

GUJARAT TECHNOLOGICAL UNIVERSITY**B E Sem-VI Examination May 2011****Subject code: 161403****Subject Name: Food Engineering Operations-II****Date: 19/05/2011****Time: 10.30 am – 01.00 pm****Total Marks: 70****Instructions:**

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

- Q.1**
- (a) Define sterilization and explain briefly the advantages of UHT processing. For a sterilized product, what are the advantages gained by a manufacturer, a retailer and a customer? **07**
 - (b) Define homogenization of milk. What are the factors that contribute to the enhanced stability of homogenized milk? **04**
 - (c) Determine the rising velocity of the fat globule of diameter $3\mu\text{m}$ at a radial position of 0.2 m in a centrifuge, rotating at a speed of 5000 rpm. The density of skim milk and fat is 1028 and 980 kg/m^3 , respectively and absolute viscosity is 1.42 centipoise. **03**
- Q.2**
- (a) Define Z-value and F-value and represent them graphically. The initial population of *C. botulinum* spores in a batch of cans is 10^3 per can. Estimate the number of surviving spores after a process for which $F_0 = 3$ minutes and $D_0 = 0.25$ minutes for *C. botulinum*. **07**
 - (b) Develop Rayleigh equation for simple batch distillation. **05**
- OR**
- (b) Define distribution coefficient for extraction. **05**
 Penicillin F is recovered from a dilute aqueous fermentation broth by extraction with amyl acetate using 6 volumes of solvent per 100 volumes of the aqueous phase. At pH = 3.2 the distribution coefficient k is 80.
 - (i) What fraction of the Penicillin would be recovered in a single ideal stage?
 - (ii) What would be the recovery with two stages extraction using fresh solvent in both stages?
 - (c) Define flooding and weeping for distillation. **02**
- OR**
- (c) Define Magma and Invariant Crystal **02**
- Q.3**
- (a) A solution of picric acid in benzene contains 30 g of picric acid per litre. Calculate quantity of water with which 10 litre of this solution must be shaken at 18°C in order to reduce picric acid concentration to 4 g per litre in benzene phase. Distribution Coefficient k is given as $y/x = C_R/C_E = 1.8248$ where C_R = concentration of picric acid in water (gmol/litre) and C_E = concentration of picric acid in benzene (gmol/litre) **06**
 - (b) Develop the equation for stripping section for distillation column for binary system with neat sketch. **04**
 - (c) What is nucleation? Give its classification with description. **04**

OR

- Q.3 (a)** A hot solution containing 5000 kg of Na_2CO_3 and water with a concentration of 25 wt % Na_2CO_3 is cooled to 293 K and crystals of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ are precipitated. At 293 K, the solubility is 21.5 kg anhydrous/100 kg of total water. Calculate the yield of crystal obtained if 5 % of the original water in the systems evaporates on cooling. **06**
- Molecular weight of $\text{Na}_2\text{CO}_3 = 106$
Molecular weight of $10\text{H}_2\text{O} = 180.2$
Molecular weight of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} = 286.2$
- (b)** Carbon disulphide is used to extract iodine from its saturated aqueous solution. The distribution of iodine between carbon disulphide and water at equilibrium may be expressed as $k = y/x = (\text{g iodine/L of carbon disulphide})/(\text{g iodine/L of water}) = 588.2$ **05**
- (i) Calculate the concentration of iodine in the aqueous phase when 1 litre of a saturated aqueous solution at 20 °C containing 0.3 gm of iodine per 1 litre of water is stirred with 50 ml of carbon disulphide.
- (ii) Repeat for two ideal extractions using 25 ml of solvent each time.
- (c)** Describe cyclone separator for centrifugal sedimentation process. **03**

- Q.4 (a)** A solution consisting of 30 percent MgSO_4 & 70 percent H_2O is cooled to 60 °F. During cooling 5 percent of the total water in the system evaporates. The solubility of MgSO_4 at 60 °F is 24.5 kg anhydrous MgSO_4 per 75.5 kg H_2O . How many kilograms of crystals of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ are obtained per 1000 kg of original mixture? **04**
- Molecular weight of $\text{MgSO}_4 = 120.4 \text{ g/gmol}$
Molecular weight of $\text{MgSO}_4 \cdot 7\text{H}_2\text{O} = 246.5 \text{ g/gmol}$
- (b)** What is the purpose of filter aid in filtration? Give example of it. Give application of ultra filtration? **05**
- (c)** Write short note on flash distillation. **05**

OR

- Q.4 (a)** What is distillation? Write uses of distillation in Food Processing Industries? **03**
- (b)** Raw whole milk at 7°C is to be pasteurized at 72°C in a plate heat exchanger at a rate of 5000 L/h and then cooled to 4.5°C. Each heat exchanger plate has an available area of 0.79 m². The overall heat transfer coefficients of regeneration section = 2700 W/(m²K). 75% of the heat exchange is required to take place in the regeneration section. Calculate the number of plates required in regeneration section. (Assume that the density and specific heat of milk are 1030 kg/m³ and 3.9 kJ/(kgK) respectively.) **05**
- (c)** Estimate the convective heat transfer coefficient in a food being frozen in an air-blast freezer. It took the product 20 minutes to freeze in the freezer. The product is in the shape of an infinite cylinder with a diameter of 2 cm. The properties of product are as follows: **06**
- Thermal conductivity of frozen material = 1.8 W/(m°C)
Density = 890 kg/m³ and the latent heat of fusion = 260 kJ/kg
Initial freezing point = -1.9°C
Initial temperature of product is = 25°C
The air temperature is = -35°C.
Geometric parameters P and R are ¼ and 1/16 respectively.

- Q.5** (a) What do you mean by fouling of heat exchanger? List out different mechanism of fouling deposit. What are the effects of fouling on the performance of a Plate Heat Exchanger (PHE)? Explain two methods of descaling of heat exchanger. **07**
- (b) Define Decimal Reduction Time (D- value) and represent it graphically. In an experiment, the thermal death time (TDT) values for a microorganism were obtained as 1.5 minutes and 8.5 minutes at 121.1 °C and 110 °C, respectively. Determine the Z-values (°C) of the microorganism. **04**
- (c) The F value at 121.1 °C equivalent to 99.9999% inactivation of a strain of *C. botulinum* is 3.6 minutes. **03**
- Calculate the D_0 value of this organism.
 - 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 100.

OR

- Q.5** (a) Write the advantages and disadvantages of effect of homogenization on physical structure of milk. **04**
- (b) Define bactofugation. Calculate the power (in kW) required to start up a centrifugal separator with the following data: **03**
- Density of bowl = 7850 kg/m³
 Revolution per second = 100
 Outer radius of disc = 0.25 m and inner radius of disc = 0.225 m
 Length where the mass is concentrated = 0.35 m
 Time to reach the running speed = 300 s
- (c) List out different types of food freezing systems. Describe briefly with diagram: **07**
- Plate freezing system
 - Immersion freezing system
