

**End Semester Examinations - 2015-16 Even Semester - May 2016**

**14FP2007 Unit Operations in Food Process Engineering - I**

**Set A**

**Time : 3 hrs**  
**Total Marks: 100**

1.                    A. Discuss the fluidization process in detail with suitable diagrams. (10 Marks)
- B. Calculate the amount of moisture evaporated from 200 kg of grain for drying it from an initial moisture content of 30 per cent wet basis to a final moisture content of 15 per cent wet basis. (10 Marks)

**OR**

2.                    A. Explain the principle and working of spray dryer with a neat sketch. (10 Marks)
- B. Determine the equilibrium moisture content of sorghum at RH = 10 % and t = 60°C using Henderson's equation where  $c = 6.12 \times 10^{-6}$  and  $n = 2.31$ . (10 Marks)
3.                    A. Draw the figure of tubular centrifuge and explain its working. Write the applications of centrifugation in food processing. (10 Marks)
- B. A. centrifuge is used to separate oil in a dispersion of fluid. The oil particles have a diameter of  $5.85 \times 10^{-5}$  m and its density is  $950 \text{ kg/m}^3$ . If the centrifuge rotates at 3000 rpm and the effective radius at which separation occurs is 4.3 cm. The specific gravity of the fluid is 0.9 and viscosity  $7.4 \times 10^{-4}$  Pa.s. Calculate the following : a) angular velocity and b) settling velocity of the particle in the centrifuge. (10 Marks)

**OR**

4.                    A. Explain the working of Plate and Frame filter press with neat diagram. (10 Marks)
- B. A tubular bowl centrifuge is used for separation of cream from milk which has the discharge diameters of 10 cm and 14 cm. If the density of milk is same as that of water and the cream density is equal to  $900 \text{ kg/m}^3$ , calculate the radius of the neutral zone. (5 Marks)
- C. A centrifuge bowl is spinning at a constant speed of 2000 rpm. Find the radius of the bowl when the g-factor is 455. (5 Marks)

5.                    A. Derive equations for material and energy balances in single effect evaporators. (10 Marks)

B. An aqueous food solution at a temperature of 18°C contains 6% solids by mass is to be concentrated to 24% solids in a single effect evaporator. The evaporator has a total heat transfer surface area of 30 m<sup>2</sup>, uses steam at 300 kPa and operates under a vacuum of 79.3 kPa. The overall heat transfer coefficient to be 2300 W/m<sup>2</sup> K, The various specific enthalpies and temperatures obtained from the steam tables are given below: Enthalpy of steam ( $h_g$ ) = 2725 kJ/kg ; Enthalpy of condensate ( $h_c$ ) = 561 kJ/kg ; Enthalpy of feed ( $h_f$ ) = 75.5 kJ/kg ; Enthalpy of vapour ( $h_v$ ) = 2613 kJ/kg ; Enthalpy of concentrated liquor ( $h_L$ ) = 260 kJ/kg. The temperature of steam ( $T_g$ ) at 300 kPa is 133.5°C and the temperature of the saturated liquid water ( $T_E$ ) at the evaporator at a pressure of 79.3 kPa is 62.2°C. Determine the mass flow rate of steam required and the evaporator economy. (10 Marks)

**OR**

6. A. Explain the different types of feeding methods in triple effect evaporators with suitable figures. (15 Marks)
- B. An evaporator is used to concentrate fruit juice. A feed of 20000 kg/day of juice containing 40% sugar is evaporated producing a 70% solution. a). Draw the process flow diagram and indicate the inputs and outputs. b). Calculate the weight of solution produced and amount of water evaporated. (5 Marks)

7. A. Describe the working of planetary mixer with a neat sketch and enumerate the applications of mixing in food processing. (10 Marks)
- B. During preparation of a dough, 1 kg of sugar was mixed with 99 kg of flour in a sigma mixer. Five samples were taken after 10 minutes of mixing and analysed for the percentage of sugar in the mixture. The results are : 0.72, 0.71, 0.68, 0.70, 0.72. Calculate the mixing index and the time required for perfect mixing. Consider  $\sigma_a = 0.01$  (10 Marks)

**OR**

8. A. Explain the working of kneader with a neat diagram. (10 Marks)
- B. A vitamin premix of 1 kg is added to 999 kg of a food supplement. After mixing for 5 minutes in a blender, three samples each of 100 grams were collected and analyzed for the vitamin premix. The results of each sample in grams are : 0.11, 0.09, 0.12. Find the standard deviation, mixing index and time required for proper mixing for a standard deviation of 0.01. (10 Marks)

9. **Compulsory**

- A. Explain the working of hammer mill with suitable diagram. (10 Marks)
- B. Sugar crystals were ground from an average diameter of 500  $\mu$ m to powder with an average diameter of 100  $\mu$ m. The net energy consumption was 0.5 kWh per ton. Calculate the net energy consumption for grinding the crystals to 50  $\mu$ m powder. Apply Rittinger's and Kick's laws. (10 Marks)

