B. Tech.

(SEM. VI) EXAMINATION, 2006-07

PROCESS EQUIPMENT DESIGN

Time : 3 Hours] [Total Marks : 100

Note : Attempt all questions. All questions carry equal marks. Assume suitable data if missing/required. Standard data books are allowed

1 Attempt any four of the following : 5×4=20
   (a) What are Design Codes? What factors are considered in design pressure.
   (b) Write note on corrosion allowance.
   (c) Discuss the various mechanical properties of the materials which are considered in the design.
   (d) What is design stress and elastic instability?
   (e) How galvanic corrosion occurs? Discuss the measures by which it is minimized.
   (f) Discuss the criteria of failure.

2 Attempt any four of the following : 5×4=20
   (a) Explain the utility and purpose of Horton sphere.
   (b) What is cylindrical shell? Develop a relation for the thickness of this shell.

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(c) Where are the rectangular storage tanks used? What are the advantages of these tanks as compared to cylindrical storage tanks.

(d) What are the design considerations for the process vessels? Discuss in brief.

(e) Write a note on optimum tank proportions for the tanks having shell thickness independent of D (diameter of the vessel) and H (height of the vessel).

(f) A process vessel is to be designed for the maximum operating pressure of 500 kN/m². 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/m² 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. What will be the standard plate thickness to fabricate this vessel?

3 Attempt any two parts of the following:

(a) What are the commonly used types of compensation for openings in process vessels?

(b) Write short notes on:
(i) Gaskets
(ii) Bolts
(iii) Nozzles.

(c) A vacuum distillation column is to operate under a top pressure of 50 mm Hg. The plates are supported on rings of 75 mm wide, 10 mm

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deep. The column diameter is 1m and the plate spacing of 0.5m. Check if the support ring will act as effective stiffening rings. The material of construction is carbon steel and the maximum operating temperature 50°C. If the vessel thickness is 10 mm, check if this is sufficient.

Date : Take the design pressure as 1 bar. 
Young's Modulus (E) for steel at 50°C = 2 × 10¹¹ N/m². factor of safety = 6.

4 Attempt any two of the followings : 2×10=20

(a) A fractionating tower is 4 m in outside diameter by 6 m in length from tangent line to tangent line of closures. The tower contains removable trays on a 1m tray spacing and is to operate under vacumm at 400°C. The material of construction is IS:2002-1962 Gr. I plain Carbon steel.

Determine the required thickness of shell without stiffeners and then with stiffeners located at the tray positions.

(b) Write notes on :
(i) Design of multi effect evaporator
(ii) Dryers and crystallizers.

(c) In a shell and tube heat exchangers, discuss the following :
(i) Design pressure and temperature
(ii) Shell
(iii) Tube
(iv) Baffles
(v) Pitches.
5 Attempt any two of the following: 2 x 10 = 20

(a) Write notes on the following:
   (i) Distillation column design
   (ii) Design of crystallizers.

(b) Outline the various steps in the design of a spray drier.

(c) For a fractionating tower of 2 m diameter, bubble cap trays are to be designed. Weight of liquid on each tray during operation will not exceed so that an edge slope of 0.25 degree occurs, determine the thickness of tray for maximum permissible deflection of 5 mm. Material of construction for trays is alloy steel with allowable stress 140 MN/m² and modulus of elasticity 190000 MN/m².