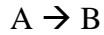


CBE 401: Chemical Reactor Fundamentals
Spring 2012
Homework Assignment

1. Batch Reactor Analysis via Analytical Expressions

Consider the following isomerization reaction



with an elementary mechanism such that the rate is

$$r = kC_A$$

where the rate constant is given by

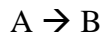
$$k = k_o \exp\left(-\frac{E_a}{RT}\right)$$

The temperature is 300 K. The activation energy is 5000 J/mol. The rate constant prefactor is 10.0 s^{-1} . The initial concentration of A is 10.0 mol/liter.

- (a) Provide an analytical expression for the residence time required to achieve a specified conversion for this reaction in a batch reactor.
- (b) What residence time is required to reach a conversion of 95%?
- (g) What conversion will one obtain if the residence time is 10 s?

2. CSTR Analysis via Analytical Expressions

Consider the following isomerization reaction



with an elementary mechanism such that the rate is

$$r = kC_A$$

where the rate constant is given by

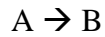
$$k = k_o \exp\left(-\frac{E_a}{RT}\right)$$

The temperature is 300 K. The activation energy is 5000 J/mol. The rate constant prefactor is 10.0 s^{-1} . The inlet flowrate is 2 liters/sec. The concentration of A in the inlet stream is 10 mol/liter.

- (a) Provide an analytical expression for the residence time required to achieve a specified conversion for this reaction in a batch reactor.
- (b) What is the Damköhler number for 95% conversion?
- (c) What residence time is required to reach a conversion of 95%?

3. PFR Analysis via Analytical Expressions

Consider the following isomerization reaction



with an elementary mechanism such that the rate is

$$r = kC_A$$

where the rate constant is given by

$$k = k_o \exp\left(-\frac{E_a}{RT}\right)$$

The temperature is 300 K. The activation energy is 5000 J/mol. The rate constant prefactor is 10.0 s^{-1} . The initial concentration of A is 10.0 mol/liter. The volumetric flowrate is 2 liter/sec.

- (a) Provide an analytical expression for the reactor volume required to achieve a specified conversion for this reaction in a PFR.
- (b) What length is required to reach a conversion of 95% if your PFR is a circular pipe with diameter 0.10 m?
- (c) What conversion is obtained in a PFR of length 2 m, if your PFR is a circular pipe with diameter 0.10 m?