

**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. Draw the schematics of 'triangular pitch' and 'square pitch' tubes arrangements.
2. Draw the front and rear end views of 1-8 shell and tube pass partition arrangements.
3. What is the effect of reflux ratio on the diameter of column required for a distillation operation?
4. Why the ΔT of a reboiler, should be less than the critical temperature difference?
5. 'Horizontal cut segmental baffles are not suitable for condensers' Justify this statement.

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 (i) heat transfer requirements, and (ii) thickness of vapor drum (Corrosion allowance: 3 mm. Allowable stress = 98 N/mm²; joint efficiency = 70%) (15)

Part C (50 marks)

8. Draw to scale the suitable views of the equipment, mark the salient parts, and dimensions.

Question for Part B & Part C

Standard Vertical Short Tube Evaporator (Calandria Evaporator)

56,000 kg/hr of aqueous caustic soda solution containing 30% NaOH is to be concentrated to 70% NaOH, in a single effect evaporator. The feed enters at 35°C. The steam chest is fed with saturated steam at 1.7 atm(a). The pressure maintained inside the evaporator is 0.16 atm(a). The boiling point elevation for the boiling solution (70% solids) is 15°C over that of water. Specific heat of feed solution can be taken as that of water. Specific heat of superheated steam can be taken as 1.871 kJ/kg.°C.

The overall heat transfer coefficient, under normal operating conditions would be 2500 W/m².°C.

A vertical short-tube evaporator with the following specifications is available.

Tubes:

OD: 100 mm, thickness: 1.5 mm
pitch: triangular, 125 mm
length: 1220 mm
number of tubes: 626

Downtake:

Inner diameter: 1500 mm
Outer diameter: 1520 mm

Tubesheet: Diameter: 3710 mm; Thickness: 36 mm

Vapor drum: Height: 3000 mm; ID of shell: 3400 mm; Thickness: 12 mm; Dished end closure; There are 2 sight glasses on the vapor drum

Calandria: Thickness: 12 mm; ID of shell: 3400 mm