Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – SUMMER 2013

Subject Code: 161403 Date: 28-05-2013

Subject Name: Food Engineering Operations-II

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)** If a slab of meat is to be frozen between refrigerated plates with the plate temperature at -34°C, how long will it take to freeze if the slab is 10 cm thick and the meat is wrapped in cardboard 1 mm thick on either side of the slab? What would be the freezing time if the cardboard were not present? Assume that for the plate freezer, the surface heat-transfer coefficient is 600 $W/(m^2.K)$, the thermal conductivity of cardboard is 0.06 W/(m.K), the thermal conductivity of frozen meat is 1.6 W/(m.K), its latent heat is 256 kJ/kg and density 1090 kg/m^3. Assume also that meat freezes at -2°C. **07**

[Take the geometric parameters for infinite slab as $P = \frac{1}{2}$ and $Q = \frac{1}{8}$]

(b) Define F_0 value and represent it graphically. The initial concentration of a spoilage organism (D_0 = 1.0 min.) is 100 spores per can. Calculate the F_0 value needed to ensure a concentration after processing of 10^{-10} spores per can. **04**

(c) What do you mean by Fouling of a heat exchanger? What are effects of fouling on the performance of a Plate Heat Exchanger (PHE)? **03**

Q.2 **(a)** Write a short note on relative volatility. **07**

A feed of 50 mole% hexane and 50 mole% octane is fed into a pipe through a pressure reducing valve and then into a flash disengaging chamber. The vapor and liquid leaving the chamber are assumed to be in equilibrium. If the fraction of the feed converted to vapor is 0.6, find the composition of the top and the bottom product.

The following table gives the equilibrium data for this system:

Mole fractions of hexane in liquid, x	1	0.69	0.4	0.192	0.045	0
Mole fractions of hexane in vapor, y	1	0.932	0.78	0.538	0.1775	0

(b) 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 20^oC and leaves the heating section at 80^oC to enter a holding tube before returning to the regenerator and the cooling section. Hot water enters at 90^oC and flows counter-currently to the mix in the heating section at a rate of 2 kg/s. If 75% of the total heat required to raise the mix to 80^oC is supplied in the regenerator, calculate the number of plates needed in the regeneration and heating sections, respectively. **07**

Heat transfer surface per plate = 0.60 m^2
Overall heat transfer coefficient (regenerator) = 2500 W/(m^2K)
Overall heat transfer coefficient (heater) = 2700 W/(m^2K)
Mean heat capacity of ice cream mix = 4.0 kJ/(kg K)
Heat capacity of water = 4.18 kJ/(kg K)

OR

(b) What do you mean by homogenization of milk? In an experiment conducted on a centrifugal separator following parameter were noted. **07**

The diameter of fat particle = 5 µm
Radius of bowl = 12 cm
Rpm of bowl = 5000
Capacity of the separator = 1500 L/h
Volume of milk in the bowl = 2 L
Density of serum and fat are 1035 kg/m^3 and 930 kg/m^3 respectively.
Absolute viscosity = 2.14 centipoises
Calculate the rate of movement and the distance travelled by a fat globule in the centrifugal separator.

Q.3 **(a)** What is the function and location of a timing pump in a HTST pasteurizer? With help of labeled diagram, describe the construction, principle and working of a single stem flow diversion device (FDD) used in a HTST pasteurizer clearly showing forward flow and divert flow. **07**

(b) What do you mean by Commercial Sterility? D_0 value of a bacterium is determined by using two thin walled glass capillary tubes filled with same bacterial suspension in distilled water. The sealed capillaries are dipped in an oil bath maintained at 121^oC and kept for 50 s and 130 s, respectively. These capillaries are cooled immediately in ice water. Number of survivals remained in the respective tubes are 2000 and 300. Calculate **05**

(i) D_0 value (in minutes) of the bacterium.
(ii) The processing time (in minutes) to kill 99.9999% of the bacteria in any food at 121^oC.

(c) Define Z - Value. Calculate the D value of an organism that shows 20 survivors from initial inoculums of 5×10^6 spores after 10 minutes at 121.1^0C. **02**

OR

Q.3 **(a)** With help of diagram, describe briefly different types of direct contact food freezing system. **07**

(b) Write a short note on bactofugation. **05**
Calculate the flow rate of milk through a centrifugal separator having 100 discs inclined at an angle of 45^o and rotating at 6000 rpm if
Limiting diameter of the fat globule = 2 µm;
R_0 = 15 cm and R_n = 7.5 cm;
Density difference between the medium and the fat globule = 107 kg/m^3;
Absolute viscosity = 1.04 cp;
and Correction factor = 0.6

(c) In an experiment, the thermal death time (TDT) values for a microorganism were obtained as 1.5 minutes and 10.5 minutes at 121.1 ^{0}C and 112 ^{0}C, respectively. Determine the z-values (^{0}C) of the microorganism. **02**

Q.4 **(a)** Write a short note on Mixer settlers for extraction. **04**

(b) What do you mean by lyophilisation? Write the basic steps involved in it. **03**

(c) Define distillation. Explain flash distillation and derive a material balance equation of flash distillation in terms of f. **07**

OR

Q.4 **(a)** Describe briefly the mechanism of homogenization such as turbulence and cavitation. How homogenization increases the density of fat globule? **04**

(b) A solution of picric acid in benzene contains 30 g of picric acid per liter. Calculate the quantity of water with which 1 liter of this solution must be shaken at 18°C in order to reduce the picric acid concentration to 4g/L in the benzene phase. Molecular weight of picric acid is 229 and the distribution co-efficient K is given as 0.548. **03**

(c) What is leaching? Write a short note on Bollman extractor. **07**

Q.5 **(a)** What is filtration? Write is short note on the types of filters. **07**

(b) Briefly explain the followings **07**
(i) Invariant crystals
(ii) Schiebel column

OR

Q.5 **(a)** Write short note on the followings **07**
(i) Centrifugal decanter
(ii) Scrapped surface crystallizer

(b) Write short note on the followings **07**
(i) Clarifying filters
(ii) Filter aids

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