

**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
$\mu (\text{Pa} \cdot \text{s})$	$5.8 \cdot 10^{-4}$