

B.Tech IV Year I Semester (R09) Regular & Supplementary Examinations December 2015

PROCESS EQUIPMENT DESIGN IN BIOTECHNOLOGY

(Biotechnology)

Time: 3 hours

Max. Marks: 70

SECTION – A

Answer any five questions from the following: (05 x 04 = 20 Marks)

- 1 Explain about common types of tube arrangements in shell and tube heat exchanger.
- 2 Briefly explain the construction of Double Pipe heat exchanger.
- 3 Explain about working of Calandria type evaporator.
- 4 Explain about estimation of pipe diameter for transportation of gases and liquids.
- 5 Explain about Spray Dryer with a neat figure.
- 6 Define HTU.
- 7 Explain about the working of Semi Batch Reactor.
- 8 Write about types of plates used in tray tower.

SECTION – B

Answer any one question (01 x 50 = 50 Marks)
(Assume suitable additional data, if necessary)

- 9 A double-effect evaporator is employed to concentrate 10,000 kg/h of caustic soda solution from 9% to 47% by weight NaOH. For this purpose backward feed arrangement is used. The feed enters the evaporator at 309 K. Process steam at 686.616 kPa.g is available and in the second effect a vacuum of 86.66 kPa is maintained. Design a suitable forced circulation system with equal heating surface in both the effects. Calculate the steam consumption and evaporation in each effect. Neglect boiling point rise. The overall heat transfer coefficients in the first and second effects are 2326 and 1744.5 W/(m².K) respectively. Take a specific heat value of 3.768 kJ/(kg.K) for all caustic streams.

Data:

For steam at 442.7 K, $\lambda_s = 2048 \text{ kJ/kg}$

For vapour at 326.3 K, $H_v = 2597.61 \text{ kJ/kg}$, $\lambda_v = 2377.8 \text{ kJ/kg}$

For vapour at 388.4 K, $H_v = 2699.8 \text{ kJ/kg}$, $\lambda_v = 2214.92 \text{ kJ/kg}$

For vapour at 392.8 K, $H_v = 2705.22 \text{ kJ/kg}$, $\lambda_v = 2202.8 \text{ kJ/kg}$

- 10 A rotary dryer using counter-current flow is to be used to dry 1200 kg/h of wet salt containing 5% water (wet basis) to 0.10% water (wet basis). Heated air at 147°C with 50°C wet-bulb temperature is available. The specific heat of the salt is 0.21. The outlet temperature of air and salt are 72°C and 93°C respectively. Calculate the length and diameter of the dryer required. Assume that wet salt enters at temperature 30°C. Mass velocity is 5000 kg/(h.m²).

Data:

λ at 50°C = 569 kcal/kg

$C_{p \text{ salt}} = 0.21 \text{ kcal/(kg. } ^\circ\text{C)}$

$C_{p \text{ vapor}} = 0.45 \text{ kcal/(kg. } ^\circ\text{C)}$

$C_{p \text{ liquid}} = 1.00 \text{ kcal/(kg. } ^\circ\text{C)}$

$H_{\text{water}} = 0.05 \text{ kg water/kg dry air}$

Humid heat, $C_{\text{salt}} = 0.263 \text{ kcal/(kg. } ^\circ\text{C)}$