Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE SEM-VII Examination-Nov/Dec.-2011

Subject code: 170502 **Date: 22/11/2011**

Subject Name: Process Equipment Design II

Time: 10.30 am-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.**

Q.1 **(a)** Examine the data given below to evaluate the requirement of compensation for the nozzle opening in a cylindrical shell. If compensation ring (Reinforcement pad) is required then find its dimensions and weight. **07**

Outside diameter of shell = 2 m

Max. Working pressure within shell = 3.5 MN/m^2

Wall thickness for the shell = 0.05 m

Corrosion allowance = 3 mm

Joint efficiency = 1 (for shell and nozzle)

MOC of shell, nozzle and reinforcement pad = IS 2002

Density of IS 2002 = 7800 kg/m^3

Allowable stress of IS 2002 = 96 MN/m^2

OD of nozzle (seamless) = 0.25 m

Nozzle wall thickness = 0.016 m

Length of nozzle = 100 mm

(b) A Reactor (ID = 1000 mm) with hemispherical heat at the bottom. Inside working pressure is 100 kgf/cm^2 gauge and working temperature is 70°C. Reactor is covered with 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 shut off discharge pressure 6 kgf/cm^2 (g). The hemispherical head is fabricated from SA 516 Grade 70 plate. Maximum allowable stress of this plate material at design temperature is 610 kgf/cm^2. **07**

Modulus of Elasticity of plate material = 193 x 10^3 N/mm^2
Poisson's ratio = 0.3
Density of plate material = 7830 kg/m^3
Joint efficiency = 0.85
Corrosion allowance = 3 mm
Find: (1) Thickness of the head (2) Weight of this head

Q.2 **(a)** i. What will happen if bolt spacing in flange joint is too small and too large? **02**

ii. Out of two stresses, circumferential and longitudinal, which is taken as design stress for a cylindrical vessel and why? **03**

iii. Which type of flange facing is preferred for high vacuum operation? Why? **02**

(b) Discuss about various safety devices used for pressure vessel. **07**

OR

(b) Different types of jackets and their selection criteria. **07**

Q.3 A fixed conical roof storage tank is fabricated from structural steel plate (IS – 2062). Based on the given following data find out the thickness of conical roof plate and size of roof curb angle. Storage tank can be classified as 'Class A Tank'. **14**

Given Data:-

1. Tank diameter = 7m
2. Tank height = 5m
3. Slope of conical roof = 1 in 6 (or 1/6)
4. Superimposed live load on roof = 125 kgf / cm^2
5. Modulus of elasticity of Plate material = 2x10^6 kgf / cm^2
6. Density of Plate material = 7800 kg / cm^3
7. Poisson's ratio = 0.3
8. Thickness of topmost shell course = 10 mm
9. Minimum size of roof curb angle = 65 mm x 65 mm x 6 mm

OR

Q.3 Explain the stepwise procedure for the design of conical roof with structural support for storage tank. **14**

Q.4 **(a)** Discuss about the design of tube, tube sheet of shell and tube heat exchanger. **07**

(b) Discuss the design of tray support. **07**

OR

Q.4 **(a)** It is desired to design a bracket support for a vertical cylindrical reaction vessel installed indoor. Following data are available. **10**

Vessel Diameter = 1.5 m , Vessel height = 2 m

Clearance from vessel bottom to foundation = 1 m

Wt. of vessel with content = 4000 kg

No. of bracket = 6

Ht. of bracket from the foundation = 2 m

Diameter Of the Anchor bolt circle = 1.65 m

Base plate dimensions for bracket= 14 cm x 15 cm

Distance between vessel wall and bracket end = 150 mm

Gusset plate are 140 mm apart from each other

Web plate dimension for bracket height: $\cos \theta = 0.707$

Channel size = 150 x 75 (Area = 21 cm^2)

Modulus of section = 19cm3

Radius of gyration = 2.2 cm

Weight = 170 N/m

Eccentricity = 7.5 cm

Base plate size : Extends 20 mm on either side of the channel

Permissible Stresses :

Tensile stress = 140 N/mm^2

Compressive stress = 124 N/mm^2

Bending stress = 158 N/mm^2

Permissible bearing pressure of concrete = 5 N/mm^2

Assuming wind pressure = 1285N/m^2

Calculate thickness of bracket and thickness of web plate and thickness of column base plate.

(b) A vacuum distillation column is to operate under a top pressure 50 mm hg (ab). Trays of distillation column are supported on periphery rings having 10 mm thickness and 75 mm width. The OD of column is 1m and the tray spacing is 0.5 m. Check if the support rings will act as effective stiffening rings. The material of construction is carbon steel and the maximum operating temperature 50°C. If shell thickness is 10 mm, check if this is sufficient. Modulus of elasticity of carbon steel at 50°C is 200 * 10^3 N/mm^2 **04**

Q.5 **(a)** Discuss about the various types of fabrication technique used for the fabrication of pressure vessel. **07**

(b) Discuss about the design Saddle support. **07**

OR

Q.5 Determine the thickness of shell of distillation column at various heights based on following data. **14**

i. Shell O.D. at top = 2000 mm
ii. Length of Shell = 27 m
iii. Internal design pressure = 3 kgf/cm^2
iv. Design temperature = 120 °C
v. Shell Material = SA-283 Grade C
vi. Type of shell plate joint = Double welded butt joint with 10% radiography
vii. Skirt height = 4 m
viii. Tray spacing = 0.3 m
ix. Top disengaging space = 1.2 m
x. Weight of one tray plus wt. of liquid over the same = 120 kg/m^2
xi. Wt. of attachments (pipes, ladders & platforms) = 150 kg/m
xii. Wind pressure = 130 kgf/m^2
xiii. Insulation thickness = 100 mm
xiv. Density of insulation = 500 kg/m^3
xv. Maximum allowable stress of shell plate material at design temperature = 890 kgf/cm^2
xvi. Modulus of elasticity = 2 x 10^6 kgf/cm^2
xvii. Poisson's ration = 0.3
xviii. Corrosion allowance = 2 mm
xix. Specific gravity of SA-283 Grade C = 7.865

Neglect the stress created by eccentric load and seismic load.

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