Dispersion Model: diffusion-like process superimposed on the PFR.

To model normal flow behavior, must model mass transport and reaction kinetics.

Inject pulse input. Amount of spreading depends on dimensionless group (D/uL)

* Large D means rapid spreading, ideal mixed flow
* Small D means slow spreading
* D=0 means no spreading, ideal plug flow

Fick’s Law: J = -D dC/dx, ∂C/∂t = D ∂2C/∂x2

Eσ = Eτ

σ = t/τ

How to determine conversion or extent of reaction with dispersion model?

Fundamental principle: conservation of mass

Determine flux from volumetric flow rate: q (m3/s)/ s = C\*u

In:

Bulk: CA,luS

Disp: -(DS dCA/dl)l

Out:

Bulk: CA,l+ΔluS

Disp: -(DSdCA/dl)l+Δl

Rxn:

-rSΔl

CA,LuS - (DS dCA/dl)l - CA,l+ΔluS + (DSdCA/dl)l+Δl = -rSΔl

u(CA,l - CA,l+Δl)/Δ - D((dCA/dl)l - (dCA/dl)l+Δl)/Δl = -r

udCA/dl - Dd2CA/dl2 + (-r) = 0

-r = kCAn

Dd2CA/dl2 - udCA/dl - kCAn = 0

Z = l/L

D/L2 d2CA/dz2 - u/L dCA/dz -kCAn = 0

D/uL d2CA/dz2 - dCA/dz - kL/uCAn = 0

τ = V/uS = SL/uS = L/u

D/uL d2CA/dz2 - dCA/dz -kτCAn = 0

CA = CA,0(1-XA)

dCA = -CA0dXA

D/uL d2XA/dz2 - dXA/dz + kτCA,0n-1(1-XA)n = 0

XA(D/uL, kτCA,0n-1, n)