**Review**

PFR: constant change in concentration

MFR: stepwise change in concentration

For general nth order reactions

Increase the number of MFRs in system, performance changes to approach PFR.

Greatest change occurs by adding second MFR.

Key steps to solve with graph:

1. Find k\*𝜏
2. Find N
3. Find where lines intersect
4. X axis gives 1-XA

MFR in Series:

-r = kC

C1 = C0/(1 + k𝜏i)

C2 = C1/(1+k𝜏2)

Cn = C0/Ⲡ(1+k𝜏i)

If 𝜏i is the same: Cn = C0/Ⲡ(1+k𝜏)n

𝜏m = (C0-C)/kC2

Key matter when you see reactors in parallel:

>>> Split flow rates

To get highest performance, conversion has to be same from each pathway.

Split flow according to total reactor volumes.

To achieve highest conversion:

q1/q2 = V1/V2

q2/q3 = V2/V3

qT = (1 + V2/V1 + V3/V1) \* q1

**Recycle Reactor**

divert product stream from plug reactor and return a portion of it to entrance of reactor.

Recycle ratio **R** = volume of fluid returned to reactor entrance/volume leaving system

Product serves as catalyst for reaction

R = 0, nothing is recycled back

R = infinity, huge amounts of backflow, huge amounts of mixing, closer to MFR.

Performance of recycle reactor:

Mixer:

C0V + RVC = C1v’

C1 = (C0V + RVC)/(R+1)V = (C0 + RC)/(R + 1)

PFR:

v’C - v’(C+dC) = -rdV

v’dC = rdV

Integrate:

1/k \* ln(C1/C) = 1/k \* ln[(C0 + RC)/(R+1)C] = 𝜏/R+1

Ɣ = k𝜏/(R + 1)

(C0 + RC)/(R+1)C = eƔ

C0 = [(R+1) eƔ - R]C

C/C0 = 1-X = 1/(R+1)eƔ-R

X = [(R+1)eƔ - (R+1)]/[(R+1)eƔ-R]

Recycle Ratio = infinity, MFR performance equation: X = k𝜏/(1+k𝜏)

Recycle Ratio = 0, PFR performance equation: X = 1-e-k𝜏

As R increases, X decreases

**Autocatalytic Reactions**

A + R --> R + R

A-->C P + C

Product catalyzes reaction

When you don’t have anything in system, reaction rate is low

As reaction occurs, accumulate products, deplete reactants

At some point, achieve max reaction rate because -rA = kCACR

Unique feature about reaction: total concentration remains the same

CA0 + CR0 = CA + CR = CT

-dCA/dt = kCA (C0 - CA)

Kt = integration (-dCA/CA(C0-CA))

Kt = integration (1/C0[1/CA + 1/C0 -CA]

Kt = 1/C0[lnCA0/CA + ln(C0-CA)/(C0-CA0)]

In this case, as reaction progresses, maximum reaction rate is reached, reactants depleted. Useful model for microbial fermentation.