

GUJARAT TECHNOLOGICAL UNIVERSITY**B. E. - SEMESTER – VI • EXAMINATION – WINTER 2012****Subject code: 161401****Date: 02/01/2013****Subject Name: Food Process Equipment Design****Time: 02.30 pm - 05.00 pm****Total Marks: 70****Instructions:**

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

- Q.1** (a) i. Differentiate dryer, oven and evaporator. **03**
 ii “The best designed food processing equipment may also fail.” Do you agree with the statement? Justify your answer. **04**
 (b) i. What do you understand by overall heat transfer coefficient? List the points which are to be kept in mind during the calculation of overall heat transfer coefficient. **03**
 ii Derive the following equation **04**

$$U_i = \frac{h_i h_o}{h_i + h_o}$$

- Q.2** (a) i. What are the different parts of a pressure vessel? **02**
 ii In general how many safety valves are used in an pressure vessel used in the food industry and where they are located? **02**
 iii. With the neat sketches describe one common type of pressure head used for the pressure vessels used in the food processing industry. **03**
 (b) In an open heart surgery under hypothermic conditions, the patient’s blood is cooled before the surgery and rewarmed afterwards. The task is accomplished by a concentric tube counter flow heat exchanger of length 500mm with a thin walled inner tube of 60mm diameter. The blood entering the heat exchanger at 20°C and 0.05 kg/s is warmed by water at 60°C and 0.12 kg/s. Determine the temperature of blood at exit from the heat exchanger and the heat flow rate. Assume the following data; **07**
- C_p of blood = 3500 J/KgK
 - C_p of water = 4186 J/KgK
 - $U_0 = 475 \text{ W/m}^2\text{K}$

OR

- (b) Discuss the classification of evaporators with diagrams. Explain the mass and enthalpy balance of multiple effects of evaporators. Define steam economy. **07**

- Q.3** (a) What is purpose of baffling in the process of agitation? **02**
 In which agitators baffles are not recommended and why? **02**
 What are the size limitations of baffles? **03**
 (b) Discuss the working principle of plate heat exchanger. Draw the diagram of Chevron plate. Also discuss the advantages of plate heat exchanger. **07**

OR

- Q.3** (a) Calculate the mass flow rate of hot air (60°C) required to dry one tone **07**

grains in a deep bin from 22% moisture content to 17% moisture content wet basis in two hours. The grain temperature in the bin is 26°C and raised maximum up to 32°C. The exit air temperature is recorded as 52°C. If the absolute humidity of incoming air is 0.012 kg water vapor per kg dry air calculate the absolute humidity of the exit air. The specific heat of dry air, moisture, water vapor and grain is 1.0, 1.9, 4.2 and 1.4 KJ/kg°C respectively. The latent heat of evaporation is 2500KJ/kg.

- (b) What do you understand by AMTD? Derive the following equation for counter flow 07

$$Q = \frac{UA[(T_{h1} - T_{c2}) - (T_{h2} - T_{c1})]}{\ln \frac{T_{h1} - T_{c2}}{T_{h2} - T_{c1}}}$$

- Q.4 (a) What do you understand by NTU method? Derive the equation of effectiveness for parallel flow. 07
 (b) Write down the steps for designing a pressure vessel and its head. 07

OR

- Q.4 (a) Discuss the followings 07
 1. Boiling point elevations
 2. Temperature profile diagram for evaporation, condensation, cross flow mixed type and cross flow unmixed type.
 (b) What will be the safe permissible stress for high carbon stainless steel working at (i) 72°C and (ii) 128°C both with fully checked lap joint (Efficiency 78%) and safety factor of 2.0. The material has allowable stress at 30°C, 100°C and 200°C as 200, 170 and 120 N/mm² respectively. 07

- Q.5 (a) Design a solid agitator shaft for the process of agitation if maximum bending moment and maximum torque developed in the process are 260 and 140 N m respectively. The material of the shaft have safe permissible tensile stress at the operating condition is 450 N/cm² and shear stress is 66% of the tensile stress. 07
 (b) What is power number? Develop its equation and discuss its significance in the process of agitation. 07

OR

- Q.5 (a) Discuss possible process hazards in pickle processing industry. Suggest precautions should be taken to overcome the same. 07
 (b) Explain the followings in brief 01
 1. Recuperators and Regenerators 01
 2. Shell and tube heat exchangers 03
 3. Spiral tube heat exchangers 03
