Total No. of Questions : 8] *[Total No. of Printed Pages : 3*

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CM-7001-CBGS

B.E. VII Semester

Examination, December 2020

Choice Based Grading System (CBGS)

Process Equipment Design -II

Time : Three Hours

Maximum Marks : 70

Note: i) Attempt any five questions.
ii) All questions carry equal marks.

1. 7,000 lb/hr. of aniline is to be heated from 100 to 150º F by cooling 10,000 lb/hr. of toluene with an initial temperature of 185º F in 2-by 1-in IPS double pipe hairpin exchangers 15 ft long pressure drops of 10 psi are allowable, and a dirt factor of 0.005 is required.
   a) How many hairpin sections are required?
   b) How shall they be arranged?
   c) What is the final dirt factor?

2. a) Explain random tower packing-type fractionators design applied to any rectifier stripping-type fractionators.
   b) Discuss the factors required for sieve tray pressure drop calculation. Explain entrainment.

3. Sulphur dioxide produced by the combustion of sulphur in air is absorbed in water. Pure SO_2 is then recovered from the solution by steam stripping. Make a preliminary design for the absorption column. The feed will be 5000 kg/h of gas containing 8 percent v/v SO_2. The gas will be cooled to 20ºC. A 95 percent recovery of the sulphur dioxide is required. Consider feed water temperature 20ºC.

4. Explain the following term:
   a) Entrainment
   b) Types of packing
   c) HETP
   d) Weeping and flooding in column

5. 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 the 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 number of plates required. The feed is admitted as a saturated liquid to the column at a rate of 9 t/h. For the following conditions find the diameter of the column. Top column temperature is 371 K, bottom column temperature 398 K, vapour velocity in the column is 0.5 m/sec, plate spacing is 0.45 m.

   Vapour-liquid equilibrium data for heptanes-octane system is as follows:

x	0.13	0.22	0.32	0.46	0.57	0.69	0.82	0.92	1.00
y	0.24	0.37	0.50	0.65	0.74	0.83	0.91	0.96	1.00

   Where, x is mole fraction of heptanes in liquid; y is mole fraction of heptanes in vapour.

6. Design a single shell direct counter current rotary dryer to dry 15 tons per hour of an ore at 26.5 ºC with an average particle size of 1.02 mm diameter from an initial moisture content of 0.13 kg moisture per kg of dry solid to a final product with 0.005 kg moisture per kg of dry solid. At these conditions the critical moisture content will be less than 0.005 kg/kg. The drying medium used is air initially at 26.5 ºC and 21.1 ºC wet bulb temperature, heated to 138 ºC before entering the dryer.

7. 55,500 lb/hr. of bottoms at 65º API gravity and smalls boiling range at 425ºF enter a kettle reboiler from which 29000 lb/hr vapour is formed at an operating pressure. 200 psig. Heat is supplied by 28º API gas oil in the range from 575 to 475ºF and 120 psig operating pressure. A pressure drop of 10 psi is permissible. Available for the service in a 25 in. ID kettle reboiler containing a six-pass $15\frac{1}{4}$ - in. Circular bundle. The bundle contains 681 in.OD, 14 BWG tubes 12'0" long on $1\frac{1}{4}$ - In. Square pitch. The bundle is baffled only by quarter-circle support plates, will the reboiler be satisfactory? What are the dirt factor and pressure drops?

8. Answer any four of the following:
   a) How do you design a vapour-liquid separator or a flash drum?
   b) List out different air flow arrangements of mechanical draft cooling towers.
   c) Define evaluation of the mean temperature difference in a heat exchangers.
   d) Explain the capacity and economy of multiple evaporator system.
   e) Define condensation with de-superheating and sub-cooling.
   f) Explain heat transfer rate in parallel and countercurrent heat exchanges.

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