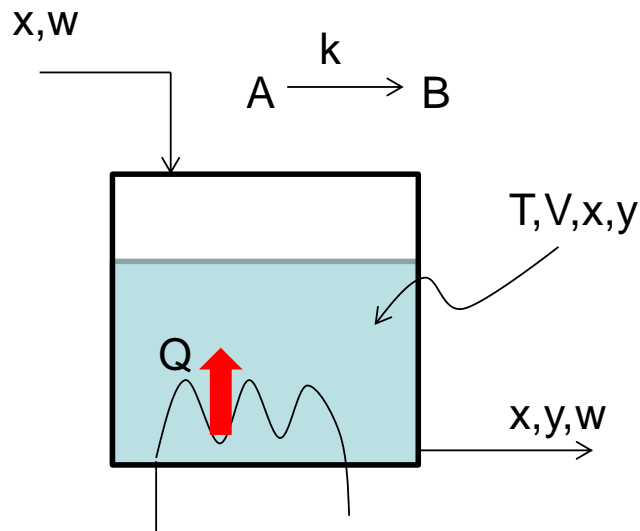


1. Consider a chemical reactor, in which a catalyst catalyzes the reaction $A \rightarrow B$ at the rate of $k = k_0 \cdot \exp(-\Delta E/RT)$. ΔE is a constant and corresponds to the activation energy for the reaction. A and B each has the molecular weight of M_A and M_B . T is the temperature of the liquid inside the reactor. The starting material A is fed to the reactor in an inlet stream of density ρ , which flows at the rate of w . The volume of the liquid is maintained at a constant V . The concentration of A in the inlet stream is x_i (mass fraction). The concentration of A in the outlet stream is x , which is the same as inside the tank. The concentration of B inside the tank is y (mass fraction), the same as in the outlet stream. The liquid is heated through a steam heater, which delivers heat at the rate of Q .



- At $T = 400^\circ\text{C}$, $\Delta E = 5 \text{ kcal/mol}$, $k = 3 \text{ mol/min}$. What is the value of k_0 ?
- Develop a dynamic model for the concentrations of A and B.
- Initially, the reaction is at steady state with the following values. What is the value of x ?

$k = 3 \text{ mol/min}$, $\Delta E = 5 \text{ kcal/mol}$, $T = 400^\circ\text{C}$, $w = 200 \text{ kg/min}$, $x_i = 0.2$, $x = 0.05$, $\rho = 1.1 \text{ kg/L}$, $V = 150 \text{ L}$, $M_A = 750 \text{ Da}$, $M_B = 650 \text{ Da}$.