Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE SEMESTER–VIII • EXAMINATION – WINTER 2017

Subject Code:170502 Date: 07-11-2017

Subject Name: Process Equipment Design - II

Time: 10:30 am to 01:30 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)** Differentiate between static and rotary equipment. Describe classification of unfired pressure vessel as per IS-2825. **07**

(b) Describe the mechanical properties of material. **07**

Q.2 **(a)** A process vessel is to be designed for the maximum operating pressure of 500 kN/m^2. The vessel has the nominal diameter of 1.2 m and tangent to tangent length of 2.4 m. The vessel is made of IS: 2002-1962 Grade 2B quality steel having allowable design stress value of 118 MN/m^2 at working temperature. The corrosion allowance is suggested to be 2 mm for the life span expected for the vessel. The vessel is to be fabricated according to class 2 of Indian Standard specifications which stipulate the weld joint efficiency of 0.85. **07**

i. What is the standard plate thickness to fabricate this vessel?

ii. If a spherical vessel having the same diameter and thickness is fabricated with the same quality steel, what maximum internal pressure the sphere will withstand safely?

(b) Describe stresses in the close cylindrical vessel due to internal pressure. **07**

OR

(b) Describe the following: **07**

1. Corrosion allowance
2. Welding joint efficiency factor

Q.3 **(a)** Describe different types of flanges. **07**

(b) A reactor (ID = 800 mm) with hemispherical head at the bottom. Inside working pressure is 75 kgf/cm^2 gauge and working temperature is 70 ˚C. Reactor is covered with a plain jacket such that 75 % lengths of shell and bottom hemispherical head are covered with jacket. Cooling water is circulated inside the jacket by pumping with a centrifugal pump having a shutoff discharge pressure 6 kgf/cm^2 gauge. The hemispherical head is fabricated from SA 516 Grade 70. (The maximum allowable stress at design temperature = 610 kgf/cm^2) **07**

Modulus of elasticity of plate material (E) = 193 x 10^3 N/mm^2.

$\mu = 0.3$, $\rho = 7.83$ gm/cm^3, Joint efficiency = 0.85

Corrosion allowance = 0.3 cm

Straight flange = 0.12 m

OR

Q.3 Determine the shell thickness for the entire tower height based on the following data. **14**

Shell Id = 3500 mm, Working temperature = 180 ˚C, Working pressure = 2 N/mm^2 gauge, 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/mm^3, Corrosion allowance = 3 mm, μ = 0.3, E = 1.93 x 10^5 N/mm^2, Insulation thickness tins = 140 mm.

Head

Type: Elliptical,

Weight = 2800 N

Attachment weights:

Pipe, ladders, platform etc. = 1600 N/m^2, Weight of column = 3 x 10^6 N, Wind pressure = 1600 N/m^2, Weight of liquid and trays = 900 N/m^2, Negligible Seismic load and Eccentricity.

Tray, numbers of trays, n = 60, tray spacing = 0.7.

Q.4 **(a)** Describe self-supporting roof design. **07**

(b) A fixed conical roof storage tank is fabricated from structural carbon steel plate (IS-2062). Based on given following data find out the thickness of conical roof plate. Storage tank can be classified as 'Class A tank'. **07**

Data Given:

Tank diameter = 7 m, Tank height = 5 m

Slope of conical roof = '1 in 6', Superimposed live load on roof = 125 kgf/m^2.

Modulus of Elasticity = 2 x 10^6 kgf/cm^2, Density of plate material = 7800 kg/m^3.

Poisson's ratio = 0.3, Thickness of topmost shell course = 10 mm

OR

Q.4 **(a)** Describe various types of jackets used for heating and cooling with neat sketch. **07**

(b) Find the thickness of shell of the reactor and thickness of jacket for the given following two options. **07**

(a) Reactor with plain jacket

(b) Reactor with channel jacket

Data Given:

Inside diameter of shell = 1500 mm, Inside diameter of jacket = 1600 mm, Shell length = 1500 mm, Diameter of half coil = 75 mm, Width of channel jacket = 75 mm, Internal design pressure for shell = 4 kgf/cm^2, Internal design pressure for jacket = 3 kgf/cm^2, Design temperature for both shell and jacket = 150 ˚C, Material of shell and jacket =SA 516 Gr 70, Maximum allowable stress at design temperature = 980 kgf/cm^2, Modulus of elasticity = 19 x 10^5 kgf/cm^2, μ = 0.3, Joint efficiency, J =0.85 , Corrosion allowance =1.5 mm, K_1 = 0.167, K_2 = 0.12.

Q.5 **(a)** Calculate the base plate thickness and gusset plate thickness for bracket support. **07**

Data Given:
Weight of vessel with contents = 7.5 tons
Diameter of vessel = 1.5 m
Height of Vessel = 1.8 m
Vessel clearance from foundation = 1 m
Height of bracket from foundation = 2 m
Number of brackets = 4
Bolt circle diameter =1.65 m
Permissible bending stress for the material = 157 N/mm^2
Base plate size = 14 cm X 15 cm
Space between gusset = 12.5 cm
Height of gusset vessel = 120 cm
Vessel is kept indoor.

(b) Explain the mechanical design for shell and tube heat exchanger. **07**

OR

Q.5 **(a)** Explain in detail about safety valve and relief valve. **07**

(b) Explain design procedure for saddle support. **07**

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