SHAHEED BHAGAT SINGH STATE TECHNICAL CAMPUS, FEROZEPUR

ROLL NO : | | | | | | | | | | | | | **Total number of pages:[2]**

Total number of questions:08

M.Tech. -CHE/ 5th Sem

Process Modeling and Simulation

Subject Code : MTCH 502

Paper ID :

Batch:2011onwards

Time allowed: 3 Hrs **Max Marks: 100**

Important Instructions:

- **Attempt any five questions**
- **Assume any missing data**
- **Additional instructions, if any**

Q. 1. (a)Write the Component continuity & energy equations for a semi-batch reactor in which B is added to A.

(i). Consecutive reaction occurring with exothermic heat of reaction λ_1 & λ_2

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

(ii). Reversible with forward reaction exothermic heat of reaction λ_1 is taking place

$$A \underset{k_2}{\overset{k_1}{\rightleftharpoons}} B$$

(b) Derive the mathematical model for a Gas-liquid bubble Reactor for a reaction of type

$$A\,(g) + B(l) \rightarrow C(l)$$

On what factors the rate of such mass transfer reactions depends. Analyze the degree of freedom of the system.

Q. 2. (a) Develop the equations describing an "inverted" batch distillation column. This system has a large reflux drum into which the feed is charged. The material is fed to the top of the column. Vapor is generated in a re-boiler in the base. Heavy material is withdrawn from thebottem of column. Derive a mathematical model for the case when tray hold up cannot be neglected.

Q. 3. Benzene is nitrated in an isothermal CSTR in three sequential irreversible reactions.

Benzene + HNO_3 $\rightarrow$ Nitrobenzene + H_2O

Nitrobenzene + HNO_3 $\rightarrow$ Dinitrobenzene + H_2O

Dinitrobenzene + HNO_3 $\rightarrow$ Trinitrobenzene + H_2O

Assuming each reaction is linearly dependent on concentrations of each reactant, if the rate constants for the first, second & the third reactions are k_1, k_2, k_3 respectively. Derive the mathematical model of the system. There are two feed streams, one pure benzene & one concentrated nitric acid (98 wt%). Assume constant densities & complete miscibility.

Q. 4. (a)Derive the Mathematical Model for a Lumped Parameter Gas Absorber. List all the assumptions used in deriving the model.

(b) Develop a Mathematical Model for heat conduction through a solid sphere of radius R.The center temperature the sphere is maintained constant at Tmax.

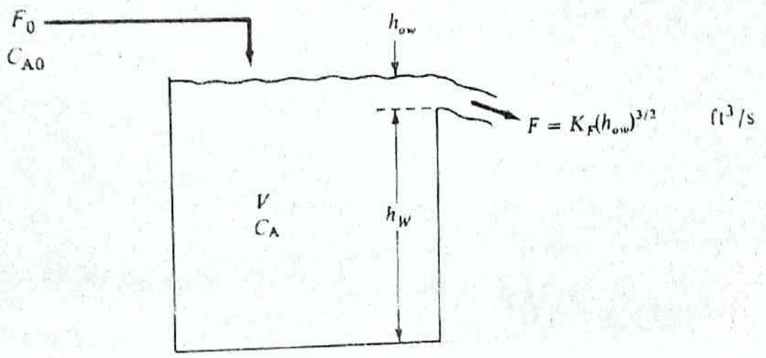
Q5. There are four storage tanks of volume V arranged so that when water is fed into the first tank, an equal volume of water overflows from the first tank into the second tank & so on. Each tank initially contains component A at some concentration C_0 & is equipped with a perfect stirrer. At time zero, a stream of zero concentration is fed into the first tank at a volumetric flow rate q. Find the resultant concentration in each of the tank as a function of time.

Q.6. (a) Derive the mathematical model for a PH system based upon Equilibrium constant method. Also give the iterative steps of the process to control the PH in the system.

(b) A perfectly mixed, isothermal CSTR has outlet weir. The flow rate over the weir is proportional to the height of the liquid over the weir, how to the 1.5 power. The weir height is hw. The cross-sectional area of the tank is A. Assume constant density. A first order reaction takes place in the tank.

$$A \longrightarrow B$$

Derive the equations describing the system.



Q. 7. Benzoic acid is continuously extracted from toluene using water as the solvent in a counter-current mode using two stages. Each stage consists of (1) a mixer where vigorous stirring of the contents takes place and (2) a settler where the mixture pumped from the mixer is slowed to settle into two layers. The upper toluene from the second stage and the lower water layer from the first stage, which varies with time are removed separately. Develop a mathematical model to find the final fraction of benzoic acid extracted by clearly mentioning the assumptions involved in the analysis.

Q. 8. Explain along with examples the following types of mathematical models:
(a). Deterministic models.
(b). Probabilistic models.
(c). Lumped Parameter models.
(d). Distributed Parameter models