

Exercise 22

Determine the maximum internal diameter in a cylindrical microchannel allowing stable operation for a fast first-order exothermic reaction. Stability criteria: $\Delta T'_{max} = 1.2$

Estimate the hot spot temperature.

(Calculate de conversion and temperature profile in the reactor - requires numerical integration)

Assumptions

- The main heat transfer resistance is on reaction channel side
- The laminar temperature profile is established

Data

Cooling temperature $T_c = 50^\circ C$

Inlet temperature $T_0 = 50^\circ C$

Rate constant at cooling temperature $k_{50^\circ C} = 0.2 \text{ s}^{-1}$

Activation energy $E = 80 \text{ kJ mol}^{-1}$

Reaction enthalpy $\Delta H_r = -150 \text{ kJ mol}^{-1}$

Inlet concentration $c_{1,0} = 0.7 \text{ kmol m}^{-3}$

Space time : $\tau = 15 \text{ s}$

Reaction mixture properties:

$\rho(\text{kg m}^{-3})$	867
$c_p(\text{J kg}^{-1}\text{K}^{-1})$	1720
$\lambda(\text{W K}^{-1}\text{m}^{-1})$	0.141
$\mu(\text{Pa} \cdot \text{s})$	$5.8 \cdot 10^{-4}$