ENZYME PROBLEM 3C

$$S_{BULK} = 5.5\,g/L = 5.5\,mg/cm^3$$

$$V_{MAX}' = 5.2 \times 10^{-3}\,mg/cm^2\,min$$

$$k_L = 3.1 \times 10^{-4}\,\frac{cm}{s} \times \frac{60s}{min} = 0.0186\,cm/min$$

i) WHAT IS LIMITING PROCESS?

.... FIND Da!

$$Da = \frac{V_{MAX}'}{S_{BULK}\,k_L} = \frac{5.2 \times 10^{-3}\,mg/cm^2\,min}{(5.5\,mg/cm^3)(0.0186\,cm/min)}$$

$$Da = 0.051 \quad (< 1)$$

THIS DAMKÖHLER NUMBER INDICATES THE SYSTEM IS LIMITED BY REACTION KINETICS.

ii) THE BEST WAY TO IMPROVE THE PROCESS IS TO INCREASE ENZYME KINETICS (e.g., IMMOBILIZE BETTER ENZYME OR IMMOBILIZE TO GREATER IMMOBILIZATION DENSITY).

iii) $K_m = 1.3\ g/L$

THEN $\alpha = \frac{K_m}{S_{BULK}} = \frac{1.3}{5.5} = 0.2364$

$\beta = Da + \alpha - 1 = 0.051 + 0.236 + 1 = -0.713$

$x = \frac{-0.713}{2}\left(-1 \pm \sqrt{1 + 4(0.236)(0.713)^2}\right)$

← WILL USE −

$x = 0.959$

$\text{REACTION RATE} = \frac{V_{MAX}' x}{\alpha + x} = \frac{(5.2\times10^{-3})(0.959)}{(0.236 + 0.959)}$

$= 4.17 \times 10^{-3}\ mg/cm^2 min$

OR... $S_{SURF} = (0.959)(55) = 5.27\ g/L$

$\text{REACTION RATE} = \frac{V_{MAX}' S_{SURF}}{K_m + S_{SURF}}$

$= \frac{(5.2\times10^{-3})(5.27)}{(1.3 + 5.27)}$

$= 4.17 \times 10^{-3}\ mg/cm^2 min$

iv) MAKE A TABLE WITH VALUES. EACH PARAMETER MUST BE CALCULATED THE SAME WAY...

PARAMETER	BASE CASE	DOUBLING V_{max}'	DOUBLING S_{BULK}	DOUBLING k_L
V_{max}' $(\times 10^{-3})$	5.2	10.4	5.2	5.2
S_{BULK} (g/L)	5.5	5.5	11.0	5.5
k_L (cm/min)	0.0186	0.0186	0.0186	0.0372
Da	0.051	0.102	0.0255	0.0255
α	0.236	↓	↓	↓
β	-0.713	↓	↓	↓
X	0.959	↓	↓	↓
v $(\times 10^{-3})$	4.17	8.27	4.19	4.19

THE GREATEST IMPROVEMENT IN REACTION RATE COMES FROM DOUBLING V_{max}'