.957	1.0

(b) Develop the equation for operating line of rectifying section for binary mixture in distillation column with neat sketch. **04**

(c) Define Leaching, Extraction & Crystallization. **03**

Q.2 **(a)** Explain Super saturation and gives techniques for preparation of supersaturated solution. Write short note on vacuum crystallizer. **07**

(b) Fill in the blanks. **04**

1) In liquid-liquid extraction, layer of solvent & solute is known as _____.
2) Full form of CSD is _____ and it is important for____ of crystallizers.
3) In the formation of crystals two steps are required; they are _____ and _____.
4) _____ is used as solvent in supercritical extraction of decaffeination of coffee

OR

(b) Write the principle of clarification with neat sketch. **04**

(c) Write short note on mixer settler with neat sketch for extraction. **03**

OR

(c) Enlist the name of equipments/techniques used for leaching and extraction. **03**

Q.3 **(a)** A solution containing 10 g/L of a valuable protein and 1 g/L of a protein impurity is extracted in a stirred vessel using an organic solvent. Distribution coefficient for valuable proteins is 8 and for impurity is 0.5. The volumes of solution and solvent are 500 litre and 400 litre respectively. What are the final concentrations in the two phases? **05**

(b) What are the requirements of selection of filter media for industrial application? Give example of filter media. **05**

(c) What is filtration? Give classification of the filters. **04**

OR

Q.3 **(a)** 1000 kg of sodium carbonate solution containing 25 % Na_2CO_3 is subjected to evaporative cooling during which process 15 % of the water presents in the solution is evaporated. From the concentrated solution $Na_2CO_3.10H_2O$ crystallizes out. Calculate how much crystals would be produced if the solubility of $Na_2CO_3.10H_2O$ is 21.5 g per 100 g of water. **05**

Molecular weight of Na_2CO_3 = 106 g/gmole
Molecular weight of 10 H_2O = 180.2 g/gmole
Molecular weight of $Na_2CO_3.10H_2O$ = 286.2 g/gmole

(b) Write short note on centrifugal extractor. **05**

(c) Define Decimal Reduction Time (D-value) and show it graphically. The F value at 121.1 ^{0}C equivalent to 99.9999% inactivation of a strain of *C. botulinum* is 1.8 minutes. **04**

(i) Calculate the D_0 value of this organism.
(ii) Calculate F_0 based on the 12D concept using the D_0 value of *C. botulinum* and a most likely spore load in the product of 1000.

Q.4 **(a)** Define Z-value and F_0 and show them graphically. **04**

(b) What do you mean by Commercial Sterility? A manufacturer of canned French bean desires to reduce the sterilization by raising the French bean temperature to 128 ^{0}C. Previously, the cans of French bean had been processed at a French bean temperature of 121.1 ^{0}C. Assume F_0 = 2.1 min., and Z = 10 ^{0}C. Determine F_{128}. **04**

(c) Write a short note on the following **06**

(i) Flow Diversion Valve (FDV)
(ii) Timing Pump
(iii) Holding Tube

OR

Q.4 **(a)** Estimate the spoilage probability at the end of a 45-minute heating process at 118 ^{0}C when D_{118} = 3.5 minutes and the initial microbial population is 2 x 10^5 organisms per container. **03**

(b) What do you mean by Fouling of heat exchangers? Briefly explain the types of fouling deposits in heat exchanger used in milk pasteurizer and their effect on performance. **04**

(c) Explain briefly the process of homogenization and its mechanisms such as turbulence and cavitation. Calculate the rate of movement and the distance travelled by a fat globule in a centrifugal separator if; **07**

The diameter of fat particle = 6 μm
Radius of bowl = 12 cm
Rpm of bowl = 7000
Capacity of the separator = 3000 L/h
Volume of milk in the bowl = 3 L
Density of serum and fat are 1037 kg/m^3 and 920 kg/m^3 respectively.
Absolute viscosity = 2.12 centipoise

Q.5 **(a)** Mention two distinct purposes for the process of milk pasteurization. List out the advantages of Heat Exchangers over in-bottle processing in pasteurization. **03**

(b) Briefly explain the influence of freezing process on the thermal properties of the food products. **04**

(c) Fish is to be frozen in a flat pack, 2 cm thick, using a plate freezer. The plates are at −30 ^{0}C and the heat transfer coefficient between the blocks and the freezer plates can be assumed to be 80 W/(m^{2}K). **07**

The following data are available:

Freezing temperature = −2 ^{0}C

Latent heat of fusion = 280 kJ/kg

Density = 880 kg/m^3

Thermal conductivity = 1.5 W/(m.K)

Geometric Constant P and R are ½ and 1/8 repectively.

(i) Estimate the time to just freeze the pack if the fish is already at the freezing temperature.

(ii) If the fish is packed using 1 mm thick cardboard, of thermal conductivity 0.7 W/(m.K), estimate the freezing time taking into account the extra thermal resistance provided by the packaging.

OR

Q.5 **(a)** An ice cream mix is to be pasteurised at a rate of 3600 kg/h in a plate heat exchanger. The mix enters the regenerator section of the exchanger at 25^{0}C and leaves the heating section at 80^{0}C to enter a holding tube before returning to the regenerator and the cooling section. Hot water enters at 90^{0}C and flows counter-currently to the mix in the heating section at a rate of 1.5 kg/s. If 80% of the total heat required to raise the mix to 80^{0}C is supplied in the regenerator, calculate the number of plates needed in the regeneration and heating sections, respectively. **07**

Heat transfer surface per plate = 0.80 m^2

Overall heat transfer coefficient (regenerator) = 2500 W/(m^{2}K)

Overall heat transfer coefficient (heater) = 2700 W/(m^{2}K)

Mean heat capacity of ice cream mix = 4.0 kJ/(kg K)

Heat capacity of water = 4.18 kJ/(kg K)

(b) List out different types of food freezing systems. Describe briefly the fluidized bed IQF freezing system. Mention two most common refrigerants used for immersion freezing system. **07**

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