

14BT3009 Advanced Process Equipment Design

**Set
B**

**Time : 3 hrs
Total Marks: 100**

1. A storage tank of mild steel plates is to be fabricated. The capacity of the storage tank is 15m^3 . Density of oil is 950 kg/m^3 ; density of steel is $10,000\text{ kg/m}^3$. The plates of $1.8\text{ m} \times 3.6\text{ m}$ are available. The tank covers are flat plates; diameter is 3 m and length 5 m . suggest a suitable design and calculate the stressed induced in the tank plates. [20 marks]

OR

2. Briefly explain the steps involved for the design of internal and external loop Airlift fermenter? [20 marks]
3. Design the shell and tube heat exchanger. A heat exchanger is to be designed to cool $1,000\text{ m}^3/\text{hr}$ of chlorine gas at 15 atmospheres from 183°C to 38°C . The gas flows on the shell side of shell and tube heat exchanger and the cooling water through the tube. The water enters the heat exchanger at 3 atmospheres and at a temperature 25°C to 32°C . The heat exchanger is constructed of mild steel with copper tubes of 1.75 cm inner diameter and 2 cm outer diameter. The tube length is not to exceed 4.8 m and the water velocity is to be maintained below 2 m/sec . calculate a) total number of tubes b).number of passes to be used on the tube side of the desired heat duty. *Specific heat of chlorine gas = 0.48 kJ/kg . $K, h_0 = 5\text{ G}^{0.7}$,*

$$h_w = [950(1.3 + 0.18t) V^{0.8}]/D^{0.2}, \text{ Bulk temperature} = 32^\circ\text{C}; \text{ Flow area on the shell side} = 0.035\text{ m}^2; R_D = 0.015, \Delta T_m = 0.8 \Delta T_{lm} \quad [20\text{ marks}]$$

OR

4. Design the distillation column. Feed mixture containing 30 mole% ethanol and rest water is to be separated in to an overhead product contains 90mole % ethanol and the residue of 10 mole% ethanol. Feed is saturated liquid at its boiling and it's estimated to the column at the rate of 150 tons per day. The reflux ratio 2 times the minimum is to be used. A column is available with 55% efficiency. *Relative volatility = 2.28 ; Plate spacing = 50cm, Top temperature = 81°C ; Bottom temperature = 109°C .* [20 marks]
5. The drier has a uniform temperature of around 200°C at any point of time (working pressure in the drier is 0.1 N/mm^2). So the material used for the construction of the dryer should withstand the high (operating) temperature. Since mild steel withstand high temperature of 210°C . The material used to construct the dryer is mild steel and permissible pressure of material used is 124 N/mm^2 . Length of drier = 25 m ; Inner diameter of the drier = 2.6 m , Heat loss = 97.006 kW , Heat transfer = $56.78\text{ W/m}^2\text{K}$, density of MS = 480 lb/ft^3 and asbestos = 577 kg/m^3 , thermal conductivity of MS = $147.6\text{ W/m}^2\text{K}$ and asbestos = $681.4 \times 10^{-3}\text{ W/m}^2\text{K}$, feed rate = $25,000\text{ lb/hr}$, temperature $T_1 = 122^\circ\text{C}$, $T_2 = 76^\circ\text{C}$, [20 marks]

OR

6. Design a plate and frame filter press from the following data. Volume of the filter is $15,000\text{ liter}$, concentration of solid is 6 gm/l , density of the solid is 3 gm/cc , area of filtration is 1000 cm^2 and frame thickness is 3 cm .

Time (sec)	Volume (liter)
20	10
150	60

$$\text{Porosity} = 0.3, \quad \text{Pressure drop} = 5\text{ kgf/cm}^2, \quad \text{Viscosity of the fluid} = 0.001\text{ N.s/m}^2 \quad [20\text{ marks}]$$

7. Briefly explain the steps involved for the design of reactor? [20 marks]

OR

8. Briefly explain the steps involved for the design of extractor? [20 marks]
9. An evaporator is fed with $15,000\text{ kg/hr}$ of solution containing 5% solute by weight. The fed is a 35°C which is concentrated to a solution 25% solute per weight. The evaporator is operating with atmospheric pressure in the vapor phase. Steam is supplied 1.4 kg/cm^3 . Boiling point elevation is negligible. Properties of solution may be taken as that of water. $750\text{ kcal/hr m}^2\text{ }^\circ\text{C}$ ($900\text{ W/m}^2\text{ }^\circ\text{C}$) may be taken as overall heat transfer coefficient of evaporator. Calendric is of MS tubes ID = 16 mm , OD = 19 mm and 24 mm triangular pitch may be assumed. Design an evaporator. [20 marks]

Wishing you All the Best