Ref. No.: Ex/FTBE/PC/B/T/321/2024

B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING THIRD YEAR SECOND SEMESTER EXAM 2024

Subject - FOOD PROCESS ENGINEERING **Time-3 hr** **full marks-100**

PART-I (50 MARKS)
(50 Marks for each Part)
Use separate answer script for each part

(Answer question no 1 and any two from the rest)

1. A machine operator was surprise to see that air temperature entering inside the spray dryer and mixing with liquid milk is more than 250^0 C but color detoreation of milk powder was not visible - explain. Discuss the working principle of Drum dryer. (4+6=10)
2. An insoluble wet granular material is dried in a pan 0.457 x 0.457 m and 25.4 mm deep. The material is 25.4 mm deep in the pan, and the sides and bottom can be considered to be insulated. Heat transfer is by convection from an air stream flowing parallel to the surface at a velocity of 6.1 m/s. the air is at 65.6^0 C and has a humidity of 0.010 kg H_2O/ kg dry air. Estimate the rate of drying for the constant rate period using. (20)
3. Derive an equation for calculation of drying time in Through-Circulation Drying in packed beds during constant rate period and falling rate period. What do you mean by geometry factor in bed? (16+4=20)
4. A continuous countercurrent dryer is being used to dry 450 kg dry solid/ h containing 0.05 kg total moisture/ kg dry solid to a value of 0.0025 total moisture/ kg dry solid. The granular solid enters at 26.7^0 C and is to be discharged at 62.8^0C. The dry solid has a heat capacity of 1.465 KJ/Kg.K, which is assumed constant. Heating air enters at 90^0 C, having a humidity of 0.010 kg H_2 O/ kg dry air, and is to leave at 37^0 C. Calculate the air flow rate and the outlet humidity, assuming no heat losses in the dryer. (20)

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B.E (FTBE) THIRD YEAR, SECOND SEMESTER EXAMINATION 2023

FOOD PROCESS ENGINEERING

PART- II (50 MARKS)

Q1. Define the following: **5 × 2 = 10**

a. Static angle of repose
b. Dimensionless freezing time
c. Holding time in a continuous sterilizer
d. Sphericity of food grains
e. Cryofreezing

Q2. Comparatively evaluate (any 4) the following with examples and diagrams wherever applicable: **4 × 5 = 20**

a. Spiral belt freezer vs. ICF-Spiral belt freezer combination
b. Dimensionless freezing time vs. Freezing time
c. Bulk density vs. True density
d. Batch FBF vs. Continuous FBF
e. Freezer for a crate of Apples vs. Custard apples

OR

Diagrammatically illustrate the following (any 2): **2 × 10 = 20**

a. Riedel chart and Mott chart for evaluation of ΔH.

b. The method you would you use to determine the moisture content of sacks of wheat flour placed in a palletized store (with inclined shelves) in a biscuit manufacturing factory and justify choice of your method over other available methods.

c. The most suitable freezer for mushrooms

Q3. Analyze the following (any 2): **2 × 10 = 20**

a. Using **Mott charts**, compute the time required to freeze a 0.1 m thick slab of vacuum packaged lean beef with 73% moisture content using a plate freezer. The product initial temperature is 5°C and the plates maintained at -40°C provide a heat transfer co-efficient of 50 W/m^2 K. Take remaining data from tables and appendices provided and

make assumptions wherever necessary, providing appropriate justification.

b. Sweet cherries, approximately 1.5 cm in diameter, are frozen in an IQF system with air at -30°C and a surface heat transfer co-efficient of 50 W/m^2K. If the initial temperature of the product is 5°C, how much time will be required to reduce its centre temperature to - 15°C? Estimate the freezing time using the **Cleland-Earle** approach. Take all relevant data from standard charts and tables.

For spherical geometry, consider:

$P = 0.1084 + 0.0924\ N_{Pk} + N_{Ste}\ (0.231\ N_{Pk} - 0.3114/N_{Bi} + 0.6739)$
$R = 0.0784 + N_{Ste}\ (0.0386\ N_{Pk} - 0.1694)$

c. An ice cream mix having μ = 60 cP and ρ = 950 kg/m^3 is being canned aseptically in a system which uses a 90 ft long-1 inch sanitary pipe as a holding tube. Flow rate of the mix is 4 gallon/min and its temperature at the exit of the holding tube is 140 °C. The concerned microorganism has D_0 = 1.8 min and its Z value is 22 °F. Take remaining data from standard tables.

1. Draw the **diagram** and neatly label all the sections and accessories.
2. Calculate S_i of the process **based on V_{max} and V_{avg}** and comment on the reliability of both data.