Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2015

Subject Code: 2141407 **Date:**05/**06/2015**

Subject Name: Food Drying and Dehydration

Time: 10:30am-1.00pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary and clearly specify them.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Differentiate between drying and dehydration with examples. Classify the types of moisture present in foods and explain multilayer moisture content. Tomato puree having a total solids content of 19% is drum dried to yield tomato powder having moisture content of 5 % (wb). Calculate the moisture evaporated in kg per kg of tomato puree and express the moisture content of the powder in % dry basis. **07**

(b) A food stuff has the following composition at 35^0C : **07**

Constituents	Water	Carbohydrates	Proteins	Fats	Ash
%	9	75	14	0.7	1.3

Calculate the thermal conductivity of the food by using series model Also calculate its specific heat in SI units. Make necessary assumptions and specify them.

Q.2 **(a)** Discuss the selection criteria of fluidized bed dryers in detail. Also list the characteristics and properties of various types of dry powders. **07**

(b) Define water activity and state how it is measured. Explain temperature dependence of water activity. 250 gram of a vegetable curry mix containing 85 gram water has a water activity of 0.45. To enhance its shelf-life, 25 g glycerol is added to it. Calculate the resultant water activity. **07**

[Take $k_{glycerol}$ = 0.38, Mol. Wt. of glycerol = 92]

OR

(b) Explain the concept of water activity of foods and state how it is expressed mathematically. A dried food product of 7.5% moisture content is exposed to an environment maintained at 17 ^{0}C and 32% RH for six hours without registering any moisture change. The product was then transferred to another environment maintained at 17 ^{0}C and 60% RH where it gains 0.1kg moisture per kg product before reaching equilibrium state. Calculate **07**

(i) Water activity of the product in both the environments.

(ii)Moisture content of the product in % dry basis in both the environments.

Q.3 **(a)** Explain the following: **07**

(i) Free moisture

(ii) Falling rate drying

A block of Paneer having 75% moisture content is cut in cubes of 1.5 cm sizes and 20 such cubes are kept in a hot air cabinet dryer where drying proceeds by convection at constant rate till the moisture of the product reaches to 30%. Hot air temperature inlet to dryer is at 100 ^{0}C and its WBT is 60 ^{0}C. Assuming the size of the Paneer cubes doesn't change during the drying period, calculate

(i) Drying rate in kg/s

(ii) Amount of moisture removed in kg per kg of dry matter.

(iii) Time required in hours to dry the product up to 30% moisture content.

Additional data available are:

Initial bulk density of product = 650 kg/m^3

Convective heat transfer coefficient = 250 W/m^{2}K

Latent heat of vaporization of water at 60 ^{0}C = 2359 kJ/kg

(b) Explain thin drying of food products with a neat sketch. A spin flash dryer reduces the moisture content of 1 metric ton tomato paste from 70% to 6% in 10 hours using hot air at 90 ^{o}C. The ambient air and dryer exit temperatures are 26 ^{o}C and 75 ^{o}C respectively. The net heat input into the system for moisture removal in the dryer is 3.44 x 10^5 kJ. Calculate **07**

(i) Thermal and adiabatic efficiency of dryer.

(ii) Coefficient of performance of the dryer.

(iii) SPC of the dryer.

Inlet temperature of tomato paste = 26°C,

Sp. Heat of tomato paste = 3.8kJ/kgK

Latent heat of vaporization of water at 75 ^{0}C = 2322 kJ/kg]

OR

Q.3 **(a)** Drying of a certain food product is taking place such that its specific drying rate is directly proportional to the free moisture present in the food at any time. Specify this type of drying and prove that the drying period for such drying process can be given by $\Delta t_f = \frac{M_s X_c}{A R_c} \ln\left(\frac{X_c}{X}\right)$. Symbols have their usual meanings. A food having an initial moisture content of 82% (w.b) is first dried at a constant rate of 0.22 kg/minute/kg dry matter until it reaches its critical moisture content of 1.31 kg/kg dry matter. Calculate the total drying time in minutes if it is dried to a final moisture content of 6.5% (wb). **07**

(b) Explain deep bed drying of foods and mention its applications. A food product initially at 25°C and containing 89% moisture content is to be dried at 65°C to reduce its moisture content to 5%. Find out the quantity of heat energy required per unit initial weight of the material for drying under vacuum of 610 mm Hg. The latent heat of vaporization of water at 65°C at saturation pressure of 150 mm Hg abs is 2352 kJ/kg. The specific heat capacity of the food is 3.89 kJ/ kg °C and that of water is 4.186 kJ kg^{-1}°C^{-1}. Also calculate the amount of moisture extracted per unit energy consumed and express it in SI units.. **07**

Q.4 **(a)** Write meaningful notes on the following: **07**

i. COP of dryers

ii. Hybrid dryers and their types.

iii. Dryer design considerations.

	(b)	Give a typical checklist for selection of industrial dryers. Provide a classification of fluidized bed dryer based on different criteria.	**07**

OR

Q.4	**(a)**	Write explanatory notes on the following: (i) Adiabatic efficiency of dryer. (ii) Freeze Dryer and its applications. (iii) Energy efficient dryers.	**07**
	(b)	Differentiate between direct and indirect dryers with examples. Explain any one of them. Provide a professional checklist for the selection of industrial dryers for foods.	**07**
Q.5	**(a)**	Discuss the following: 1. Superheated steam drying and its feasibility. 2. TPA graph with all notations.	**07**
	(b)	Discuss the following: 1. Advantages of drying 2. Mechanism of moisture transport in different foods 3. Thermal properties of food	**07**

OR

Q.5	**(a)**	Describe the principles of conduction of heat in metal, non metal and food products. Explain parallel, series and Krisher models for thermal conductivity.	**07**
	(b)	Discuss the following in brief: 1. Shrinkage 2. Rehydration 3. Porosity 4. Nutritional changes during drying.	**07**

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