Model Examination - October 2013
Seventh Semester - Chemical Engineering

CH 2407 – Process Equipment Design II

Time: Three hours   **Maximum: 100 marks**

Answer ALL Questions

Part A (5 x 2 = 10 marks)

1. Differentiate between 'McCabe-Thiele' and 'Ponchon-Savarit' methods of distillation column design.
2. What is the effect of 'absorption factor' on the number of stages (or transfer units) required for an absorber?
3. What is the effect of hydrostatic head of liquid in the evaporator on the boiling point of solution?
4. What are the design codes available for the design of shell and tube heat exchangers?
5. How do you specify the dimensions of a pipe?

Part B (20 marks)

6. Write down the steps involved in estimating the design dimensions of the following equipment. (5)

7. Make suitable calculations to show that the given design is satisfactory in meeting the heat transfer requirements. (No need to verify for pressure drop requirements). Start with an approx value for U of 600 $W/m^2.^oC$. (15)

Part C (50 marks)
8. Draw to scale the suitable views of the equipment, mark the salient parts, and dimensions.

Shell-and-tube Heat Exchanger

A shell and tube heat exchanger is to be designed to sub-cool condensate from a methanol condenser from 95°C to 40°C. Flow-rate of methanol is 28 kg/s. Brackish water will be used as the coolant, with a temperature rise from 25° to 40°C. Allowance should be made for fouling by including a fouling heat transfer coefficient for methanol as 5000 (W/m^2.^{o}C) and 3000 (W/m^2.^{o}C) on the brackish water stream. Thermal conductivity of cupro-nickel alloys is 50 W/m.^{o}C.

The fluid properties at their mean temperatures are given as:

Property	Water (at 32.5^{o}C)	Methanol (at 67.5^{o}C)
Specific heat (kJ/kg.^{o}C)	4.2	2.84
Thermal conductivity (W/m.^{o}C)	0.59	0.19
Density (kg/m^3)	995	750
Viscosity (cP)	0.8	0.34

The following heat exchanger configuration is available:
- Fixed tube sheet shell and tube exchanger: 1 shell pass and 2 tube passes.
- Brackish water on the tube side and methanol on the shell side.
- 918 number of cupro-nickel tubes of 20 mm OD, 16 mm ID, 4.88 m long each, arranged in triangular pitch, pitch of 1.25 times OD.
- Shell diameter: ID 894 mm, baffle spacing: 356 mm; 25% cut segmental baffles
- Tube side nozzle flanges: 100 NB, 150 psi, Shell side nozzle flanges: 150 NB, 150 psi