

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER– VI (New) EXAMINATION – WINTER 2019****Subject Code: 2161401****Date: 04/12/2019****Subject Name: Food Process Equipment Design****Time: 02:30 PM TO 05:00 PM****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Steam table is permitted

- Q.1** (a) Describe Heat Capacity ratio, Steam economy and Fouling factor. **03**
- (b) What are the factors affect the performance of the dryer? How it can be improved? **04**
- (c) Design a belt conveyor for troughed belt with 20° surcharge angle. The material to be conveyed in wheat @45 tons/hr (1875 ft³/hr). The conveyor length is 400 ft with an inclination of 15°. Calculate the HP required and width of belt as per the manufacturer data given below. **07**

Belt width (inches)	Clear Margin, M (inches)	Total C/S area for surcharge angle (ft ²)			Maximum Speed (ft/min)		A	B
		10	20	30	Fine materials	Grains		
14	1.7	0.074	0.096	0.117	300	400	0.20	0.00140
16	1.8	0.101	0.131	0.162	300	450	0.25	0.00140
18	1.9	0.134	0.173	0.214	400	450	0.30	0.00162

- Q.2** (a) “Whatever best design consideration has been taken, failure of equipment can’t be ruled out.” Justify **03**
- (b) Briefly explain factors considered for the selection of an agitator? **04**
- (c) A steel pipe of 25mm of internal diameter and 30 mm of outer diameter is carrying a steam at 121°C. The convective heat transfer coefficient due to steam flow is 5000 W/m²K. The steel pipe has a glass wool insulation of 10mm thickness on the outside. The near stagnant air is at 30°C on the outside insulation provides a heat transfer coefficient of 10 W/m²K. The thermal conductivity of steel and insulation are 43 and 0.031 W/mK respectively. Calculate the overall heat transfer resistance based on inside surface area of pipe of every meter length. **07**

OR

- (c) Derive the equation of Number of Transfer Unit for parallel flow: **07**

$$\varepsilon_h = \frac{1 - \exp[-NTU(1+C)]}{1+C}$$

- Q.3** (a) Differentiate Dryer, Evaporator and Oven **03**
- (b) Why BPR (Boiling Point Rise) is important in evaporator? Describe the Duhring lines with help of diagram. **04**
- (c) Explain time scheduling of an LSU dryer? **07**

OR

- Q.3 (a) Differentiate: Thin and thick wall pressure vessel www.FirstRanker.com 03
- (b) Discuss possible material hazard in rice milling industry? State how it can be minimized? 04
- (c) Design a head of a pressure vessel having diameter 1500 mm and operating at 0.37 N/mm² and 62°C. If the safe stress considering joint efficiency and operating temperature is 120N/mm² and it is desired to have factor of safety as 2.5. Only following plates are available in the stock. 07
- Width (mm): 1000, 1250, 1500 and 1800 and Thickness (mm): 6, 8 and 10
- If required following formula can be used
- Corners radius is 6 percent of heads radius. $V = \pi R_i^2 H$
- $t = p D_i / \{2f - p\}$; $t = \{p R_i W\} / 2f$; $W = 0.25 [3 + \{R_i / R_c\}^{0.5}]$
- Q.4 (a) Differentiate between AMTD and LMTD. Give the limitations of AMTD 03
- (b) Derive the energy balance equation for single effect evaporators. 04
- $$m_f + H_f + m_s + H_{vs} = m_v H_{v1} + m_p H_{p1} + m_s H_{cs}$$
- (c) A solution with initial solid concentration of 10% is being concentrated in single effect evaporator to 40% solid concentration at a vacuum of 40Kpa. Steam at a pressure of 101 kPa is used to concentrate the liquor. The feed is entering at a temperature of 35°C and the temperature of final liquor is 86°C corresponding to a vacuum of 40kPa. If feed rate is 1000kg/hr, find the quantity of steam required, heat transfer area. Specific heat of feed is 5Kj/kg°C and U is 1.9 Kw/m² °C 07
- OR**
- Q.4 (a) Differentiate: Pressure vessel and Closed container 03
- (b) What are the major and subsidiary loads considered in the design of a pressure vessel? 04
- (c) Design a pressure vessel 3000 kg juice capacity of 1.04 Sp gr, working at 0.24 N/mm² and 58°C. If safe permissible stress of material at 25 and 100°C are 200 and 175 N/mm² respectively, joint and joint checking efficiencies are 80 and 78% respectively and factor of safety 2.2. Only following plates are available in the stock. Corners radius is 6 percent of heads radius. 07
- Width (mm): 1000, 1250, 1500 and 1800 and Thickness (mm): 5.5, 6, and 8
- Q.5 (a) What is significance of power number of an agitator? 03
- (b) With neat sketch describe different head of pressure vessel used in the food industry? 04
- (c) With the Buckingham's II theorem derive the power function of an agitator? 07
- OR**
- Q.5 (a) What is function of baffles in the agitator? 03
- (b) Explain working of cone agitator? Which are the food processing operations where it can be used? 04
- (c) Design a solid agitator shaft for the process of agitation if maximum bending moment and maximum torque developed in the process are 200 and 180 N m respectively. The material of the shaft have safe permissible tensile stress at the operating condition is 640 N/cm² and shear stress is 80% of the tensile stress. 07
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