

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 °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 $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ crystallizes out. Calculate how much crystals would be produced if the solubility of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ is 21.5 g per 100 g of water. Molecular weight of $\text{Na}_2\text{CO}_3 = 106$ g/gmole
Molecular weight of $10 \text{H}_2\text{O} = 180.2$ g/gmole
Molecular weight of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} = 286.2$ g/gmole **05**
- (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°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°C . Previously, the cans of French bean had been processed at a French bean temperature of 121.1°C . Assume $F_0 = 2.1$ min., and $Z = 10^\circ\text{C}$. 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°C when $D_{118} = 3.5$ minutes and the initial microbial population is 2×10^5 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 = $6 \mu\text{m}$
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. **03**
List out the advantages of Heat Exchangers over in-bottle processing in pasteurization.
- (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°C and the heat transfer coefficient between the blocks and the freezer plates can be assumed to be $80\text{ W}/(\text{m}^2\text{K})$. **07**
The following data are available:
Freezing temperature = -2°C
Latent heat of fusion = 280 kJ/kg
Density = 880 kg/m^3
Thermal conductivity = $1.5\text{ W}/(\text{m.K})$
Geometric Constant P and R are $\frac{1}{2}$ and $\frac{1}{8}$ respectively.
(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 $0.7\text{ W}/(\text{m.K})$, 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°C and leaves the heating section at 80°C to enter a holding tube before returning to the regenerator and the cooling section. Hot water enters at 90°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°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) = $2500\text{ W}/(\text{m}^2\text{K})$
Overall heat transfer coefficient (heater) = $2700\text{ W}/(\text{m}^2\text{K})$
Mean heat capacity of ice cream mix = $4.0\text{ kJ}/(\text{kg K})$
Heat capacity of water = $4.18\text{ kJ}/(\text{kg K})$
- (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**
