Reactor Combinations

A + P --> P + P

CT = CA0 + CP0 = CA + CP

𝜏m = C0-C/-r = CA0 - CA/kCA(1-CA)

𝜏p = 1/kCT \* ln(CA0/(1-CA0)/CA/(1-CA))

Use MFR to get to optimal concentration (where max reaction rate occurs)

Where dr/dC = 0, find C\* where this occurs

Total space-time = 𝜏m + 𝜏p = C0-C\*/kC\*(1-C\*) + 1/kCT \* ln(C\*/(1-C\*)/CA/(1-CA))

In example from last time, the combination of MFR + PFR increased efficiency by 50-60%!

**Example**

500L MFR

Product B or product C from raw material A

A --> 2B or 2A -->C

K = 0.3 min-1

K = 0.2 min-1

CA0 = 0.5 mol/L

V = 50L/min

A costs $5/mol

B sells for $15/mol

C sells for $40/mol

Which product to make maximize profits?

*Profits = Revenues - Expenses*

A --> 2B

-rA = kCA

𝜏m = C0-CA/kCA = 0.5-CA/0.3\*CA = 10 min

3CA = 0.5CA

4CA = 0.5

CA = 0.125 mol/L

CB = 2(CA-CA0) = 0.75 mol/L

250 mol \* $5 = $1250

375 mol \* $15 = $5625

Profit = $4375

Profit / min = $437.50

2A --> C

-rA = kCA

𝜏m = C0-CA/kCA = 0.5-CA/0.2\*CA = 10 min

2CA = 0.5CA

3CA = 0.5

CA = 0.167 mol/L

CC = 1/2(CA-CA0) = 0.167 mol/L

250 mol \* $5 = $1250

83.3 mol \* $40 = $3333.33

Profit = $2083.33

Profit / min = $208.33

**A --> 2B should be used!!!**

Biomedical Modeling Example

Comparison of enzymatic protein digestion in stomach vs. colon

Stomach: V = 4.71 L, v = 0.2 L/hr (MFR model)

Colon: r = 1 cm, L = 15 cm (PFR model)

R = -Vm[P]/Km+[P], Vm = 0.1gm/L\*hr, Km = 0.5 gm/L, [P0] = 1gm/L

Calculate the conversion in each

Start with performance equations (spacetimes)

𝜏m = Vm/v0= [P0] - [P]/ Vm[P]/Km+[P]

𝜏p = Vp/v0 = pi\*1cm2\*15m/v0 = 0.0001 m2 \* pi \* 15 m/v0 = 0.004712 m3/v0 = 4.712 L / v0 = ∫d[P]/ -Vm[P]/Km+[P] = ∫ Km+[P]/Vm[P] d[P]

𝜏p = Km/Vm \* ln([P\*0]/[P]) + 1/Vm([P\*0]-[P])

For concentration entering colon, use ending concentration from stomach.