Reg. No. : | | | | | | | | | | | | |

Question Paper Code: 2037249

B.E. / B.Tech. DEGREE EXAMINATIONS, NOV/ DEC 2024
Seventh Semester
Chemical Engineering
U20CH703 - PROCESS EQUIPMENT DESIGN FOR CHEMICAL ENGINEERS
(Regulation 2020)

Time: Three Hours | Maximum: 100 Marks

Answer ALL questions

PART – A (10 x 2 = 20 Marks)

1. What are following steps involved in design procedure?
2. What are the characteristics to be considered for materials of construction?
3. How are heat exchangers classified?
4. What do you meant by “fouling’ in heat exchangers?
5. State the Duhring’s rule.
6. Define Boiling Point of Elevation (BPE).
7. What are the desirable characteristics of packing materials in packed towers?
8. How column diameter is calculated for bubble cap tray towers?
9. Define dynamic wind pressure.
10. Why valve tray is preferred to bubble cap tray and sieve tray is distillation column?

PART – B (5 x 16 = 80 Marks)

11. (a) Write short notes on following, (16)
    (1) Design Pressure
    (2) Design Temperature
    (3) Design Stress
    (4) Factor of safety
    (5) Corrosion allowance3xx
    (6) Weld Efficiency factor

(OR)

(b) Describe the details about materials of construction. (16)

12. (a) A single pass shell and tube heat exchanger is to be built to cool 16000 kg/hr of heptane from 88°C to 32°C using water entering at 18°C and leaving at 70°C. the heptane will flow inside the tubes, which are to be 32mm standard steel pipes; the water will flow outside and essentially parallel to the pipes, which are so spaced that an average Reynolds number of 50000 and a equivalent diameter of 38.1mm. Pressure drop considerations limit the heptane flow to a maximum mass velocity of 486000 kg/hr.m^3. Calculate:

(i) Number of tubes required in parallel

(ii) Length of each tube (16)

(OR)

(b) Design a 1 – 1 shell and tube condenser, where 30000 kg/hr of pure isobutane vapours are to be condensed at 58.5°C on the shell side. The cooling water flows through the tube entering at 28°C and leaving at 43°C. The heat loss to the surrounding is negligible. The orientation of the condenser is horizontal. Copper tubes 19 mm OD and 15.7 mm ID and 5m long are to be used. Metal wall resistance and fouling factors may be neglected. The average velocity of water through the tube may be taken as 3m/sec. The following average properties of isobutane may be used:

λ = 86 kcal/kg

K = 0.1125 kcal/hr m °C

ρ = 575 kg/m^3

No of tubes (vertical stock) =26, Calculate overall heat transfer coefficient and shell diameter. (16)

13. (a) Illustrate the working principle of forced circulation evaporator and describe in detail about the calculation steps of multiple effect evaporator. (16)

(OR)

(b) A 5% aqueous solution a high molecular weight solute has to be concentrated to 40% in a feed forward double effect evaporator at the rate of 8000 kg/hr. the feed temperature is 40° C. Saturated steam at 3.5 kg/cm^2 is available for heating. A vacuum of 600 mm Hg is maintained in the second effect. Calculate the area requirements, if calandria of equal area are used. The overall heat transfer coefficients are 550 and 370 kcal/hr.m^2.°C in the first and last effect respectively. The specific heat of the concentrated liquor is 0.87 kcal/kg° C. (16)

14. (a) It is desired to absorb 96% of the acetone in a 2 % (mole) mixture of acetone in air in a continuous counter current absorption tower using 20% more than the minimum liquid rate. Pure water used as solvent is introduced at the top of the tower and the gas mixture is blown into the bottom of the tower at 450kg/hr. Find the height and diameter of the tower packed with 2.54 cm wet-packed stoneware Raschig rings operating at 50% of the flooding velocity. The tower may be assumed to be operating at 1 atm. Pressure and 300K. The equilibrium relation is y = 2.5 x, where y and x are fractions of acetone in air – acetone mixture and acetone -water solution respectively. Density of acetone-air mixture is 1.181 kg/m^3, Density of the solution and also water is 998.4 kg/m^3, Characteristic factor of the packing = 160

The following relationship and data are available:

H_{OG} = Hg + (mG/L) H_l

Where, H_g = 0.54 m, H_l = 0.32 m

(16)

(OR)

(b) Describe the details about the steps involved in the determination of number of stages in the absorption column using in graphical method and numerical method. (16)

15. (a) Describe the details about mechanical design of tray column and determine the shell thickness at different heights in detail. (16)

(OR)

(b) A continuous fractionating column is to be designed for the separation of a mixture containing 0.5 mol fraction of n heptane and the rest n octane. If the overhead and bottom products are to have 99% purity and the column is to operate at atmospheric pressure with reflux ratio of 2.5, find out the column diameter, no of plates required. The feed is admitted as a saturated liquid to the column at the rate of 9000kg/h. Vapour velocity in the column is 0.5 m/s, plate spacing is 0.45 m. VLE data for heptane-octane system is as follows. (16)

X	0.13	0.22	0.32	0.46	0.57	0.69	0.82	0.92	1.00
y	0.24	0.37	0.5	0.65	0.74	0.83	0.91	0.96	1.00

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