

# Workshop 09: External and internal diffusion effects

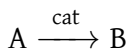
Lecture notes for chemical reaction engineering

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## P 14-9

The irreversible gas-phase reaction



is carried out adiabatically over a packed bed of solid catalyst particles. The reaction is first order in the concentration of A on the catalyst surface

$$-r'_{As} = k' C_{As}$$

The feed consists of 50% (mole) A and 50% inerts, and enters the bed at a temperature of 300 K. The entering volumetric flow rate is  $10 \text{ dm}^3/\text{s}$  (i.e.,  $10,000 \text{ cm}^3/\text{s}$ ). The relationship between the Sherwood number and the Reynolds number is

$$Sh = 100Re^{1/2}$$

As a first approximation, one may neglect pressure drop. The entering concentration of A is 1.0 M. Calculate the catalyst weight necessary to achieve 60% conversion of A for

- isothermal operation.
- adiabatic operation.

Additional information:

- Kinematic viscosity:  $\mu/\rho = 0.02 \text{ cm}^2/\text{s}$
- Particle diameter:  $d_p = 0.1 \text{ cm}$
- Superficial velocity:  $U = 10 \text{ cm}/\text{s}$
- Catalyst surface area/mass of catalyst bed:  $a = 60 \text{ cm}^2/\text{g} - \text{cat}$
- Diffusivity of A:  $D_e = 10^{-2} \text{ cm}^2/\text{s}$
- Heat of reaction:  $\Delta H_{Rx}^\circ = 10,000 \text{ cal}/\text{gmol}A$
- Heat capacities:  $C_{pA} = C_{pB} = 25 \text{ cal}/\text{gmol} \cdot K$ ,  $C_{pS}(\text{solvent}) = 75 \text{ cal}/\text{gmol} \cdot K$
- $k'(300K) = 0.01 \text{ cm}^3/\text{s} \cdot \text{g} - \text{cat}$  with  $E = 4000 \text{ cal}/\text{mol}$