B.E – VII – Sem – Chem.

Process Equipment Design/VII/CBGS/CHEM/PED.

(1)

QP Code : 5878

(25)

.15

(4 Hours) [Total Marks : 80

N. B. : (1) Question No.1 is **compulsory**.
(2) Attempt any **three** questions from question Nos. 2 to 6.
(3) Assume any suitable data wherever required.
(4) Draw figures wherever needed.
(5) **Figures** to the **right** indicate **full** marks.

1. Write short notes on any **four**. 20
 (a) Difference between U -Tube and fixed tube heat exchanger.
 (b). Autofrettage
 (c) Packed distillation column
 (d) Design considerations for crystallizers
 (e) Explain different methods of fixing tubes to tube sheet.

2. Design a U-tube heat exchanger for the following data:

(1) Shell side:
Design pressure= 0.55 N/mm^2
Permissible stress for shell material,Carbon steel= 100 N/mm^2
Standard torispherical head with knuckle radius as 6% of crown radius
25% cut segmental baffles are provided
Gasket on shell side- Flat metal jacketed asbestos filled
Gasket factor= 3.75
Gasket seating stress= 53.7 N/mm^2

(2) Tube side:
Number of tubes= 60
Tube outside diameter= 19 mm
Design pressure of tube side fluid= 2.0 N/mm^2
Permissible stress of tube material = 120 N/mm^2
Tube pitch =square

(3) Channel and channel cover:
Material of construction - carbon steel
Joint with tube sheet- Ring facing
Ring gasket width = 18 mm
Gasket factor = 5.5
Gasket seating stress= 126 N/mm^2
Allowable stress for bolt material = 140 N/mm^2

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(a) Design

(i) Shell (diameter and thickness) 3

(ii) Head 2

(iii) Flange joint between shell and tubesheet 3

(iv) Flange joint between channel and tubesheet 3

(v) Tube sheet thickness 2

(vi) Channel and channel cover thickness for a flat cover 2

(b) Draw to a recommended scale the assembly drawing of the above given U-Tube heat exchanger. 5

3. (a) Write the detail design procedure of shell wall of a tall column for varying thickness. Design must include all the stresses working on tall vessel. 15

(b) Discuss various ways of making high pressure vessel. 5

4. Design a short tube calendria type evaporator with the following data assuming that it has wire mesh for entrainment separation.

Evaporator drum under vacuum	external pressure 0.1 N/mm^2
Amount of water to be evaporated	3000 kg/hr
Heating surface required	$350 m^2$
Steam pressure	0.15 N/mm^2
Density of liquid	995 kg/m^3
Density of vapour	0.83 kg/m^3
Effective Tube length	1500 mm
Tube outside diameter	40 mm
Tube thickness	1.8 mm

Tubes laid on triangular pitch

Assume central down take pipe as 40% of the total tube cross sectional area

Permissible stress for low carbon steel = 98 N/mm^2

Modulus of elasticity for low carbon steel= 19×10^4 N/mm^2

Modulus of elasticity for brass = 9.5×10^4 N/mm^2

(a) Design the

(i) Calendria (Diameter and thickness) 4

(ii) Tubesheet thickness 4

(iii) Vapor drum (Diameter and thickness) 4

(iv) Top torispherical head 2

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(b) Draw to a recommended scale the sectional front view of the above designed calendria. 6

5. (a) Show the symbols for the following components: 5
   (i) Tray column
   (ii) Filter press
   (iii) Heat Exchanger
   (iv) Autoclave
   (v) open tank

(b) Write notes on 10
   (i) Process flow diagram
   (ii) Piping and Instrumentation Diagram

(b) Estimate the optimum pipe diameter for a water flow rate of 10 kg/sec at 20°C. Carbon steel pipe is used. Viscosity of water is 1.1×10^{-3} Ns/m^2. Density of liquid is 990 kg/m^3. Also find whether flow is laminar or turbulent 5

6. (a) A high pressure compound cylinder consists of an inner tube of inside diameter as 200mm and outside diameter as 250 mm. A tube of 300 mm external diameter is shrunk fit into it. The contact pressure in the 2 tube surfaces after shrink fit is 7.85 N/mm^2. The combination ofthe cylinder assembly is then subjected to an internal pressure of 83 N/mm^2. Design the original dimensions required for the tube and determine the stress distribution. If the co-efficient of thermal expansion is 12×10^{-6}/°C determine what temperature the outer cylinder should be heated to achieve the necessary shrinkfit. $E = 2 \times 10^5$ N/mm^2 12

(b) Plot the stress distribution along the wall of the above designed high pressure vessel. 8
