Question Paper

Exam Date & Time: 29-Nov-2022 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

V Semester End Semester Examination

Process Modelling and Simulation (CHE-3153)

PROCESS MODELLING AND SIMULATION [CHE 3153]

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

Descriptive Questions

Answer all the questions. Section Duration: 180 mins

1) A) A tank contains 500 kg of a 10% salt solution. A stream containing salt at 20% concentration enters the tank at 10 kg/h and the mixture leaves the tank after thorough mixing at a rate of 5 kg/h. Determine an expression for the salt concentration in the tank as a function of time and the salt concentration in the tank after 3 hours. (4)

B) Solve the following system of equations using Newton- Raphson method (4)

$$x^2 - 1.732xy + 2y^2 = 10$$
$$4x^2 + 5.197xy + y = 22$$

Take $x_o = 1$ and $y_o = 0.5$. Perform 2 iteration.

C) Identify the disavantages of Modelling (2)

2) A) The chlorination of benzene produces mono-chlorobenzene, di-chlorobenzene and tri-chlorobenzene with reaction rate of K_1, K_2, K_3 respectively. The reaction is exothermic and carried out in semi-batch reactor fitted with cooling coils and reflux condenser. Develop model equations for maximizing the yield of the products formed. (4)

B) Develop the mathematical model for the pure liquid boiling in a jacketed vessel. (4)

C) Compare and contrast the Lumped and Distributed model (any 4 points) (2)

3) A) 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)

B) List the general modeling equations for a ternary equilibrium column of five stages including condenser and reboiler for a multi-component distillation column. (3)

C) Explain the boiling of pure liquid in an open vessel (2)

4) Derive Crank-Nicholson finite difference technique for solving Heat equation (4)

A)

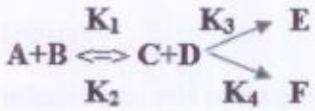
B) Derive Centre difference technique for solving convective problems (4)

C) Derive the heat equation (2)

5) Consider an tank open to the atmosphere, the inflow F_1 passes through a fixed inlet valve from a pressure source P_1 and the pressure downstream side is P_2. Whereas the pressure, upstream and (5)

A) downstream side of the outlet valve is P_2 and P_3 respectively with a flow rate of F_2. The flow is influenced by level Z and the pressure. **Derive the relation of Flow rate and Pressure across one of the valve. Draw the IFD**

B) Construct the dynamic response of components in a continuous stirred tank reactor when the volume of the tank is V , the inlet and outlet total volumetric flow rate is F_0 and F, the inlet concentration of A is C_{Ao}, and B is C_{Bo} for the following reaction (3)



C) Explain the Phenomenological model with an example (2)

-----End-----