

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VI • EXAMINATION – SUMMER 2013****Subject Code: 161401****Date: 24-05-2013****Subject Name: Food Process Equipment Design****Time: 10.30 am - 01.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1 (a)** Hot oil is to be cooled by water in a one shell and eight tubes passes heat exchanger. The tubes are thin walled and made of copper with an internal diameter of 1.4cm. The length of each tube pass in the exchanger is 5m, and overall heat transfer coefficient is $310 \text{ W/m}^2\text{K}$. The water flows through the tube at the rate of 0.2 kg/s and the oil through the shell at the rate of 0.3 kg/s . The water and oil enter at the temperature of 20°C and 150°C respectively. Calculate the rate of heat transfer in the heat exchanger and the outlet temperature of water and oil. Take the specific heat of water and oil as 4.18 and 2.13 KJ/kg K . Effectiveness of heat exchanger is 0.52 . **07**
- (b)** Describe the followings in brief **07**
- (1) Steam Economy, (2) Proof stress, (3) Fatigue,
 - (4) Creep, (5) Crystallization, (6) Pitch in PHE, (7) Importance of material handling equipments

- Q.2 (a)** Calculate the flow rate of hot air required to carry the liberated moisture from 6 tonnes of freshly harvested grains from 22% wet basis to 14% wet basis in 6 hours. The density of the air is 1.10 kg/m^3 and its inlet and outlet absolute humidity is 0.012 and $0.024 \text{ kg of water vapor per kg dry air}$ respectively. **07**
- (b)** A liquid food is to be slowly agitated at low temperature till it become solid. Which type of agitator you are going to recommend and why? **07**
- With the Buckingham's Π theorem derive the power function of an agitator.

OR

- (b)** Describe Capacity Ratio, Heat exchanger effectiveness and develop the expression of effectiveness for parallel flow heat exchanger. **07**

$$\epsilon = \frac{1 - \exp\left[-\frac{UA}{C_{\min}}\left\{1 + \frac{C_{\min}}{C_{\max}}\right\}\right]}{\frac{C_{\min}}{C_{\max}}\left\{1 + \frac{C_{\min}}{C_{\max}}\right\}}$$

- Q.3 (a)** List out different advantages of PHE. Hot fluid is flowing in a PHE with 0.00478 m equivalent diameter, 140 kg/s mass flow rate, total number of plate is 105 having only one pass. Pitch of the plate is 0.0036 m and thickness is 0.0006 m . Effective channel width is 0.63 m . Viscosity of hot fluid is $5.11 \times 10^{-4} \text{ N-S/m}^2$. Show that the design of PHE is correct or not with respect to the above data. **07**
- (b)** What is pressure vessel? How it is differing from closed container? **07**

Evaluate the performance of the thin layer baffle type dryer used to dry freshly harvested wheat from 24% moisture content wet basis to 18% moisture content wet basis in 6 hours. If atmospheric air of 22°C, having 17°C wet bulb temperature is heated to 65°C and the hot air leaving the dryer at 52°C having wet bulb temperature of 28°C. Calculate the heat utilization factor, coefficient of performance and total heat efficiency of the dryer. How the performance of the dryer can be improved.

OR

Q.3 (a) Differentiate between single and multiple effect evaporators. Develop an equation for material and enthalpy balance for multiple effect evaporators. **07**

(b) A triple effect evaporator concentrating a liquid that has no appreciable elevation in boiling point. The temperature of steam in 1st effect is 108°C. The boiling point of solution in last effect is 52°C. The overall heat transfer coefficients are 2500, 2000, 1000 Kcal/hr m² °C. At what temperature approximately liquid boils in 1st and 2nd effect. **07**

Q.4 (a) Differentiate thin and thick wall pressure vessels. Calculate the capacity of the blower in cubic meter per minute, required to cool the food material (2.5 t/h) by 18°C. The maximum permissible rise in air temperature is 4°C. The density of the air is 1.15kg/m³ and specific heat of food and air is 2.14 and 1.03kJ/kg°C respectively. Considering there is no loss of moisture during the process of cooling. **07**

(b) With neat sketch describe different types of pressure vessel head. State their uses and limitations. **07**

OR

Q.4 (a) Design a pressure vessel and its shallow dished head to hold 15 kilo liters of juice. If operating pressure is 0.3 N/mm² and the safe permissible stress at operating temperature after considering safety factor and joint efficiency is 100 N/mm². **07**

Sheets available in the stock are: Length any size.

Width: 1000, 1500 and 2500mm and thickness: 5.5, 6.0 and 7.0 mm

If required use the following: Corners radius is 6 percent of heads radius.

$$V = \pi R_i^2 H; \quad W = 0.25 [3 + \{R_i / R_c\}^{0.5}]$$

$$t_{\text{head}} = \{p R_i W\} / 2f; \quad t_{\text{vessel}} = p D_i / \{2f - p\}$$

(b) What are the process hazards in pickle industry? How they can be checked? **07**

Q.5 (a) List the factors affecting selection of agitator. What is role of baffles in an agitator? What are the dimensional limitations of baffles? **07**

(b) Describe the criteria for the selection of material for evaporator construction. Also discuss different types of evaporators in details. **07**

OR

Q.5 (a) Design a bucket elevator conveying corn to a storage bin 5.6m tall at a horizontal distance of 7m from the elevator. The elevator specification from manufacturer as under **07**

Bucket size:	15X10cm
Bucket capacity at 90% fill efficiency:	920cm ³
Head pully diameter:	40cm
RPM:	75
Bucket spacing:	30cm
Bulk density of corn:	760 kg/m ³

- (b) Calculate the safe stress for high alloy stainless steel operated at 62°C with randomly checked lap joint (Efficiency 72%) and safety factor of 2.0. The material has allowable stress at 25°C and 140°C as 200 and 90 N/mm² respectively. **07**
