Process Equipment Design

BE Sem-VII (CBSGS) Chemical - PED 24/11/16

extra

Q.P. Code : 616700

(3 Hours) **Marks : 80**

Note : 1. Question **no. 1** is **compulsory.**
2. Attempt **any three** questions out of remaining out of remaining **five** questions.
3. Assume any suitable data wherever required.
4. Draw figures wherever needed.

1. Write short notes on **any four.** **20**
   (a) Autofrettage
   (b) Drum Filter
   (c) Entrainment separators for evaporators
   (d) Baffles and tie rods
   (e) Differences between U -Tube and fixed tubesheet heat exchanger.

2. Design a Fixed tubesheet heat exchanger for the following data:
   Shell side:
   Design pressure= 0.95 N/mm²
   Permissible stress for shell material = 100 N/ mm²
   Standard torispherical head with knuckle radius as 6% of crown radius
   25 % cut segmental baffles are provided
   Tube side:
   Number of tubes= 40
   Number of passes= 1
   Tube outside diameter = 20 mm
   Design pressure of tube side fluid 2.0 N/mm²
   Permissible stress of tube material= 120 N/mm²
   Tube pitch = Square
   Channel and channel cover:
   Material of construction - same as shell
   Joint with tube sheet- Ring facing
   Ring gasket width = 18 mm
   Gasket factor= 5.5
   Gasket seating stress= 126 N/ mm²
   (a) Design
      i) Shell (diameter and thickness) **6**
      ii) Flange joint between channel and tubesheet **6**
      iii) Tube sheet thickness **4**
      iv) Channel and channel cover thickness for a flat cover **4**

3. A high pressure vessel of internal diameter 300 mm is to be designed to withstand an internal pressure of 150 N/mm². The permissible stress of the material is 300 N/mm². Determine

(a) The thickness of the monoblock cylinder with the design based on Maximum principal stress theory. **5**

(b) Assuming shrink fit construction for the above designed vessel determine the stress distribution. Take interface pressure as 50 N /mm² **10**

(c) Plot the stress distribution for the above designed shrinkfit construction **5**

4. Design a 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/mm²
Amount of water to be evaporated	2,500 Kg/hr
Heating surface required	300m²
Steam pressure	0.2 N/mm²
Density of liquid	995 Kg/m³
Density of vapor	0.085 Kg/m³
Tube length	1250 mm
Tube outside diameter	100 mm
Tube thickness	1.5 mm

Tubes laid on triangular pitch

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

Permissible stress for evaporator material	= 98 N/ mm²
Poisson's ratio	0.3
Modulus of elasticity for carbon steel	19 x10⁴ N/mm²
Modulus of elasticity for brass	9.5 x 10⁴ N/mm²

Design the

(i) Calendria (Diameter and thickness) **6**

(ii) Vapor drum (Diameter and thickness) **6**

(iii) Tubesheet thickness **5**

(iv) Top torispherical head **3**

5. (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) Draw schematic diagram of tall vessel with plates **5**

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6. (a) Show the symbols for the following components **5**
(i) Packed column (ii) Spray dryer (iii) Centrifugal pump
(iv) Kettle reboiler (v) Ball mill

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

(c) Estimate the optimum pipe diameter for flow of ortho-dichlorobenzene with mass flow rate of 2.78 kg/s at 20° C. Carbon steel pipe is used. Density of ortho-dichlorobenzene is 1306 Kg/m3. Viscosity of orthodichlorobenzene at 20° C is 0.9×10^{-3} Ns/m^2. Also find whether flow is laminar or turbulent. **5**
