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SE-7325

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

April/May – 2011

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,.....) : **Nil**

Seat No. :

Student's Signature

(2) Q. 1 and Q. 4 are compulsory.

(3) Assume suitable data wherever necessary and mention it clearly.

(4) Figure to the right indicate full marks.

(5) Use of scientific calculator Casio fx82, fx83, fx100 or equivalent of other companies are allowed.

(6) Draw neat and clean figure / diagram whenever necessary.

1 (a) Answer the following : **10×1=10**

(i) Define modulus of elasticity.

(ii) What is the effect of Cr as alloying element on carbon steel ?

(iii) List the types of jackets.

(iv) What do you mean by fillate joint ?

(v) List various constructions of high pressure vessel.

(vi) Define corrosion allowance.

(vii) What will be the axial stress due to internal pressure on the shell wall of vessel ?

(viii) When the joint efficiency factor is unity ?

(ix) Define reaming of material.

(x) Classify flanges based on flange facings.

(b) Following data are given for pressure vessel in surge tank : 8

- Capacity = 10000 Lt.
- Operating pressure = 10 kg/cm^2.
- Allowable stress = 980 kg/cm^2.
- Specific gravity of MOC = 7.7.
- Joint efficiency factor = 0.8.
- Plate thickness (allowable) = 4, 6, 8, 10, 12, 14 mm.
- Head = Torrispherical.

  Crown radius = 10% excess of ID of shell.

  Knuckle radius = 10% of crown radius.
- Nozzle ID = 50 mm.

(i) Assuming suitable L/D ratio, calculate thickness of shell.

(ii) Calculate thickness of torrispherical head.

(iii) Calculate thickness of nozzle.

(iv) Calculate weight of the vessel.

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

(a) Give step by step design procedure for reinforcement pad.

(b) Design ring flange based on following data.

(excluding bolt / gasket)

- Shell OD = 1000 mm.
- Shell thickness = 10 mm.
- Internal design pressure = 10 kgf/cm^2.
- Design temperature = 150^{o}C
- Welded neck flange material : SA 2004 Cr 2

  maximum allowable stress = 1000 kg/m^2.
- Maximum allowable stress for bolt = 1380 kg/m^2.
- Gasket factor = 2.75
- Gasket seating stress = 255 kgf/cm^2.
- Gasket thickness = 1.8875 mm.
- Bolt size = 18 mm.
- Root area of bolt = 1.54 $\times$ 10^{-4} m^2.
- Stress intensification factor = 18.55.

(c) Write a short note on "Ferrous Materials".

3 Answer the following : **8×2=16**

(a) List method of corrosion prevention and discuss.

(b) Write short note on "Non-destructive tests for vessel and joints".

(c) Calculate thickness for plain and half coil jacket using following data :

- Shell ID = 2100 mm.
- Shell OD = 2120 mm.
- Shell internal pressure = 0.6 N/mm^2.
- Plain Jacket ID = 2200 mm.
- Half coil diameter = 100 mm.
- Maximum allowable stress = 100 N/mm^2.
- Jacket internal pressure = 0.4 N/mm^2.
- Joint efficiency factor = 0.85.

4 (a) Answer the following questions. **8**

(i) What do you mean by tube pitch in heat exchanger ? **1**

(ii) Best handled liquor in a long tube vertical evaporator is _____. (Fill in the blank). **1**

(iii) Column support for the roof of a cylindrical storage tank must be provided for_____ diameter tank. (Fill in the blank). **1**

(iv) Shell side pressure drop in a shell and tube heat exchanger is maximum for_____ battle. (Fill in the blank). **1**

(v) Briefly explain classification of heat exchanger. **2**

(vi) Briefly describe TEMA classification of heat exchanger. **2**

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

Internal design pressure = 5 kg/cm^2.

Agitator diameter = 500 mm

Maximum agitator RPM = 200

Viscosity and liquid in vessel = 600 CP

Specific gravity = 1.2

Overhang = 1200 mm

Numbers of agitator blade = 6

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

Modulus of elasticity, $E = 19.5 \times 10^4$

Power number = 6 for $N_{Re} < 4500$

= 4.5 for $N_{Re} > 4500$

(i) Calculate power required and suggest suitable motor H.P.

(ii) Calculate shaft diameter.

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

(a) Calculate the shell thickness at different height and total numbers of plate required to fabricate storage tank.

Data given :

Storage capacity of the tank = 1000 m^3.

Density of fluid = 950 kg/m^3.

Material of construction = carbon steel, J = 0.8,

$f = 980 \frac{kg}{cm^2}$, C.A. = 2 mm

Height of each course = 1 m

Available plate = 2m × 2m, 3m × 2m

(b) It is desired to design a bracket support for a vertical cylindrical reaction vessel installed indoor. Following data are available :

Data :

Vessel diameter = 1.5 m

Vessel height = 2 m

Clearance from vessel botton to foundation = 0.8 m

Weight of vessel with content = 4000 kg.

Number of bracket = 6

Height of bracket from foundation = 2 m

Diameter of anchor bolt circle = 1.65 m

Baseplate dimensions for bracket = 14 × 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 × 75 (Area = 21 cm^2)

Modulus of section = 19 cm^3.

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.

Wind pressure = 1285 N/m^2.

Calculate thickness of bracket and thickness of web plate.

(c) Write a short note on standard fixed root and vapor lift root type storage tank.

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

(a) Briefly describe the classification of shell and tube heat exchanger.

(b) List out various types of evaporators and discuss long tube vertical evaparator in detail.

(c) List out various types of crystallisers and discuss tank crystalliser and jacketed through crystallizer in detail.
