Exercise 23

A second order quasi-instantaneous reaction $A_1 + A_2 \rightarrow P$ is carried out in a microreactor. Multi-point injection of reactant A_2 is required to reduce the hot spot.

Data

Mean heat capacity of reaction mixture $c_p = 1700\, J\, kg^{-1}K^{-1}$

Density of reaction mixture $\rho = 1142\, kg\, m^{-3}$

Reaction enthalpy $\Delta H_r = -120\, kJ\, mol^{-1}$

Inlet concentrations $c_{1,0} = c_{2,0} = 1.56\, kmol\, m^{-3}$

Total inlet flowrates $\dot{V}_{10} = \dot{V}_{20} = 0.9 \cdot 10^{-7}\, m^3\, s^{-1}$

Number of injection points for reactant A_2 = 6

Equal flow partition of reactant A_2

Microchannel diameter $d = 150 \cdot 10^{-6} m$

Overall volumetric heat transfer coefficient : $U_v = 5 \cdot 10^6\, Wm^{-3}K^{-1}$

Cooling temperature and inlet flow temperatures $T_c = T_{inj} = T_0 = 50°C$

Questions

- Calculate the adiabatic temperature rise at each injection point assuming $t_{rx} \ll t_{heat}$ and $t_{rx} \ll t_{mx}$
- For each segment, calculate the length required to remove 50% of the reaction heat.