T. E sem VI CBGS Chemical

sub: HTO-II

Q. P. Code: 13232

(REVISED COURSE)

(3 Hours)

[Total Marks: 80

20 + 20 + 20 + 14 + 10.

N.B. :

1) **Question – 1 is compulsory**. Answer any **three** questions from remaining.
2) Use of "**Heat Exchanger databook**" is permitted.
3) Assume data if necessary and **specify the assumptions** clearly.
4) Draw neat sketches wherever required.
5) Answer to the sub-questions of an individual question should be grouped and written together i.e. one below the other.

1. (a) What are the major issues in furnace design? Explain briefly. [05]
   (b) Explain working of barometric condenser with neat sketch. [05]
   (c) What are the limitations of Plate Heat Exchanger? [05]
   (d) Explain how overdesign is inevitable when standard shell diameters need to be selected. Also discuss its effect on shell and tube heat exchanger operation. [05]

2. A 1200 kg/h condensate water need to be cooled from 60°C to 35°C before being discharge in open trench, using cooling water available at 30°C. Temperature of cooling water at inlet of cooling tower should not exceed 38°C. It is decided to use Plate Heat Exchanger for this duty with stainless steel (k = 15 $W/m{\cdot}K$) plates of 0.6 mm thick. Maximum operating pressure and allowable pressure for both fluids is 3 barg and 0.7 bar respectively and maximum permissible velocity is 2.5 m/s. [20]

   Show one iteration of design calculation including thermal and hydrodynamic and if design is not satisfactory in first iteration then comment on the calculations?

   Data:

Property	Cooling water	Condensate
Specific heat, $kJ/kg \cdot K$	4.179	4.183
Viscosity, cP	0.705	0.504
Thermal conductivity, $W/m \cdot K$	0.6248	0.6493
Density, kg/m^3	993.685	985.69

3. (a) Write stepwise procedure for process design of furnace using Lobo Evans method. [15]
   (b) Discuss operational problems in barometric condenser. [05]

4. (a) Explain Shell side stream analysis with neat sketches. [12]
   (b) Explain working of vertical thermosyphon reboiler with schematic sketch. [08]

5. (a) 22680 kg/h of saturated acetone vapour will be condensed at 80°C and 2.14 bar(a) using a tube bundle containing 316 tubes arranged for a single pass. The tubes are 25.4 mm OD, 16 BWG with a length of 7.62 m. The molecular weight of acetone is 58.08 and the liquid specific gravity is 0.79. For the purpose of this problem, assume constant physical properties and neglect the effects of condensate subcooling and interfacial shear. Calculate the condensing-side heat-transfer coefficient for the tube bundle is horizontal and condensation occurs outside the tubes. **[16]**

Data:

Density of condensate, kg/m^3	791.0
Viscosity of condensate, cP	0.3311
Thermal conductivity of condensate, $W/m \cdot K$	0.1512
Specific heat of condensate, $kJ/kg \cdot K$	2.1562

(b) What are the different causes of fouling? Explain any one in brief. **[04]**

6. Condensate from methanol condenser is sub-cooled in shell and tube heat exchanger from 95°C to 40°C. Flow rate of methanol is 100,000 kg/h. Properties of methanol at average temperature are, **[20]**

Specific heat, $kJ/kg \cdot K$	2.84	Thermal conductivity, $W/m \cdot K$	0.19
Viscosity, cP	0.34	Density, kg/m^3	750.00

Using Bell-Delware method, calculate the shell side pressure drop for following data.

Summary of proposed design					
Number of tubes	918		Pitch 1.25△	25	mm
Shell ID	894	mm	Tube length	4830	mm
Bundle diameter	826	mm	Baffle pitch	356	mm
Tube OD	20	mm			

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