Exam Date & Time: 09-Jan-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

PROCESS MODELLING AND SIMULATION
(CHE 3153)
MAKE UP EXAM, JAN-2024

PROCESS MODELLING AND SIMULATION [CHE 3153]

Marks: 50 **Duration: 180 mins.**

DESCRIPTIVE

Answer all the questions. Section Duration: 180 mins

***Answer ALL Questions**
*** Assume missing data suitably**
***Write neatly and Legibly**

1A) Water is flowing into a well-stirred tank at 150 kg/hr and methanol (MeOH) is being added at 30 kg/hr. The resulting solution is leaving the tank at 120 kg/hr. Because of effective stirring, the concentration of the outlet solution is the same as that within the tank. There are 100 kg of fresh water in the tank at the start of the operation, and the rates of input and output remain constant thereafter. Determine the outlet concentration (mass fraction of methanol) after 1 hr. (4)

1B) A dilute solution at 20°C is added to a well-stirred tank at the rate of 180 kg/hr. A heating coil having an area of 0.9 m^2 is located in the tank and contains steam condensing at 150°C. The heated liquid leaves at 120 kg/hr and at the temperature of the solution in the tank. There is 500 kg of solution at 40°C in the tank at the start of the operation. The overall heat-transfer coefficient is 342 kg/hr m^2 °C and the heat capacity of water is 1 k cal/kg °C .Determine the outlet temperature after 1 hr. (4)

1C) Discuss the Mechanistic model with an example (2)

2A) A gaseous mixture of components A and B is separated by permeating this mixture through a semi-permeable material. The apparatus used for this operation consists of a thin walled glass tube enclosed in a larger tube, through which the gaseous mixture flows at a high pressure. Gas permeates from the shell side, flows through the wall of the inner tube and out, while the remaining gas on the shell side flows out at the other end . This arrangement allows the gases on the shell side and the tube side to flow counter-currently. The gas A permeates through the wall of the glass tube much faster than gas B and the gas flowing out of the inner tube will be greatly enriched in component A. Develop the model equations to compute the flow rates and pressure inside the tube. Give briefly the solution procedure (5)

2B) Develop the mathematical model of the steady state co-counter current flow heat (3)

exchange in a double pipe heat exchanger.

2C) Discuss stochastic model with an example. (2)

3A) Derive Centre difference technique for solving convective problems (4)

3B) A fluid at velocity V is flowing through the unsteady state heat exchanger of diameter D. The heat Exchanger is steam heated. Develop the unsteady state mathematical model equation for the given system. List the assumption used. (4)

3C) Develop the heat equation. (2)

4A) Solve the following equation for f using Wegstein method

$$\frac{1}{\sqrt{f}} = -0.86\, ln\left[\frac{\frac{\varepsilon}{D}}{3.7} + \frac{2.51}{R_e\sqrt{f}}\right]$$ (5)

Where $\varepsilon/D = 10^{-4}$ and $R_e = 10^5$. Use starting f value as 0.01 and perform two iterations .

4B) Determine using the method of Newton –Raphson , the bubble point temperature for Vapor liquid equilibrium calculation for multi component mixture. (3)

4C) List the disadvantage of Modelling (any 4 points). (2)

5A) A water tank 6m high and 3m in diameter is drained by an orifice at the bottom. The exit velocity is given by $V_2 = 0.61*(2gh)^{0.5}$ m/sec . The orifice is 100mm in diameter and the tank is initially full. Determine the time taken to drain the tank to half its capacity. (4)

5B) Develop an equation for boiler. (4)

5C) Discuss briefly about boiling of multicomponent(say A, B,C) mixture (2)

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