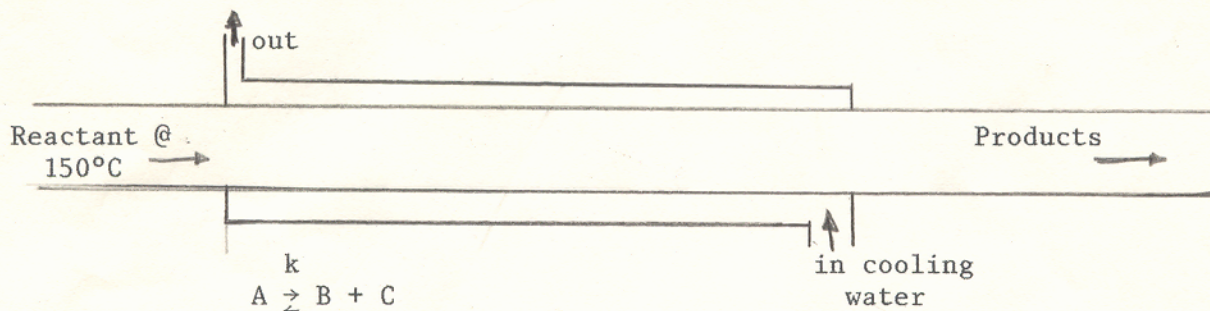


I. 50 points

You have been studying the use of a double pipe heat exchanger for an exothermic reversible reaction. The reactor is the inner tube of the exchanger and can be considered plug flow. The system operates countercurrently.



The reaction takes place in the liquid phase so that it may be considered constant density. The reaction is elementary.

Obviously, the energy balance for the reaction, the energy balance for the cooling water, and the material balance equations are coupled through the temperature. So you set up an iterative procedure to solve the equations. The first step of the procedure is to guess a temperature profile in the reactor and solve the material balance based on the assumed profile. The attached graph shows one of the assumed temperature profiles for one of the iterations along with the equilibrium curve. Given:

$$\begin{aligned}
 A &= 2.8 \times 10^7 \text{ min}^{-1} \\
 E &= 15000 \text{ cal/mole} \\
 C_{A0} &= 2 \text{ moles/lit} \\
 C_{B0} &= C_{C0} = 0 \\
 \Delta H_R &= 33,000 \text{ cal/mole (assume constant)} \\
 C_{PMIX} &= 18.0 \text{ cal/mole}^\circ\text{K (assume constant)} \\
 T_o &= 150^\circ\text{C} \\
 \tau &= 4.5 \text{ min}
 \end{aligned}$$

What is the calculated fractional conversion and exiting temperature for this iteration?

