**Effects of different geometries on reaction rates for fluid-solid reactions**

Sphere

Ash phase control:

Assumes surface concentration is same as bulk concentration

Reaction is instantaneious at core surface

No volume changes upon reaction

Film Layer control System:



CAg = CAs = CAc

Assumes Concentration at core interface is same as bulk concentration

In = Rxn

-r = 1/v \* -dN/dt

-1/s \* dNB/dt = -1/s \* vb/va \* dNA/dt = vb/va \* ks \* (CAg - CAc)

b = vb/va

NB = ρB \* v = ρB \* 4πr3/3 = dNB/dt = ρB \* 4πr3/3 \* dr/dt

-1/s \* dNB/dt = -ρB \* dr/dt

-ρB \* dr/dt = vb/vaksCAg

-∫Rrc dr = vbks/va ρB \* CAg \* -∫0t dt

R - rc = vbksCAgt/vaρB

rc = 0

τ = ρBvaR/vbksCAg

Θ = t/τ = 1 - rc/R = 1 - (1 - XB)1/3

rC/R = (1 - XB)1/3

1 - XB = (rc/R)3

Example: Enzyme loading controlled by binding reaction (1st order WRT enzyme concentration) ks = 0.02 cm/s

Calculate times for complete loading

If restricted to 24 hours of loading, what is % of loading

E + B --> EB

ρB = 102 moles of binding sites / cm3

R = 1 cm

D = 1.2 \* 10-4 cm3/s

CEg = 0.01 mol/cm2

-1/s \* dNB/dt = -1/s \* vb/va \* dNA/dt = vb/va \* ks \* (CAg - CAc)

τ = ρBvaR/vbksCAg

τ = 102/cm\* 1 \* 1 / 1\* 0.02/s \* 0.01 =

Total tau = taufilm + tau rected layer + taureaction

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Remember the rows and columns

Film diffusion controlled

Flat plate: L = 1 cm

Cylinder R = 1 cm

Sphere R = 1 cm

Which has fastest complete reaction time?

Derive model for time(t) required for reaction front to move to position X, i.e. t = f(x)

Nomenclature: b = vb/va

vaA + vbB --> P

**Flat Plate**

S = Area

V = Area \* Δx

NB = ρBV

dNB/dt = ρ(area) \* dX/dt

-dNB/dt = -b \* dNA/dt

b = vb/va

-dNB/dt = b \* Area \* kf \* (CAg - CAs)

ρ \* Area dX/dt = b \* Area \* kf \* CAg

dX/dt = (b \* Area \* kf \* CAg) / ρ

X = bkfCAgt/ρ

τ = ρL/bkfCAg

**Sphere**

V = πr2 \* z

dV/dt = 2πrz \* dr/dt

-dNB/dt = ρdV/dt = 2ρπrz dr/dt

-dNB/dt = 2πrzbkfCAg

-r \* dr/dt = bkfCAgR/ρ

∫Rr -r dr = ∫0t RbkfCAg/ρ dt

(R2 - r2)/2 = RbkfCAgt/ρ