Code No: NR410805 **NR**

IV B.Tech I Semester Supplementary Examinations, April/May 2005
PROCESS MODELLING & SIMULATION
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. Consider a continuous stirred tank reactor in which a chemical reaction is taking place in the liquid in the tank. Component A reacts irreversibly and at a specific reaction rate k to form product, component B.

$$\mathbf{A} \xrightarrow{\mathbf{k}} \mathbf{B}$$

The concentration of component A in the inflowing feed stream be C_{AO} and in the reactor C_A. Assuming a simple first order reaction, the rate of consumption of reactant A per unit volume will be directly proportional to the instantaneous concentration of A in the tank. Write the component continuity equations (component balances) and the total continuity equation (mass balance) for the above system.

2. Referring to the figure shown below, write the force balance equation for the liquid flowing through the pipe of cross sectional area A_p (m^2) and length L (m). The velocity of the liquid flow through the pipe is v (m/s). The vertical cylindrical tank has a cross-sectional area of A_T (m^2). The density of the liquid is ρ (kg/m^3). Assume the flow is turbulent, plug flow and the fluid is incompressible. State any other assumptions you make and explain the notation scheme used clearly.as shown in the figure1 below

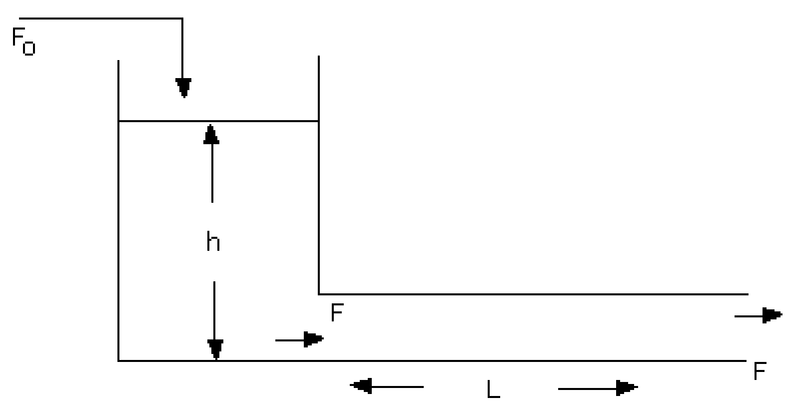

Figure 1:

3. A mixture of two immiscible liquids is fed into a decanter. The heavier liquid α settles to the bottom of the tank. The lighter liquid β forms a layer on the top. The two interfaces are detected by floats and are controlled by manipulating the two flows F_α and F_β.

$F_\alpha = K_\alpha h_\alpha$

$F_\beta = K_\beta \,(h_\alpha + h_\beta)$

The controllers increase or decrease the flows as the levels rise or fall. The total feed rate is F_O. The weight fraction of liquid α in the feed is x_α. The two densities ρ_α and ρ_β are constant. Write the equations describing the dynamic behavior of this system as shown in the (figure2).

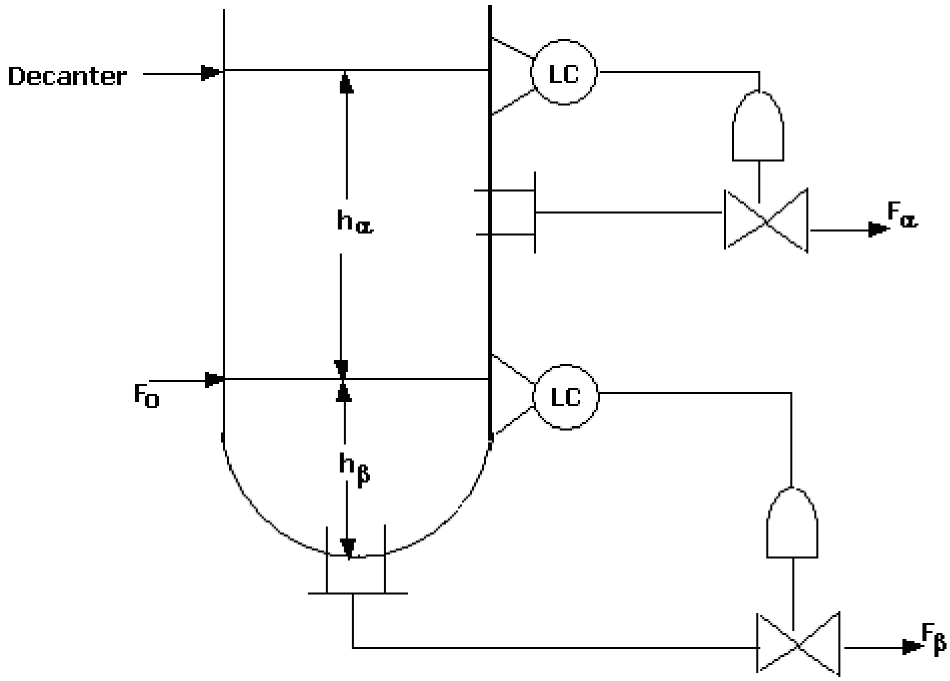

Figure 2:

4. Explain the Mass Transfer phenomena in a Reactor with a case study.

5. Derive the Model equations to describe the Batch distillation of a multicomponent mixture.

6. Explain the convergence procedure to find the bubble point temperature of a binary vapour-liquid mixture.

7. Develop a mathematical model for a gravity flow tank into which an incompressible liquid is pumped at a variable flow rate of F_o (m^3/s) .This inflow rate can vary with time because of changes in operations in the upstream The height of the liquid in the vertical cylindrical is h (m) .The flow rate out of the tank is F (m^3/s).Discuss the Explicit first order Euler method for solving the modeled equations.

8. Discuss the general "Newton - Rapshan" algorithm to determine the bubble point temperature for a binary system of components 1 and 2. Assume the system is ideal, Raoult's and Dalton's laws are applicable.

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