2/2015

T.E/VI/CBus/Chem/H To II

~~T.E.~~ Heat Transfer Operations – II

QP Code : 6366

(Revised Course)

(3 Hours)

22

[Total Marks: 80

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 advantages of Plate Heat Exchanger? [05]
   (b) How do you ensure negative pressure in furnace while design? [05]
   (c) Explain working of reflux condenser with neat sketch. [05]
   (d) How does Kettle type reboiler work? [05]

2. There is a requirement to cool 150,000 kg/h of a ethanol from 70 to 30°C. Cooling water will be used for cooling, with inlet and outlet temperatures of 20 and 60°C. Design a gasketed-plate heat exchanger for this duty with stainless steel ($k = 15\ W/m \cdot K$) plates of 0.5 mm thick. Maximum operating pressure and allowable pressure for both fluids is 2 barg and 0.6 bar respectively and maximum permissible velocity is 3 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 | Ethanol |
|---|---|---|
| Specific heat, $kJ/kg \cdot K$ | 4.179 | 2.46 |
| Viscosity, $cP$ | 0.705 | 0.67 |
| Thermal conductivity, $W/m \cdot K$ | 0.62 | 0.171 |
| Density, $kg/m^3$ | 995 | 772 |

3. (a) Explain use of sealing strips in shell and tube heat exchanger. [04]
   (b) How do overdesign influence operation of heat exchangers like condenser, reboiler and coolers? [04]
   (c) Explain working of horizontal thermosyphon reboiler with schematic sketch. [12]

4. (a) Write Algorithm for Lobo-Evans method. [15]
   (b) Explain operation of barometric condenser. [05]

5. A shell-and-tube heat exchanger has the following configuration: [20
The shell-side fluid is a hot water(mass flow = 7375 kg/h) with the following properties:

| | | | |
|---|---|---|---|
| Specific heat, $kcal/kg \cdot K$ | 4.3706 | Viscosity, $cP$ | 0.3307 |
| Thermal conductivity, $W/m \cdot K$ | 0.5787 | Specific gravity | 0.9673 |

Using Bell-Delaware method, calculate the shell side heat transfer coefficient for following data.

| Summary | | | | | |
|---|---|---|---|---|---|
| Number of tubes | 34 | | Pitch 1.25△ | 31.75 | mm |
| Shell ID | 279.401 | mm | No. of baffles | 35 | |
| Bundle diameter | 254.88 | mm | Baffle spacing (centre to centre) | 75 | mm |
| Tube OD | 25.4 | mm | Baffle cut | 24.48 | % |
| Sealing strips | none | | | | |

6. (a) 9072 kg/h of saturated cylcohexane vapour will be condensed at 83.33°C and 1.103 bar a using a tube bundle containing 147 tubes arranged for single pass. The tubes are 1 in. OD, 14BWG thickness with a length of 6096 mm. Calculate the condensing-side heat-transfer coefficient for the tube bundle is vertical and condensation occurs inside the tubes. Also calculate for horizontal condenser with condensation over tube, and comment on result. [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, if fouling is not considered while exchanger design? [04

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