Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (FT)/SEM-6/FT-604/2011

2011
FOOD PROCESS & EQUIPMENT DESIGN

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

$10 \times 1 = 10$

i) Essentiality of Autoclave in food processing industry for

a) Pasteurization of milk

b) Sterilization of bottled or canned products

c) Processing of fish or meat

d) Steam generation.

ii) Autoclave like High pressure vessels are used for a pressure range of

a) $20N/mm^2$ to $300\ N/mm^2$.

b) $10\ N/mm^2$ to $15\ N/mm^2$.

c) $1000\ N/mm^2$ to $1500\ N/mm^2$.

d) $500\ N/mm^2$ to $1000\ N/mm^2$.

iii) Mango flakes can be prepared using a

a) Spray drier b) Drum drier

c) Tray drier d) Fluidized bed drier.

iv) Fluidized bed drier has particle density between

a) 1000kg/m^3 to 2000 Kg/m^3.

b) 2000kg/m^3 to 4000 kg/m^3.

c) 100kg/m^3 to 200 kg/m^3.

d) 10kg/m^3 to 20 kg/m^3.

v) In a single screw extruder minimum water content should be

a) 20% b) 30%

c) 40% d) 50%.

vi) A vacuum drum drier is used only when the product is

a) Heat sensitive b) Heat ejective

c) Heat non sensitive d) Heat absorption.

vii) Plate type freezer is essentially required for

a) Increasing shelf life for fruits and vegetables

b) Freeze drying

c) Keeping of fish fresh

d) All of these.

viii) Fluidized bed drier is best suited for drying of

a) Very fine powder

b) Material having large particle size

c) Smaller seeds

d) none of these.

ix) Single screw extruder can be classified according to the extent of shearing action on the food into

a) High shear b) Medium shear

c) Low shear d) All of these.

x) The speed of rotation of the shaft in a rotary drier should be maintained at

a) 330RPM b) 220RPM

c) 440RPM d) 550RPM.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

$3 \times 5 = 15$

2. Briefly explain the working principle of a pulping machine.

3. What is the difference between freezing and freeze drying ?

4. Write the operational equations of filteration. Also describe (in short) the types of filters.

5. Prove for a steam jacketed vessel time required to heat the food material (mass = m kg) from T_0^0 C to T^0 C by saturated steam (temperature T_s^0 C) is :-

   $t = mC_p/UA \ln [(T_s - T_0)/(T_s - T)]$, where, C_p = Specific heat of food, U = overall heat transfer coefficient, A = heat transfer area.

6. Write the design criteria of "stiffeners".

7. Write the design loads for pressure vessel.

8. Write a short note on freeze drier.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

9. a) Raw milk (Density = 1020 kg/m^3) is flowing through a homogenizer @ 1.5 liter/minute. Viscosity of milk is 0.001 Pa-sec and interfacial tension between milk and fat globules is 0.01 N/m. If diameter of passage through which milk flows is 58 mm and pressure drop across first stage homogenization valve is 2500 psi, calculate diameter of the homogenized fat globule. 8

   b) Briefly describe the working principle of a plate freezer. 7

10. a) Calculate the water activity of a food preserve containing 65% soluble solids, 2% insoluble solids, and the rest water. The soluble solids may be assumed to be 50% hexose sugars and 50% sucrose. 10

    b) What are different design parameters for designing a dryer ? 5

11. a) Draw a neat sketch of vacuum concentrator, labeling all parts. 9

    b) What are the advantages of continuous concentrator system ? 4

    c) What is a steam jacketed pan ? 2

12. a) Why do we need basket press in the filtration unit ? 3

    b) Briefly discuss the design aspect of basket press with a clean diagram. 9

    c) What is a solid Mixer ? 3

13. Raw milk at 8°C is to be pasteurized at 75°C in a plate heat exchanger at a rate of 5000 lt. h^{-1} and then cooled to 5°C. The hot water is supplied at 7500 lt h^{-1} at 85°C and chilled water has a temperature of 2°C. Each heat exchanger plate has an available area of 0.8 m^2. The overall heat transfer coefficients are calculated as 2890 W $m^{-2}k^{-1}$ in the heating section, 2750 W $m^{-2}k^{-1}$ in the cooling section and 2700W $m^{-2}k^{-1}$ in the regeneration section, 75% of the heat exchange is required to take place in the regeneration section.

    Calculate the number of plates required in each section.

    Given data :

    Density of milk is 1030 kg m^{-3} and density of water is 958 kg m^{-3} at 85°C and density of water 1000 kg m^{-3} at 2°C,

    The specific heat of water is constant at 4.2 $Kjkg^{-1}k^{-1}$ and the specific heat of milk is constant at 3.9 $kjkg^{-1}$ k.

    15

14. a) A drum drier has diameter of .7 m and length of .85 m. Feed enters at 100°C and gets dried at 150°C

Initial moisture content of feed = 80%

Final moisture content of feed = 20%

Feed density = 1020 kg/m^3

Overall heat transfer coefficient = 1200 W/m^2k

The doctor's blade removes the feed after every $^3/_4$ revolution of drum ($^1/_4$ kept empty)

The feed layer thickness of the drum surface = .6 mm

The latent heat of vaporization of the product

= 2.258 X 10^6 j/kg

Calculate the speed of the drum. 8

b) Draw a neat sketch of Twin Screw Extruders along with proper labeling. 7

15. A plate type conveyer drier is required to dry peas from an initial moisture content of 78% to 16% moisture, in a bed 10 cm deep which has a voidage of 0.4. Air at 85°C with a relative humidity of 10% is blown perpendicularly through the bed at 0.9 m/s. The drier belt measures 0.75 m wide and 4 m long.

Calculate the drying time and energy consumption in both the constrain and the falling rate periods.

Given data :

Moisture content of the peas is 9%,

the critical moisture content is 300%,

the average diameter of peas is 6mm,

the bulk density = 610 kg/m^3,

the latent heat of evaporation = 2300 Kj/Kg,

the saturated water vapour pressure at wet bulb temperature = 61.5 torr

and the mass transfer coefficient = 0.015 Kg/m^2 s. 15