Department of Chemical Engineering
Assignment No.4

Subject: Chemical Process Simulation Semester: 7th, Chemical Engineering

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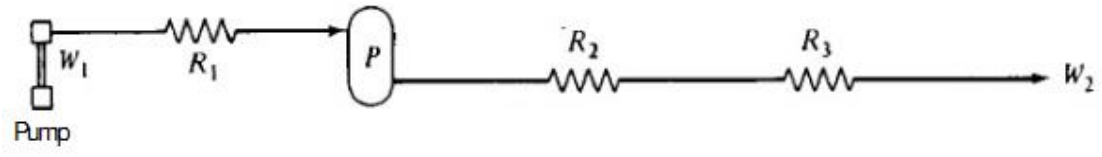
Q1. Consider the isothermal hydraulic system sketched below. A slightly compressible polymer liquid is pumped by a constant-speed, positive displacement pump so that the mass flow rate W_1 is constant. Liquid density is given by:

$\rho = \rho_0 + b*(P - P_0)$



Where ρ_0, b and P_0 are constants, ρ is the density, and P is the pressure. Liquid is pumped through three resistances where the pressure drop is proportional to the square of the mass flow: $\Delta P = RW^2$. A surge tank of volume V is located between R_1 and R_2 and is liquid full. The pressure downstream of R_3 is atmospheric. (a) Derive the differential equation that gives the pressure P in the tank as a function of time and WI. (b) Find the steady state value of tank pressure P.

Q2. Benzene is nitrated in an isothermal CSTR in three sequential irreversible reactions:

$$Benzene + HNO_3 \xrightarrow{k1} nitrobenzene + H_20$$
$$Nitrobenzene + HNO_3 \xrightarrow{k2} dinitrobenzene + H_20$$
$$Dinitrobenzene + HNO_3 \xrightarrow{k3} trinitrobenzene + H_20$$

Assuming each reaction is linearly dependent on the concentrations of each reactant; derive a dynamic mathematical model of the system. There are two feed streams, one pure benzene and one concentrated nitric acid (98 wt %). Assume constant densities and complete miscibility.

Q3. (a) Differentiate between lumped and distributed model. Explain these models with suitable example in context of chemical industry.

(b) How empirical model differ from statistical model? State the limitation of stochastic model.

(c) What do you understand from parametric sensitivity? How it plays an important role in mathematical modeling.