Seat No.: \_\_\_\_\_ Enrolment No.\_\_\_\_ **GUJARAT TECHNOLOGICAL UNIVERSITY BE - SEMESTER-VI (NEW) - EXAMINATION - SUMMER 2016** Date:06/05/2016 Subject Code:2161401 **Subject Name: Food Process Equipment Design** Time: 10:30 AM to 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. 4. Use of steam table and psychometric chart is permitted. Q.1 What is pressure vessel? How it is differing from closed container? 03 i. What are factors affecting overall heat transfer coefficient? 03 ii. What is the role of baffles in agitator? What are its size limitations? 04 iii. "The best designed food processing equipment may also fail." Do you agree iv. 04 with the statement? Justify your answer. Q.2 i. Differentiate dryer, oven and evaporator. 03 (a) ii. What are different subsidiary loads considered while designing pressure 04 vessels? Evaluate the performance of the thin layer baffle type dryer used to dry freshly 07 (b) harvested wheat from 23% moisture content wet basis to 15% moisture content wet basis in 10 hours. If atmospheric air of 22°C, having 17°C wet bulb temperature is heated to  $65^{\circ}$ C and the hot air leaving the dryer at  $52^{\circ}$ 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 07 Calculate the capacity of the blower in cubic meter per minute, required to (b) cool the food material (2.5 t/h) by  $18^{\circ}$ C. The maximum permissible rise in air temperature is  $6^{\circ}$ C. The density of the air is 1.15kg/m<sup>3</sup> 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. If the drop in pressure is 1.5 cm of water column, calculate the horse power of motor required for the blower? Q.3 (a) What is power number? Develop its equation and discuss its significance in 07 the process of agitation.

(b) 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/cm<sup>2</sup> and shear stress is 66% of the tensile stress.

OR

- Q.3 (a) What is the purpose of agitation in the food industry? What are the factors 07 considered while selecting the agitator in the food process industry?
  - (b) Calculate the mass flow rate of hot air (60°C) required to dry one tonne grains 07 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.
- Q.4 (a) i. What are the process hazards in the pickle industry? How they can be 03 checked?
  - ii. With neat sketch describe different types of pressure vessel head. 04
  - Design a pressure vessel to hold 10 kilo liters of juice. If operating pressure is 07 (b)  $0.3\pm0.03$  N/mm<sup>2</sup> and the safe permissible stress at operating temperature after considering safety factor and joint efficiency is 80 N/mm<sup>2</sup>. Sheets available in the stock are: Length any size. Width: 1000, 1500, 1800 and 2500mm and Thickness: 5.5, 7.0, 8.0 and 10.0 mm If required use the following: Corners radius is 6 percent of heads radius.  $V = \pi R_i^2 H;$ W = 0.25  $[3 + {R_i / R_c}^{0.5}]$  $t_{vessel} = p D_i / \{2f - p\}$  $t_{head} = \{p R_i W\} / 2f;$ OR i. Differentiate thin and thick wall pressure vessels. 03 (a) ii. Discuss process hazards of beverage industry? How they can be checked? 04

Q.4

- (b) Design a shallow dished head to hold 10 kilo liters of juice. If operating pressure is  $0.3\pm0.03 \text{ N/mm}^2$ , temperature is  $58^{\circ}\text{C}$  and the permissible stress at 25 and  $124^{\circ}\text{C}$  are 200 and 140 N/mm<sup>2</sup>. The factor of safety is 1.8 and joint efficiency is 80%, which is fully checked by radio graph. Sheets available in the stock are: Length any size. Width: 1000, 1500,1800 and 2500mm and Thickness: 5.5, 7.0, 8.0 and 10.0 mm If required use the following: Corners radius is 6 percent of heads radius.  $V = \pi R_i^2 H;$   $W = 0.25 [3+\{R_i / R_c\}^{0.5}]$  $t_{head} = \{p R_i W\} / 2f;$   $t_{vessel} = p D_i / \{2f - p\}$
- Q.5 (a) A LSU dryer (Capacity 10 t) 2400 x 2400 mm having 6 discharge rollers 07 having angular speed of 10 RPM mounted on the shaft of 50mm with flange width of 25mm. The height of drying chamber is 5000 mm. The bulk density of the material is 560 N/m<sup>3</sup>, frictional coefficient is 0.48 and the ratio of lateral pressure to vertical pressure is 0.135. The safe stress of the steel used is 1000 N/cm<sup>2</sup>. Design the roller for its thickness. Calculate the power requirement to operate the rollers.
  - (b) Describe working of turbine type agitator with different types of its blades and 07 their limitations with the neat sketch.

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- Q.5 (a) Give the advantages of PHE with its application in food industry. Draw the 07 detailed plate diagram and list out its maximum limit of different parameters for performance.
  - (b) Explain the following passes and flow arrangements in plate heat exchanger 07 with diagram;
    - i. U- arrangement
    - ii. Z- arrangement
    - iii. 2x4/1x8 arrangement

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