Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SEVENTH SEMESTER B. TECH DEGREE EXAMINATION (S), FEBRUARY 2024
CHEMICAL ENGINEERING
(2020 SCHEME)

Course Code : **20CHT401**

Course Name: **Chemical Process Equipment Design - I**

Max. Marks : **100** **Duration: 3 Hours**

Instructions to Candidates

1. *Missing data may be assumed suitably.*
2. *Apart from scientific calculators the following books and data books are permitted for the exam:*
   - *Steam table.*
   - *Perry's Chemical Engineering Handbook.*
   - *Attested copies of Dühring's charts, Nomographs, charts and data tables used in design taken from TEMA standard/ Other editions of Handbook.*

(Answer any ONE question from each module, each question carries 50 marks)

MODULE I

1. 6,500 kg/hr of nitrobenzene is to be cooled from 124°C to 95°C by using benzene which is heated from 25°C to 50°C. The pipe sections available are 2-inch and 1.25-inch NPS standard pipes. Length of the pipe is taken as 3 m. The total dirt coefficient is 1500 W/m^{2}K. Find how many hairpins are required and also calculate the pressure drop on each side. (50)

   Physical properties of nitrobenzene at mean temperature:

   Specific heat = 1574.94 J/kgK.
   Density = 1205 kg/m^3.
   Thermal Conductivity = 0.1523 W/mK.
   Viscosity = 0.5 x 10^{-3} kg/ms.

OR

2. A shell and tube exchanger of 1-2 pass is required to cool 66700 kg/hr of ethylene glycol from 120°C to 103°C using toluene as coolant. Toluene is heated from 27°C to 63°C. Tubes of 14 BWG thickness OD of ¾ inch are used. The shell containing 25% cut segmental baffles are spaced 152 mm apart. Let ethylene glycol flow through tubes as it is more corrosive. Design the heat exchanger. (50)

   The properties of ethylene glycol are as follows:

   Density: 1045 kg/m^3
   Viscosity: 1.5 × 10^{-3} PaS
   Specific Heat: 2.856 kJ/kg°C
   Thermal Conductivity: 0.1776 W/mK

MODULE II

3. Design a single effect short tube vertical evaporator that has to be constructed to concentrate 15,000 kg/hr of 5% by weight NaOH solution, available at 25°C to a final concentration of 25% by weight. Saturated steam is available at 3.5 kgf/cm^2 (abs.) as the heating source. The pressure inside the evaporator is 50 cm Hg. The cross-sectional area of the downcomer should be approximately 50% of the total cross flow area of tubes. 50 mm outer diameter tubes having 4 mm thickness shall be used. The overall heat transfer coefficient is 1650 W/m^{2}K. (50)

OR

4. A cooling tower operates in the counter current mode, process hot water entering at 48°C and the cold-water leaves at 8°C approach to the wet bulb temperature. The entering air has a humidity of 0.001 kg/(kg dry air) and wet bulb temperature of 18°C. The cross-sectional area of the tower is 7 m^2. Determine the height of the fill required for a tower operating with a liquid loading of 1700 kg-H_2O/h·m^2 and an air loading of 1950 kg-air/h·m^2. The overall mass transfer coefficient $K_{y'a}$ is 2500 kg/m^3·h. Also determine the make-up water requirement and fan hp for 90% performance. (50)

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