

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII(NEW) • EXAMINATION – WINTER 2016****Subject Code:2170502****Date:21/11/2016****Subect Name:Process Equipment Design –II****Time: 10.30 AM to 1.30 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)** Design the bracket support for the reaction vessel with the following data. **10**
 O D of shell - 1052.7 mm, Thickness of shell - 6.35 mm, Height of vessel - 2.1524 m, Clearance from vessel bottom to foundation - 0.75 m, Weight of vessel with contents - 3918.9 kg, Wind pressure - 100 kgf/m², Bolt circle diameter - 1202.7 mm, Size of base plate for bracket - 150 mm × 150 mm, Size of C channel - 150 mm × 75 mm, Height of bracket from foundation - 2.0264 m, C/S area of C channel - 20.88 cm², Modulus of section - 19.4 cm³, Radius of gyration - 2.21 cm, Maximum allowable tensile stress - 1400 kgf/cm², Maximum allowable compressive stress - 1233 kgf/cm², Maximum allowable bending stress - 1575 kgf/cm². Assume the height of triangular portion of bracket - 145 mm.
- (b)** Explain “Radiography test” for pressure vessel. **04**
- Q-2 (a)** Define the two most important stresses generated in a thin cylindrical shell and discuss the classification of the unfired pressure vessel as per IS – 2825. **07**
- (b)** State and discuss the various types of flanges used in industries. **07**
- OR**
- (b)** What is gasket? Define gasket seating stress and discuss the various types of gaskets used in industries. **07**
- Q-3 (a)** A Reactor of 800 mm inside diameter is covered with hemispherical head at the bottom. Inside working pressure is 75 kgf/cm² (g) & working temperature is 70 °C. Reactor is covered with plain jacket such that 75% length of shell & bottom hemispherical head is covered with jacket. Cooling water is circulated inside the jacket by pumping with a centrifugal pump having a shut off discharge pressure 7.0 kgf/cm²(g). The hemispherical head is fabricated from SA-516 Grade 70. The maximum allowable stress at design temperature is 610 kgf/cm². Modulus of Elasticity of plate material (E) = 193 × 10³ N/mm². Poisson’s ratio (μ) = 0.3, ρ = 7.83 gm/cm³, Joint efficiency (J) = 0.85. Take 3 mm corrosion allowance. Find: (i) thickness of the head (ii) volume of head and (iii) weight of the fabricated head **06**
- (b)** (i) Briefly discuss about Fatigue and Creep. **08**
 (ii) Discuss stress vs strain curve.
- OR**
- Q-3 (a)** Turbine agitators operating in a vessel of 1.6 m diameter is to be designed with the following data. **10**
 Internal design pressure – 5 kgf/cm², Agitator diameter – 500 mm, Maximum agitator rpm – 200, Viscosity of liquid – 600 cp, Specific gravity of liquid – 1.2, Over hang length of shaft – 1.2 m, No. of agitator blade – 6, Elastic limit – 250 N/mm², Permissible shear stress in shaft – 55 N/mm², Modulus of elasticity – 19.5 × 10⁵ kgf/cm². Calculate (i) power required and (ii) shaft diameter and (iii) critical speed. Power number – 8 for NRe < 1500, 6 for 1500 < NRe < 3000, 4.5 for 3000 < NRe < 4500, 3 for 4500 < NRe < 6000 and 2 for NRe > 6000.
- (b)** Briefly explain the uses of various types of jackets for reaction vessel. **04**

- Q-4 (a)** Determine the total number of shell plates and plate thickness of a storage tank to store Phosphoric acid of 85% w/w for phosphoric acid plant having production capacity of 762.83 MT. Density of pure H_3PO_4 is 1834 kg/m^3 . Allowable stress of Monel is 170 MPa and D/H is 1.5. Corrosion allowance is negligible. **07**
- (b)** Explain Normal and Emergency venting for storage vessel. **07**

OR

- Q-4 (a)** Examine the data given below to evaluate the requirement of reinforcement pad for the nozzle opening in cylindrical shell. OD of shell = 2 m, maximum working pressure within shell = 3.5 MN/m^2 , thickness of shell = 0.05 m, corrosion allowance = 3 mm, joint efficiency of nozzle and shell = 1, MOC = IS 2002, Allowable stress = 96 MN/m^2 , Density = 7800 kg/m^3 , OD of nozzle = 0.25 m, Nozzle wall thickness = 0.016 m, length of nozzle = 100 mm **07**
- (b)** Discuss the design steps for the calculation of tube side heat transfer coefficient and pressure drop. **07**

- Q-5 (a)** Explain the types of tray supports. **04**
- (b)** Determine the shell thickness for the entire tower height based on the following data. **10**

Shell I D – 3500 mm, Working temperature – 180°C , Working pressure – $2 \text{ N/mm}^2(\text{g})$, Design temperature – 200°C , Top disengagement space – 200 mm, Base chamber height – 3200 mm, Specific gravity of material – 7.7, Permissible tensile stress – 95 N/mm^2 , Insulation density – 7700 N/m^3 , Corrosion allowance – 3 mm, Poisson's ratio (μ) = 0.3, Modulus of Elasticity of plate material (E) = $1.93 \times 10^5 \text{ N/mm}^2$, Insulation thickness – 140 mm, Weight of top elliptical head – 2800 N, Weight of attachment (pipes, ladders & platform) – 1600 N/mm^2 , Weight of column – $3 \times 10^6 \text{ N}$, Weight of liquid and tray – 900 N/m^2 , No. of trays – 60, Tray spacing – 0.7 m. Neglect the stress created by eccentric and seismic load. Determine the thickness of distillation column.

OR

- Q-5** A distillation column subjected to full vacuum is fabricated and installed, having following specifications. **14**

Shell O D - 2000 mm, Tangent to tangent length of shell - 35 m, Design temperature - 120°C , Shell material - SA-283 Grade C, Type of shell plate joint - Double welded butt joint with 10 % radiography, Height of skirt support - 4 m, Tray spacing – 0.3 m, No. of trays – 106, Top disengaging space – 1.2 m, Weight of liquid and tray – 120 kg/m^2 , Weight of attachment (pipes, ladders & platform) – 150 kg/m , Wind pressure – 130 kgf/m^2 , Insulation thickness – 500 kg/m^3 , Maximum allowable stress of shell plate material at design temperature – 605.22 kgf/cm^2 , Modulus of elasticity – $2 \times 10^6 \text{ kgf/cm}^2$, Poissons ratio – 0.3, Corrosion allowance – 2 mm, Specific gravity of shell material – 7.865, Weight of top head – 315.55 kg, Stiffening ring of 8 mm thick and 100 mm width are available. Neglect the stress created by eccentric and seismic load. Determine the thickness of distillation column.
