

(6)

Ex/FTB/T/321/117/2013

9. A drum drier is being used to dry starch based breakfast food. The initial moisture content of the food is 75% (Wet basis). The drum surface temperature is 138°C and the food layer outer surface is 100°C. The estimated heat transfer coefficient from the drum surface to the drying food is 800 J/m<sup>2</sup>-s-°C. Assume that the thickness of the food on the drum is 0.3mm and the thermal conductivity of the food is 0.55 J/m-s-°C. The drum has a length of 1m and diameter of 1m (outside) and is rotating at 2 revolutions/minute. If the food occupies three-quarters of the circumference, estimate the moisture content of the film being scrapped off. Assume the critical moisture content of the food material is 14% on a dry basis and that conduction heat transfer is through the whole film thickness. Assume the density of food paste to be 1060 kg/m<sup>3</sup>. 20

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**BACHELOR OF TECHNOLOGY (FTBE) EXAMINATION, 2013**

(3rd Year, 2nd Semester)

**Food Process Engineering**

Time : Three hours.

Full Marks : 100

Use a separate Answer-Script for each part.

**PART - I (50 marks)**

Answer **q.no. 1** and any **two** from the rest.

1. Fill in the blanks : 1x10=20
- (a) ..... is the critical temperature zone in freezing of foods.
  - (b) Insulated vans have ..... thickness of PUF.
  - (c) Thawing curves are ..... than freezing curves.
  - (d) 'n' is known as ..... in GL method of calculation of freezing time.
  - (e)  $\delta =$  ..... in Tao solutions.
  - (f)  $\beta_1 =$  ..... in an Ede chart.
  - (g) ..... method is used to predict freezing time for frozen fishes.
  - (h) Microwave thawing has limited applicability due to .....
  - (i) Bulk freezing is achieved in ..... freezer.
  - (j) Food freezing is commonly by ..... contact freezing.

(Turn Over)

(2)

2. (a) Describe the freezers you would use to freeze (any **three**) 3x2=6
- (i) Cherries
  - (ii) Cod
  - (iii) Prawns
  - (iv) Diced carrots
- (b) Where does thawing find application in industries? Why is complete thawing not preferred for a food product undergoing processing? 2+2=4
- (c) Sweet cherries, approximately 1.5cm in diameter, are frozen in an IQF system with air at  $-30^{\circ}\text{C}$  and a surface heat transfer co-efficient of  $50\text{ W/m}^2\text{K}$ . If the initial temperature of the product is  $5^{\circ}\text{C}$ , how much time will be required to reduce its centre temperature to  $-15^{\circ}\text{C}$ ? Estimate the freezing time using the Celand-Earle approach. Take all relevant data from standard charts and tables.
- For spherical geometry :
- $$P = 0.1084 + 0.0924 N_{PK} + N_{Ste} (0.231 N_{PK} - 0.3114/N_{Bi} + 0.6739)$$
- $$R = 0.0784 + N_{Ste} (0.0386 N_{PK} - 0.1694)$$
3. (a) With diagrams, comparatively evaluate the two latest designs of fluidized bed freezing equipments used industrially. 4

(5)

7. (a) Write the mathematical expressions (model equation) which define die characteristic; metering zone characteristic and feed zone characteristic for an extruder.
- (b) How would you calculate LEI, SEI & VEI of extrudates?
- (c) How do rate of heat transfer relates mass transfer during surface heating of a tray of food material?
- (d) State how does air flow rate relate surface heat transfer coefficient in both parallel and perpendicular flow.
- (e) Mention the bed height range usually maintained in belt drying.
- (f) Why 'Bin drier' is used as 'finishing drier'?
- (g) Write some applications of drum drying. 6+4+3+2+1+2+2=20
8. (a) What do you mean by 'foam mat drying'?
- (b) Write the advantages of funnel drier.
- (c) With a schematic diagram show the operating principle of a cabinet drier.
- (d) Write the objectives of employing
- (i) distributor
  - (ii) Plenum chamber
  - (iii) free board in fluidized bed drier
- (e) Mention different types of atomizer used in spray drier and write the mechanism of action of ultrasonic atomizer.
- (f) How the process of spray drying is designed to cause little damage to food material during drying? 4+2+5+4+3+2=20

(Turn Over)

(4)

**PART - II** (50 marks)

Answer **q.no. 1** and any **two** from the rest.

5. Answer any **two** questions : 5x2=10
- (a) Write the principle of extrusion of food material with neat sketch.
  - (b) Write the advantages of limitations of different types of air flow pattern in a funnel drier.
  - (c) Write a short note on fluidized and drier.
6. (a) What are the advantages and disadvantages of extrusion processing over other conventional processing methods.
- (b) Make a comparison between single screw and twin screw extrusion system.
- (c) Mention the process variables associated with extrusion processing.
- (d) Extrudate materials are light and brittle (for expanded products)—Why?
- (e) If the feed material for an extrusion contains high amount of soyabean flour then what type of values are expected for BD, ER & WHC. Justify your answer.
- (f) Nutritional quality and digestibility of extrudate products are high—Explain. 3+3+3+3+5+3=20

(3)

- (b) A continuous plate-freezing system is being designed to freeze 0.5Kg cod fillet packages at a rate of 500 Kg/h. The package dimensions are 0.04m by 0.1m by 0.14m and it enters the freezer at 5°C. The plates for each station are 1m wide and will accommodate 8 packages of the indicated dimensions. The plates are maintained at a temperature of -30°C and the surface heat transfer coefficient is 28W/m<sup>2</sup>K. The package material has thickness of 8x10<sup>-4</sup>m and a thermal conductivity of 0.05W/mK. Compute the number of freezing stations (or compartments) required for freezing the product to -25°C by **Plank** and **Mott** procedures. Use standard tables and charts. Comment on discrepancies of results, if any. 16
4. (a) Diagrammatically describe the operation of a continuous LN freezer. What parameters influence its productivity? 6+2
- (b) What is refrigeration load? How are the following calculated for a cold storage?
- (i) Freezing load
  - (ii) Respiration load of fruits and vegetables stored in the cold storage. 2+4
- (c) Using Gurnie-Lurie chart, determine the time required for the centre of a package of meat of 5cm x 10cm x 30cm dimensions to reach 4.4°C. Consider the following data :  $t_a = 1.7^\circ\text{C}$ ,  $t_o = 26.7^\circ\text{C}$ ,  $h = 1.95 \text{ cal/h/cm}^2\text{C}$ ,  $C_p = 0.85$ ,  $K = 5.21 \text{ cal/hcm}^2\text{C}$ ,  $\rho = 1.04 \text{ g/cc}$ . 6

(Turn Over)