

**B.Tech Odd Semester (CBCS) Exam.,
December—2017**

AGRICULTURAL ENGINEERING

(5th Semester)

Course No. : AECC-24

(Thermal Operations in Food Processing)

Full Marks : 50

Pass Marks : 15

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 margin indicate full marks for the questions.

1. (a) What is heat exchanger? Discuss different types of heat exchanger with neat sketch. 7
- (b) Define fouling factors. How do they affect the overall heat transfer coefficient? 3

2. 0.2 kg/sec of nitrobenzene is to be cooled from 400 K to 315 K by heating a stream of benzene from 305 K to 345 K. A tubular heat exchanger is available with a shell fitted with 165 tubes (OD = 19 mm and ID = 15 mm) each 5 m long. What value of scale resistance on the outer surface of the inner tube could be allowed if these units were used? The benzene side heat transfer coefficient h_i 1000 W/m²-K (which flow through the tube) and nitrobenzene side heat transfer coefficient h_o 750 W/m²-K, temperature correction factor = 0.8, specific heat capacity of nitrobenzene = 2380 J/kg-K. 10
3. (a) Discuss D-value. 3
- (b) The F_0 for 99.999% inactivation of *C. botulinum* type B is 1.1 min. Calculate F_0 for 12 D inactivation and the F value at 275 °F (135 °C) when $z = 18$ °F. 3
- (c) Discuss thermal death rate kinetics of microorganism. 4
4. (a) Define water activity. Explain the method for measurement of water activity at high moisture content. 6
- (b) An evaporator is used to concentrate cane sugar. A feed of 100 kg/h of a solution containing 38% sugar is evaporated producing a 74% solution. Calculate the weight of solution produced and amount of water removed. 4

(3)

5. (a) Write down the methods of operation of evaporators and calculation the methods for single-effect evaporators. 6
- (b) Calculate the water activity of a 50% glucose solution. (Given : $K = 0.7$) 4
6. (a) Define the following numbers : 4
- (i) Biot
- (ii) Prandtl
- (iii) Grashoff
- (iv) Nusselt
- (b) A cold storage is made up of an outer wall of concrete (100 mm thick), middle wall of polyethane foam (100 mm thick) and inner wall of wood (10 mm thick). The thermal conductivity of concrete, polyethane foam and wood are 0.80 W/m-K, 0.025 W/m-K and 0.17 W/m-K respectively. Calculate the rate of heat transfer per unit area if inner wall temperature is 5 °C and outer wall temperature is 20 °C. Also calculate the interface temperature at different layers. 6
7. (a) Explain the working principle of spray dryer along with its parts and draw its neat sketch. 6

(4)

- (b) Define the following terms : 4
- (i) Freeze drying
- (ii) Bound moisture
- (iii) Critical moisture content
- (iv) Sorption isotherm
8. Draw the neat sketch of drying curve. Explain the phenomena and theory of moisture movement during falling rate period of cereal grains. 4+6=10
