Roll No. | | | | | | | | | | | | | Total No. of Pages : 02

Total No. of Questions : 09

B.Tech.(CHE) (2011 Onwards) (Sem.–7,8)

CHEMICAL PROCESS SIMULATION

Subject Code : BTCH-801

Paper ID : [A2976]

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.
2. SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt ANY FOUR questions.
3. SECTION-C contains THREE questions carrying TEN marks each and students have to attempt ANY TWO questions.

SECTION-A

1. Write briefly :

a) What is the significance of modeling and simulation in chemical industry?

b) What do you understand by parametric sensitivity?

c) Describe multicomponent flash drum.

d) What are the distributed parameter models?

e) Define Raoult's law and give its applications.

f) State the equations of state.

g) Distinguish between isothermal and non isothermal plug flow reactor.

h) What are the dynamic variables?

i) What is the need for modeling a heat exchanger?

j) What is the role of fundamental laws in mathematical modeling?

SECTION-B

2. Develop a mathematical model for three perfectly mixed isothermal CSTRs in series of isothermal CSTRs with constant holdup in which an irreversible exothermic reaction $A \xrightarrow{k_1} B$ occurs. State the assumption clearly. Also comment on the degree of freedom.

3. Consider a CSTR in which consecutive 1st order elementary liquid phase exothermic reactions $A \xrightarrow{k_1} B \xrightarrow{k_2} C$ occurs with exothermic heats of reaction λ_1 and λ_2 (energy units/mole of A or B reacted respectively). Heat of reaction is removed by a cooling jacket surrounding the reactor. Develop a mathematical model for the system assuming that the CSTR has a lumped cooling jacket. State the assumptions clearly and define the terms. Also comment on the degree of freedom.

4. Develop a mathematical model for an isothermal constant volume Gas-phase, pressurized CSTR which is fed with a perfectly mixed, mixture of gases and the reversible reaction $A \leftrightarrow B$ takes place in it. The forward reaction is 1.5th order *w.r.t.* A; while the reverse reaction is 1st order in B. The pressure in the vessel is P. The gas flows out of the reactor passes through a valve into another vessel held at a constant pressure P_D. State the assumptions clearly. Also comment on the degree of freedom.

5. Develop a liquid and vapour phase dynamics model for a vaporizer to which liquefied petroleum gas comprised of only pure propane is fed through valve into a pressurized tank to hold the liquid level in the tank. The heat is added to hold the desired pressure in the tank by vaporizing the liquid and gas is drawn off the top of the tank. State the terms and assumptions clearly. Also comment on the degree of freedom.

6. State and describe the continuity equation with the help of an example of application in generating the mathematical modeling equation for the turbulent flow of fluid through constant diameter cylindrical pipe by assuming the plug flow conditions.

SECTION-C

7. a) Develop a mathematical model for non-interacting tanks system. Comment on the degree of freedom of the model.

   b) Write the model equations involved in a batch reactor when it is in the cooling phase with a neat diagram.

8. Develop a mathematical model for ideal binary distillation column. State the assumptions completely. Comment on the degree of freedom.

9. a) In a cascade of stages in series, Benzoic acid is continuously being extracted from toluene using water as solvent. Vigorous stirring of the contents takes place at each stage. A settler is utilized where the mixture pumped from the mixer is allowed to settle into layers. The upper layer containing toluene and the lower water layer are removed separately. Develop a mathematical model for this counter current operation.

   b) Develop a mathematical model involving energy equation for two heated tanks connected in series. State the terms and assumptions clearly. Also comment on the degree of freedom.