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Department of Chemical Engineering & Bio Technology

Assignment No.2
Subject: Chemical Process Simulation

Q1. Develop a mathematical model for a simple gravity flow tank into which an incompressible liquid is pumped at a variable flow rate of F_0 (m^3/s). This inflow rate can vary with time because of changes in operations 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 Newton-Raphson algorithms for solving the modeled equations.

Q2. A first order irreversible exothermic reaction $A \rightarrow B$ occurs in a series of three perfectly mixed CSTRs. Feed enters the first reactor and product leaves the third reactor. Derive the mass balance and component continuity equations considering isothermal and constant holdups. Assume constant density for the system, which is a binary mixture of A and B.

Q3. A fluid of constant density ρ is pumped into a cone-shaped tank of total volume $H = \pi R^2/3$. The flow out of the bottom of the tank is proportional to the square root of the height 'h' of liquid in the tank. Derive the equations describing the system and discuss the computer simulation for solving the equations.

Q4. An irreversible exothermic reaction is carried out in a single perfectly mixed non-isothermal CSTR. The reaction is $A \rightarrow B$. The reaction is n th order in reactant A and has heat of reaction λ (energy units/mole of A reacted). Negligible heat losses and constant densities are assumed. To remove the heat of reaction, a cooling jacket surrounds the reactor. Cooling water is added to the jacket at a constant volumetric flow rate. Develop a mathematical model for the system assuming that the CSTR has a non-uniform cooling jacket. State all the assumptions made and explain the notation scheme used clearly.