(b) Explain decimal reduction time (D-Value). Also established the relation with sterilization (inactivation) time. 4

8. (a) Explain the freeze drying process with the help of neat sketch and also mention the advantages of freeze drying system. 6

(b) Cut and blanched pieces of cauliflower are dehydrated in a cabinet dryer. The initial moisture content of cauliflower was 80% (wb) and it is to be dried to 4% moisture content (wb). The critical moisture content is 25% (wb). Constant rate drying continues for 6 minutes, estimate the total drying time for the product. 4

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B. Tech Odd Semester Examination, February, 2023

Agricultural Engineering

(5th Semester)

Course No.: AECC-24
(Thermal Operation in Food Processing)

Full Marks: 50
Pass Marks: 25

Time: 2 hours

Note: 1. Attempt any five questions.
2. Begin each answer in a new page.
3. Answer parts of a question at a place.
4. Assume reasonable data wherever required.
5. The figures in the right margin indicate full marks for the question.
6. All the mathematical symbols and abbreviations have their usual meanings.

1. (a) Calculate the heat loss per m^2 of the surface area of an insulating wall composed of 30 mm thick fibre insulating board, where the inside temperature o 350 K and the outside temperature is 297.1 K. 2

(b) Derive the formula for conduction through a composite slab in series. 2

(c) An electric wire having a diameter of 1.5 mm and covered with a plastic insulation (thickness = 2.5 mm) is exposed to air at 300 K and h_o = 20 W/m^2K. The insulation has a k of 0.4 W/m-K. It is assumed that the wire surface temperature is constant at 400 K and is not affected by the covering.

i. Calculate the value of the critical radius

ii. Calculate the heat loss per m of wire length with no insulation

iii. Repeat (ii) for the insulation present   4

(d) Explain the concept of thermal contact resistance.   2

2. (a) Define heat exchanger. Briefly classify its types.   2

(b) A double pipe parallel flow H.E. use oil (C_p = 1.88 kJ/kg-K) at an initial temperature of 205 °C to heat water, flowing at 225 kg/hr from 16 °C to 44 °C. The oil flow rate is 270 kg/hr.

(a) What is the heat transfer area required for an overall heat transfer coefficient of 340 W/m^2-K.

(b) Determine the number of transfer unit (NTU).

(c) Calculate the effectiveness of the H.E.   5

(c) Describe the shell and tube heat exchanger in detail with appropriate diagram.   3

3. By using Newtonian cooling, derive an expression for calculating temperature of a body at any instant of time. Assume thermal resistance of body is zero.   10

4. What is Fourier's law of heat transfer? Derive the conduction heat transfer equation for a cylindrical pipe.   10

5. (a) Explain the drying kinetics of a food product.   2

(b) Write the practical significance of (a) vapour pressure, (b) water activity.   2

(c) Explain the working of a vertical tube evaporator with appropriate diagram.   2

(d) What is steam economy? How can you improve the steam economy for an evaporator?   2

(e) A fruit juice is to be concentrated in a single-effect forced recirculation evaporator from 5% to 50% soluble solids. The feed rate is 35 kg/min. Steam condensing at 121.1 °C is used for heating. The vapor temperature in the evaporator should be at 54.4 °C (assuming no boiling point rise). The specific heat of the juice is 2679 J/kg-K. The feed is at 51.7 °C. The heat transfer coefficient (U) is 2839 W/m^2-K. Calculate the heating surface area required. [h_g at 54.4 °C = 2.679 MJ/kg, h_f at 51.7 °C = 0.216 MJ/kg]   2

6. (a) Explain thermal death rate kinetics of micro-organism at constant temperature.   6

(b) A suspension containing 3×10^5 spores of organism A having a D-value of 1.5 min at 121.1 °C and 8×10^6 spores of organism B having a D-value of 0.8 min at 121.1 °C is heated at a uniform constant temperature of 121.1 °C. Calculate the heating time for this suspension at 121.1°C needed to obtain a probability of spoilage of 1/1000.   4

7. (a) Discuss the following

i. Sterilization

ii. Pasteurization

iii. Constant rate drying

iv. Unbound moisture   6