Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII • EXAMINATION – WINTER • 2014

Subject Code: 170502 Date: 02-12-2014

Subject Name: Process Equipment Design-II

Time: 10:30 am - 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)** Discuss about various types of fabrication technique used for fabrication of pressure vessel. **07**

(b) A nozzle having I.D 400 mm is fabricated from S.S 316 plate. It is attached by welding to a vessel having I.D 1500 mm. Internal design pressure is 10 kgf/cm^2 and design temperature is 300°C. Maximum allowable stress at design temperature is 612.4 kgf/cm^2. Joint efficiency is 0.85 and corrosion allowance is 1.5 mm for both shell and nozzle. Density of material of fabrication is 7830 kg/m^3. Calculate thickness and weight of reinforcement pad. **07**

Q.2 **(a)** It is desired to design a bracket support for a vertical cylindrical reaction vessel. Following are the data available. **07**

Vessel diameter = 1.5 m
Vessel height = 2.0 m
Clearance from vessel bottom to foundation = 1.0 m
Weight of vessel with contents = 40000 N
No. of brackets = 4
Height of bracket from foundation = 2.0 m
Diameter of 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 plates are 140 mm apart from each other
Web plate dimension for bracket height: cosΘ = 0.707
Permissible stresses:
Tensile stress = 140 N/mm^2
Compressive stress = 123.3 N/mm^2
Bending stress = 157.5 N/mm^2
Assuming wind pressure = 1285 N/m^2
Calculate thickness of base plate and thickness of web plate.

(b) Discuss about design of tube, tube sheet of shell and tube heat exchanger. **07**

OR

(b) Define the following. **07**

a. Elasticity b. Brittle fracture c. Yield stress d. Resilience e. Toughness f. Creep g. Welding joint efficiency factor.

Q.3 **(a)** A flat blade turbine agitator with six blades is installed centrally in vertical tank. The tank is 1.83 m in diameter, turbine is 0.61 m in diameter and is positioned at 0.61 m from the bottom of tank. Calculate (i) power required for agitation (ii) shaft diameter (iii) thickness of agitator blade based on following data. **14**

Height of liquid in tank = 1.83 m
Viscosity of liquid = 15 cp
Density of liquid = 1500 kg/m^3
Speed of agitator = 90 rpm
Length of agitator shaft between bearing and agitator = 2.1 m
Width of blade = 120 mm
No. of baffles at tank wall = 4
Ultimate stress = 4200 kg/cm^2
Yield stress = 2300 kg/cm^2
Maximum allowable shear stress in shaft = 550 kg/cm^2
Modulus of elasticity = 19.5 x 10^5 kg/cm^2.

OR

Q.3 **(a)** Explain the statement "Generally jackets are used for coils are used for cooling". Discuss various types of jackets and coils. **07**

(b) A fixed conical roof storage tank is fabricated from structural carbon steel plate. Based on the following data find the thickness of conical roof plate and size of roof curb angle. Storage tank is classified as Class A tank. **07**

Tank diameter = 7 m
Tank height = 5 m
Slope of conical roof = 1 in 6
Superimposed live load on roof = 125 kg/cm^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 top most course = 10 mm.

Q.4 **(a)** Design a ring flange based on given data **14**

Internal design pressure = 10 kgf/cm^2
Design temperature = 150°C
Shell O.D = 900 mm
Basic gasket seating width = 10 mm
Shell thickness = 10 mm
Maximum allowable stress of flange material at atmospheric temperature = 1257.9 kg/cm^2
Maximum allowable stress of bolting material at design temperature = 816.5 kg/cm^2
Maximum allowable stress of bolting material at atmospheric temperature = 1020.7 kg/cm^2
Bolt size = 3/4"
Root mean area of bolt =0.302 in^2
Gasket factor = 2.75
Gasket seating stress = 257.77 kg/cm^2
Calculate gasket and flange dimensions with no. of bolts and every factor of flange design.

OR

Q.4 **(a)** Write a note on Pressure relieving devices. **07**

(b) Discuss design of trays and supports for a tray tower. **07**

Q.5 Design a skirt support for distillation column based on following data. **14**

Diameter of column = 2500 mm
Height of distillation column = 40 m
Maximum weight of vessel, its attachments and contents = 300,000 kg
Type of skirt support = straight cylindrical
Diameter of skirt = 2500 mm
Height of skirt = 5 m
Wind pressure at the bottom of vessel = 100 kg/cm^2
Wind pressure at the top of vessel = 128.5 kg/cm^2
Allowable tensile stress of material = 1400 kg/cm^2
Allowable compressive stress of material = 666 kg/cm^2
Allowable bending stress of material = 157.5 kg/cm^2
Allowable compressive stress of concrete = 35 kg/cm^2
Seismic coefficient = 0.8
Joint efficiency = 0.85
Minimum weight of empty vessel = 250,000 kg
Allowable tensile stress of bolt material = 1020.7 kg/cm^2

OR

Q.5 **(a)** Discuss design steps for column supported conical roof. **07**

(b) Find out thickness of shell of the reactor and thickness of jacket for the following three available options: (i) Reactor with plain jacket ii) Reactor with channel jacket iii) Reactor with half coil jacket. **07**

Given data:
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 of shell = 4 kgf/cm^2
Internal design pressure of jacket = 3 kgf/cm^2
Design temperature for both shell and jacket =150° C
Maximum allowable stress at design temperature =980 kgf/cm^2
Modulus of elasticity = 19 x 10^5 kgf/cm^2
Poisson's ratio = 0.3
Joint efficiency = 0.85

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