Ref. No. Ex/FTBE/PC/B/T/321/2022

B.E (FTBE) THIRD YEAR, SECOND SEMESTER EXAMINATION 2022

FOOD PROCESS ENGINEERING **TIME: 3 H** **FULL MARKS = 100**

PART- I (50 MARKS)

ANSWER Q1 AND ANY TWO FROM THE REST

USE SEPARATE ANSWER SCRIPT FOR EACH PART

Q1. Comparatively evaluate (any 5) the following with examples and diagrams wherever applicable: **5 × 4 = 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
f. Decimal reduction vs. Probability of survival

Q2. a. One kg of packaged IQF jumbo prawns (average size of 8 cm each) during transit had its temperature raised to 20 °C and then transported through POLARSTREAM maintained at -20 °C. Determine the time required to re-freeze the IQF prawns to - 4 °C considering:

i) Steady state approach **4**
ii) Unsteady state approach **4**

Take remaining data from tables and appendices and make justified assumptions wherever necessary. Analyze the freezing time obtained by i) and ii). **2**

b. Heat penetration curve is plotted for canned green beans processed in a retort at 230 °F. It took 6 min from the introduction of steam to the time the retort reached 230 °F. If the initial product temperature was 110 °F and steam was introduced into the retort for 35 min, determine the F_o value by Stumbo's procedure taking data from relevant tables and graphs (consider simple heating curve). Given: heating and cooling curves parameters- $f_h = f_c = 20$ min; $J_h = 1.4$ and $J_c = 1.6$. Consider Z value for a relevant test organism form tables. **5**

Q3. a. Figure 1 below shows an air sterilization system that supplies sterile air to a fermenter. Calculate the length of the holding tube necessary to sterilize the air. The most heat resistant organism that must be avoided here requires 60 min of heating at 151 °C for its lethality and has a Z value of 70 °C. The OD of the holding tube is 1 inch. Assume plug flow ($V_{max} = V_{avg}$). **5**

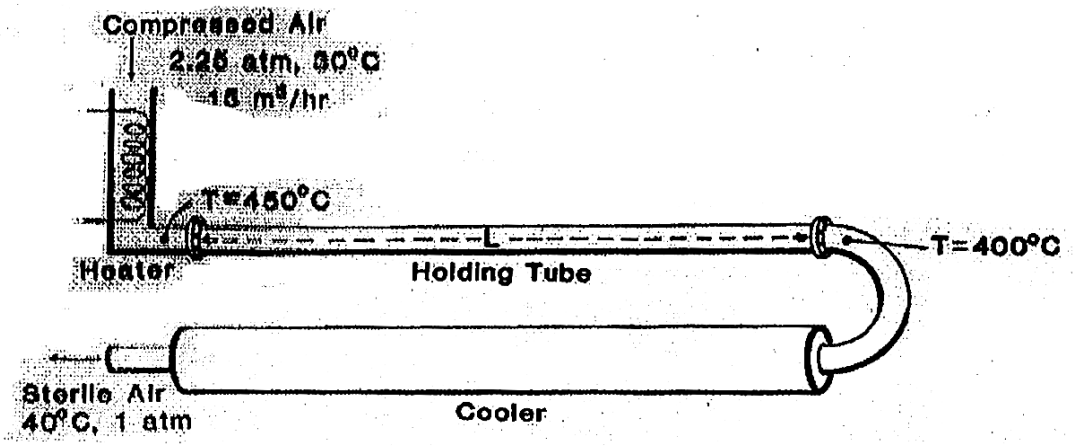

Figure 1

b. Compute the time required to freeze a 0.1 m thick slab of 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 and make assumptions wherever necessary, providing appropriate justification. **5**

c. Sacks of wheat flour are placed in a palletized store (with inclined shelves) in a biscuit manufacturing factory. It is important to estimate moisture content of the flour before they enter the mixing section floor. Diagrammatically illustrate the method you would you use to determine the moisture content of the flour and justify choice of your method over other available methods. **5**

Q4. a. Why is lag time of microbial growth not considered in calculating lethal value of a sterilization process? **2**

b. An ice cream mix having μ = 70 cP and ρ = 1000 kg/m^3 is being canned aseptically in a system which uses a 100 ft long-1 inch sanitary pipe as a holding tube. Flow rate of the mix is 5 gallons/min and its temperature at the exit of the holding tube is 142 °C. The concerned microorganism has D_0 = 1.8 min and its Z value is 22 °F. Taking remaining data from standard tables, calculate:

1. S.V of the process based on V_{max} **4**
2. S_i of the process based on V_{max} and V_{avg} and comment on the reliability of both data **5**

c. Diagrammatically explain the apparatus used for determination of terminal air velocities of food grains and seeds. In the diagram (inside the air column), indicate positions of *cumin seeds, pumpkin seeds and chick pea seeds* whose terminal air velocities you can measure using this apparatus with justification. **4**

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B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
THIRD YEAR
SECOND SEMESTER EXAM 2022
FOOD PROCESS ENGINEERING

FM=100 **Time: 3 hrs.**

PART-II

Answer Question No. 1 and any two from the following

1. Explain the rate of drying with a proper curve clearly denoting the rate periods. 10
2. An insoluble wet granular material is dried in a pan 0.55 x 0.55 m and is placed 25.5 mm deep in the pan. The metal bottom of the pan has a thickness of $z_M = 0.615$mm and having a thermal conductivity $k_M = 43.5$ W/m.K. The thermal conductivity of the solid can be assumed as $k_S = 0.87$ W/m.K. Heat transfer is taking place by means of convection by an air stream flowing parallel to the surface at a velocity of 7.5 m/s. The air is at 68.3 ^{0}C (155 ^{0}F) and has a humidity of 0.011 Kg H_2O/ Kg dry air. The top surface also receives direct radiation from steam heated pipes whose surface temperature is 95 ^{0}C (203 ^{0}F). The emissivity of the solid is, $\varepsilon = 0.92$. Estimate the rate of drying for the constant rate period using SI units. 20
3. A continuous counter-current dryer is being used to dry 445 kg dry solid/h containing 0.039 kg total moisture/kg dry solid to a value of 0.003 kg total moisture/kg dry solid. The granular solid enters at 27.1 ^{0}C and discharged at 64 ^{0}C. The dry solid has a heat capacity of 1.465 KJ/kg. K, which is assumed constant. Heat enters at 93.5 ^{0}C, having a humidity of 0.010 Kg H_2O/Kg dry air, and is to leave at 37 ^{0}C. Calculate the air flow rate and outlet humidity, assuming no heat losses in the dryer. 20
4. Derive an equation for a through circulation drying in packed Beds. Show how does rate depends on geometry factors in a bed. 20