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RN-7325

B. E. - IV (Sem. VII) (Chemical) Examination

May / June – 2010

Process Equipment Design & Drawing

Time : **3** Hours] [Total Marks : **100**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. - 4 (Sem. 7) (Chemical)**

Name of the Subject :

☛ **Process Equipment Design & Drawing**

☛ Subject Code No. : **7 3 2 5** ☛ Section No. (1, 2,.....) : **1&2**

Seat No. :

Student's Signature

(2) Answer each section in **separate** answer book.

(3) Question **1** is **compulsory** and carries **18** marks.

(4) Assume suitable data wherever necessary and mention them clearly.

(5) Figures to the right indicate full marks.

SECTION - I

1 (a) Do as directed : **10**

(i) Define ultimate stress.

(ii) _____ is used to prevent leakage from an agitator shaft.

(iii) Define proportional limit.

(iv) What is metallic coating?

(v) Why do we use linings for chemical equipments?

(vi) What is radius of Gyration?

(vii) What is gasket factor?

(viii) Give types of reaction vessel.

(ix) How will you calculate tangential and axial stress for cylindrical vessel?

(x) List types of corrosion.

(b) A reactor having an inside diameter of 1 meter with a seamless torrispherical head having a crown radius 1 meter and knuckle radius of 100 mm. Inside maximum working pressure is 13 kg/cm^2 and working temperature with plain jacket such that 75% length of cylindrical shell and bottom torrispherical head are covered with jacket. Inside the jacket cooling water is circulated. Cooling water is supplied to reactor jacket by centrifugal pump, having shut off discharge pressure 6 kgf/cm^2. Design bottom torrispherical head of the reactor. Max. allowable stress 612.40 kgf/cm^2 at design temperature. 8

Data :

Modulus of Elasticity of plate material = 19500 kgf/mm^2.

Poisson's ratio μ = 0.3

Specific gravity = 7.83

2 Answer the following : (any **two**) **16**

(a) A nozzle having inside diameter 400 mm is fabricated from SA 516 Gr 70 plate. It is attached by welding to a vessel shell that has an inside diameter of 1500 mm. Internal design pressure of vessel is 120 kgf/cm^2 and design temp is 300^{o}C. Vessel shell is also fabricated from SA 516 Gr 70 plate. Check whether this nozzle requires reinforcement pad or not. If reinforcement pad is required then decide its dimensions.

Max. allowable stress of SA 516 Gr 70 = 612.4 kg/cm^2

Joint efficiency = 0.85 for both shell and nozzle.

Corrosion Allowance = 1.5 mm.

(b) Weight of distillate = 500 tonnes, ρ = 400 kg/m^3

MOC = structural steel, J = 0.85

Plate size = 4 m $\times$ 1.5 m, f = 1070 kgf/cm^2

Plate thickness in mm 5,6,8,10,12,14,16

Density of plate material = 7700 kg/m^3. Assume H/D ratio.

(i) Shell thickness at different heights

(ii) Total no. of plates required to fabricate the shell.

(c) Following are the specifications for vertical cylindrical fluid storage vessel :

Shell I.D. = 1200 mm

MOC = stainless steel

Allowable stress = 1300 kg/cm^2

Internal pressure = 3 kg/cm^2

Joint efficiency = 0.85

Weight of vessel and its contents = 200 kg

Torque due to offset piping = 50 kg.m.

Calculate and suggest shell plate thickness. Also check stress condition for satisfactory design.

3 Answer the following : (any **four**) **16**

(a) Give details about constructional features of high pressure vessel.

(b) Draw manhole and suggest material of construction for NaOH and H_2SO_4.

(c) Draw different flange facings.

(d) Discuss about heating system in case of reaction vessel.

(e) Explain internal pressure and design pressure.

SECTION - II

4 (a) Do as directed : **10**

(i) Mention various parts of packed tower.

(ii) Give advantages of skirt support.

(iii) What is constant rate filteration?

(iv) When Froude number will be important in agitation?

(v) (i) For self supporting roof, slope of cone is limited to _____

(ii) In large storage tanks pressure is _____ at bottom.

(vi) What is pitch in heat exchangers? State types of pitch.

(vii) What is critical speed of agitation?

(viii) List various types of coils and jackets in reaction vessel.

(ix) List out supports for horizontal and vertical vessels.

(x) List various types of constructions for high pressure vessel.

(b) Turbine agitators operating in a vessel of 1600 mm diameter is to be designed with following data : **10**

Internal design pressure = 5 kg/cm^2

Agitator diameter = 500 mm

Maximum agitator rpm = 200

Viscosity of liquid in vessel = 600 cp

Specific Gravity = 1.2

Overhang = 1200 mm

No. of agitator blades = 6

Permissible shear stress in shaft = 55 N/mm^2

Modulus of Elasticity = 19.5×10^4

Power No = 6 for $N_{Re} < 4500$

4.5 for $N_{Re} > 4500$

Yield stress : 250 N/mm^2.

(i) Calculate power requirement and suggest suitable motor HP.

(ii) Calculate shaft dia based on torque, bending moment and critical speed of agitator.

5 Answer the following : (any **two**) **7×2=14**

(a) Find out thickness of shell of the reactor and thickness of jacket for given available options :

(i) Reactor with plain jacket

(ii) Reactor with half coil jacket

Given data are as follows :

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 = $4kgf/cm^2g$

Internal design pressure of jacket = 3 kgf/cm^2g

Design temp. for both shell and jacket = 150^oC

Maximum allowable stress at design temp = 980 kgf/cm^2

Modulus of Elasticity E = 19×10^5 kgf/cm^2

Poisson's Ratio = 0.3

Joint Efficiency = 0.85

(b) Design a bracket support based on following data:

Diameter of vessel = 1.5 m

Height of vessel = 2.0 m

Clearance from vessel bottom of foundation = 1 m

Weight of vessel with contents = 40,000 N

Wind pressure = 1285 N/m^2

No. of brackets = 4

Dia of bolt circle = 1.65 m

Permissible stress for MOC

Tension = 140 N/mm^2

Compression = 123.3 N/mm^2

Bending = 157.5 N/mm^2

Base plate dimensions = 140×150 mm^2. Cos θ = 0.707.

(c) List various types of evaporators and explain any one in detail.

6 Answer the following : (any **two**) **8×2=16**

(a) (i) Compare IS, BS and ASME

(ii) Write a note on safety relief devices.

(b) (i) Write a note on various losses from storage tank.

(ii) Explain non-destructive tests for pressure vessels.

(c) A distillation column is to be fabricated and installed having following specifications.

Shell OD at top = 2000 mm

Shell length tangent line to line = 35 m

Internal design pressure = 3 kgf/cm^2

Design temp. 120°C

Skirt Height = 4 m

Tray spacing (106 trays) = 0.3 m

Top disengaging space = 1.2 m

Weight of liquid and tray = 120 kg/m^2.

Weight of attachment = 150 kg/m.

Wind pressure PW = 130 kgf/m^2

Insulation thickness = 100 mm

Density of insulation = 500 kg/m^3.

Maximum allowable stress of shell plate material f = 890 kgf/m^2.

Modulus of elasticity = 2×10^6 kgf/cm^2

Poisson's ratio = μ = 0.3

Corrosion Allowance = 2 mm

Sp. gr. of material = 7.865

Neglect eccentric and seismic load. Calculate the thickness of shell plate for entire tower.
