Exam III: Lectures from October 4 - November 1

**Conversion in Non-Ideal Flow Reactors**



∫0∞Edt = 1

XA = 1 - Cout/Cin

Cout = ∫C Edt

E(t) = a + bt + ct2 + dt3 + ... ntn

Conversion at the reactor exit is the sum of the concentration of reactant remaining in an element multiplied by the fraction of exit between t and t+dt

XbarA = ∫XA Edt

Concentration element term depends on order

Zero order:

-rA = -dCA/dt = k

∫CA0CA -dCA = ∫0t kdt

CA0 - CA = kt

CA0-CA/CA0 = kt/CA0

1-CA/CA0 = kt/CA0

CA/CA0 = 1 - kt/CA0

First Order:

-rA = -dCA/dt = kCA

-dCA/CA = kdt

lnCA/CA0 = -kt

CA/CA0 = e-kt

Second Order:

-rA = -dCA/dt = kCA2

-dCA/CA2 = kdt

1/CA - 1/CA0 = kt

1 - CA/CA0 = CAkt

CA/CA0 = 1/(1 + CA0kt)

Nth Order:

-rA = -dCA/dt = kCAn

dCA/CAn = -kdt

1/(1-n) dCA1-n = -kdt

1/(1-n) (CA1-n - CA01-n) = -kt

(CA/CA0)1-n - 1 = (n-1)ktCA0n-1

(CA/CA0)1-n = 1 + (n-1)ktCA0n-1

CA/CA0 = (1 + (n-1)ktCA0n-1)1/(1-n)

**Conversion in Non-Ideal Flow vs. Ideal Flow Reactors**

* The space time parameter, τ, is equal to the reactor volume divided by the volumetric feed rate. τ is an important parameter in calculating conversion in ideal flow reactors
* Position where τ falls on x axis on E curve indicates how much more or less conversion is occurring in a non-ideal reactor sas compared to an ideal reactor.
* Area to left of τ is % of flow exiting reactor before τ. Less residence time than τ. Less likely to be converted.
* Want more particles to have residence time greater than tau. (Higher conversion)

**Example 11.4: Determining Conversion in Non-Ideal Reactors**

* Problem statement: A liquid is decomposing in a non-ideal reactor in Example 11.1 at a rate which can be expressed by rA = kCA where k = 0.307 min-1.
* Determine: Fraction of reactant unconverted in the real reactor and compare this with the fraction unconverted in a plug flow reactor of the same size.
* First order reaction
* τ = 15 minutes
* τp,ideal = ∫dC/r = ∫dC/-kC = 1/k lnCA0/CA
* CA/CA0 = e-kτ = 0.01
* Fraction of reactant unconverted in ideal PFR is 1%
* CA/CA0 = ∫CA/CA0 Edt = Σ(CA/CA0)EΔt = Σe-ktEΔt = 0.0469
* Fraction of reactant unconverted in non-ideal PFR is 4.69%