KERALA AGRICULTURAL UNIVERSITY
B.Tech.(Food Technology) 2020 Admission
V Semester Final Examination – February 2023

Pafe.3127   Food Process Equipment Design (2+1)   Marks: 50
                                                                          Time: 2 hours

I   **Fill in the blanks**   **(10x1=10)**
   1.   .... is the measure of deformability of material.
   2.   Cast iron usually has .... % carbon.
   3.   Evaporation is normally performed by .... pressure and .... steam.
   4.   Class B storage tanks are designed for internal pressure of .... and vacuum of .... water gauge.
   5.   The source of hazards are divided into .... hazards and .... hazards.
        State True or False
   6.   Deflection of the shaft creates a slope, while the torque creates an angular twist.
   7.   Aluminum has low strength and high melting point.
   8.   Baffling is essential for efficient mixing.
   9.   Tray and cabinet dryers are the simplest convective dryers.
   10. Glass and ceramics are non-resistant to acids and sufficiently resistant against lye.

II   **Write short notes on ANY FIVE of the following**   **(5x2=10)**
   1.   What is difference between single and twin-screw extruders?
   2.   Differentiate between plate heat exchanger and scraped surface heat exchanger.
   3.   What is screw conveyor? Write applications and formula to find the capacity of screw conveyor.
   4.   Write the principle behind working of fluidized bed dryer.
   5.   Define fatigue limit. Enlist the factors which influence fatigue.
   6.   Define riveted joint and classify riveted joints.
   7.   Write the equation to determine the thickness of cylindrical shell of pressure vessel.

III   **Answer ANY FIVE of the following**   **(5x4=20)**
   1.   Derive an equation for drying time considering both constant and falling rate period drying of food.
   2.   What is centrifuge? Write the type of centrifuges used in food separation. Explain about working of disc centrifuge in detail with diagram.
   3.   What are the design conditions and stress for pressure vessels and explain in detail about design criteria for pressure vessels?
   4.   What is baffling in mixing? Explain baffling arrangement with diagram and which size and disposition of baffles are preferred?
   5.   Which types of safety measures are taken in process industry and explain categories of relief devices used on process equipment?
   6.   A spherical food product (7 cm diameter and 1000 kg/m^3 density) is being frozen in an air-blast freezer. The initial product temperature is 10°C and the cold air temperature is -40°C. The initial freezing temperature is -1.25°C. Compute the freezing time in minutes, if the thermal conductivity of the frozen product is 1.2 W/(m.K) and latent heat of fusion is 250 kJ/kg.
   7.   Describe about types, components and design parameters of fermenters.

IV   **Write an essay on ANY ONE of the following**   **(1x10=10)**

1. Apple juice is being concentrated in a natural circulation single effect evaporator. At steady state conditions, dilute juice is the feed introduced at a rate of 0.67 kg/s. The concentration of dilute juice is 11% total solids. The juice is concentrated to 75% total solids. The specific heats of dilute and concentrated apple juice are 3.9 and 2.3 kJ/kg.°C, respectively. The steam pressure is measured to be 304.42 kPa. The feed enters at 43.3°C and boils at 62.2°C inside the evaporator. The overall heat transfer coefficient is 943 W/m².°C. Assume negligible boiling point rise. Calculate:

    a. The mass flow rate of the concentrated product,
    b. Steam requirements,
    c. Steam economy,
    d. The heat transfer area, and
    e. The evaporation rate

    Use steam table.

2. A liquid food (specific heat = 4.0 kJ/[kg °C]) flows in the inner pipe of a double-pipe heat exchanger. The liquid food enters the heat exchanger at 20°C. The flow rate of the liquid food is 0.5 kg/s. In the annular section, hot water at 90°C enters the heat exchanger and flows in counter-current direction at a flow rate of 1 kg/s. The average specific heat of water is 4.18 kJ/(kg °C). The average overall heat transfer coefficient based on the inside area is 2000 W/(m²°C), and the diameter of the inner pipe is 5 cm and length is 6.45 m. Assume steady state conditions. Calculate the exit temperature of liquid food and water. Use the effectiveness-NTU method to solve.

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