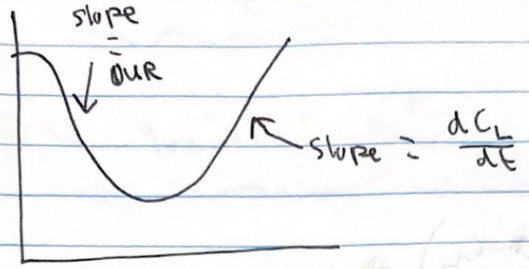
Josh Whitehead
ChEn 5103

HW 6

1) $K_L a = \dfrac{\dfrac{dC_L}{dt} + q_{O_2} X}{(C^* - C_L)}$



OUR
average ~~K_L a~~ ≈ 1

average $\dfrac{dC_L}{dt} \approx 0.5$

$\therefore K_L a = \dfrac{0.5 + 1}{7.3 + C_L}$

$\rightarrow$ $K_L a \approx -9.60 \times 10^{-2}$

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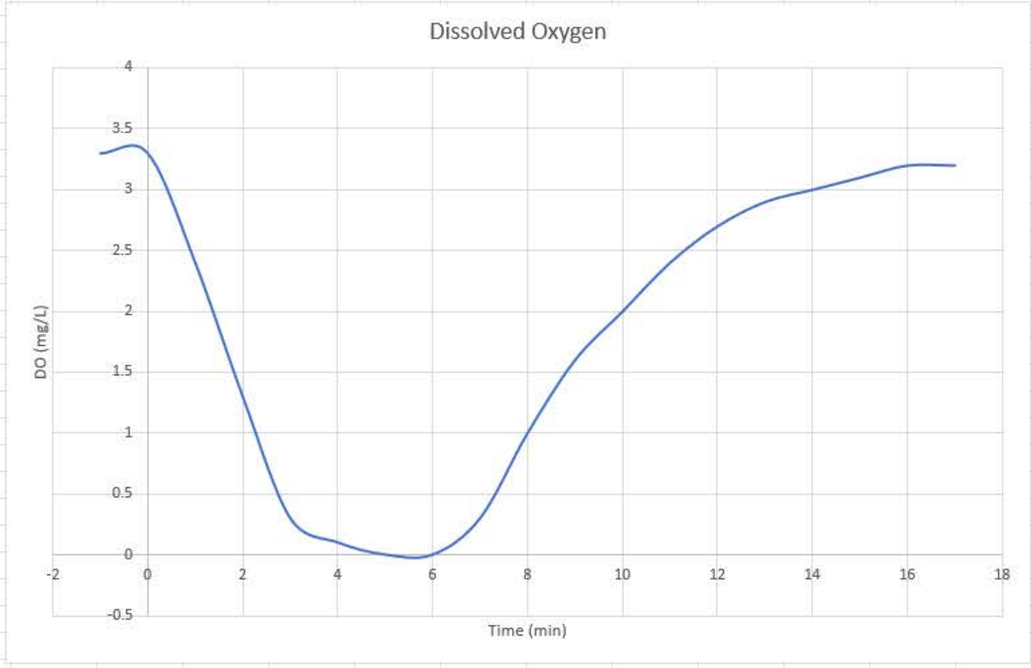
J37

	A	B	C	D	E	F
1	t	DO	c*	OUR	dcLdt	kLa
2	-1	3.3	7.3			-0.125
3	0	3.3				-0.125
4	1	2.4		-0.9		-0.10204
5	2	1.3		-1.1		-0.08333
6	3	0.3		-1		-0.07143
7	4	0.1				-0.06944
8	5	0				-0.06849
9	6	0				-0.06849
10	7	0.3			0.3	-0.07143
11	8	1			0.7	-0.07937
12	9	1.6			0.6	-0.08772
13	10	2			0.4	-0.09434
14	11	2.4			0.4	-0.10204
15	12	2.7			0.3	-0.1087
16	13	2.9			0.2	-0.11364
17	14	3			0.1	-0.11628
18	15	3.1			0.1	-0.11905
19	16	3.2			0.1	-0.12195
20	17	3.2				
21						
22				avg	avg	avg
23				-1	0.5	-0.09599



Format Shape

Fill

Line

No line

Solid line

Gradient line

Sheet1

Hw 6

2) $q_{O_2} = 10 \frac{mmol\ O_2}{g_{cell}\ hr}$

@ SS: $q_{O_2} X = K_L a (C^* - C_L)$

$K_L a = \frac{20}{hr}$

$C_L = 0.2 \frac{mg}{L}$

$C^* = 7 \frac{mg}{L}$

$$X_{max} = \frac{K_L a (C^* - C_L)}{q_{O_2}}$$

$$q_{O_2} = \frac{10\ mmol\ O_2}{g_{cell}\ hr} = \frac{0.010\ mol}{g_{cell}\ hr} = \frac{1\ g}{32\ mol} \cdot \frac{1000\ mg}{1\ g}$$

$$= 0.3125 \frac{mg\ O_2}{g_{cell}\ hr}$$

$$\therefore X_{max} = \frac{20(7 - 0.2)}{0.3125} = 435.2$$

$$\approx 435. \frac{g_{cell}}{hr}$$

IF $X = 1 \frac{mg}{L}$: $C^* = C_L + \frac{q_{O_2} X}{K_L a}$

$$= 0.2 + \frac{0.3125\ (1)}{20}$$

$$= 0.216 \frac{mg}{L}$$

.985

HW 6

3) $X = 20 \frac{g}{L}$ $\quad q_{O_2 max} = 240 \frac{mg\,O_2}{g_{cell}\,hr}$

$q_{O_2} = \frac{q_{O_2 max} C_L}{0.2 \frac{mg}{L} + C_L}$ $\quad K_L a = 120 \frac{}{hr}$

$C^* = 20 \frac{mg}{L}$

@ SS $q_{O_2} X = K_L a (C^* - C_L)$

$\therefore \frac{q_{O_2 max} C_L}{0.2 \frac{mg}{L} + C_L} = \frac{K_L a (C^* - C_L)}{X}$

$\therefore C_L = 0.196 \frac{mg}{L}$

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Hw 6

4) $D\frac{d^2S}{dy^2} = aS$

$a = \frac{2}{min}$

$D = 2\frac{cm^2}{min}$

$L = 1\,cm$

$d\left(\frac{dS}{dy}\right) = \frac{a}{D} S\,dy \rightarrow \frac{dS}{dy} = \frac{a}{D} S y + C_1$

@ $y = L$, $\frac{dS}{dy} = 0$ $\therefore$ $0 = \frac{a}{D} S(1) + C_1$

$\rightarrow C_1 = -\frac{a}{D} S$

$\frac{dS}{dy} = \frac{a}{D} S y - \frac{a}{D} S$

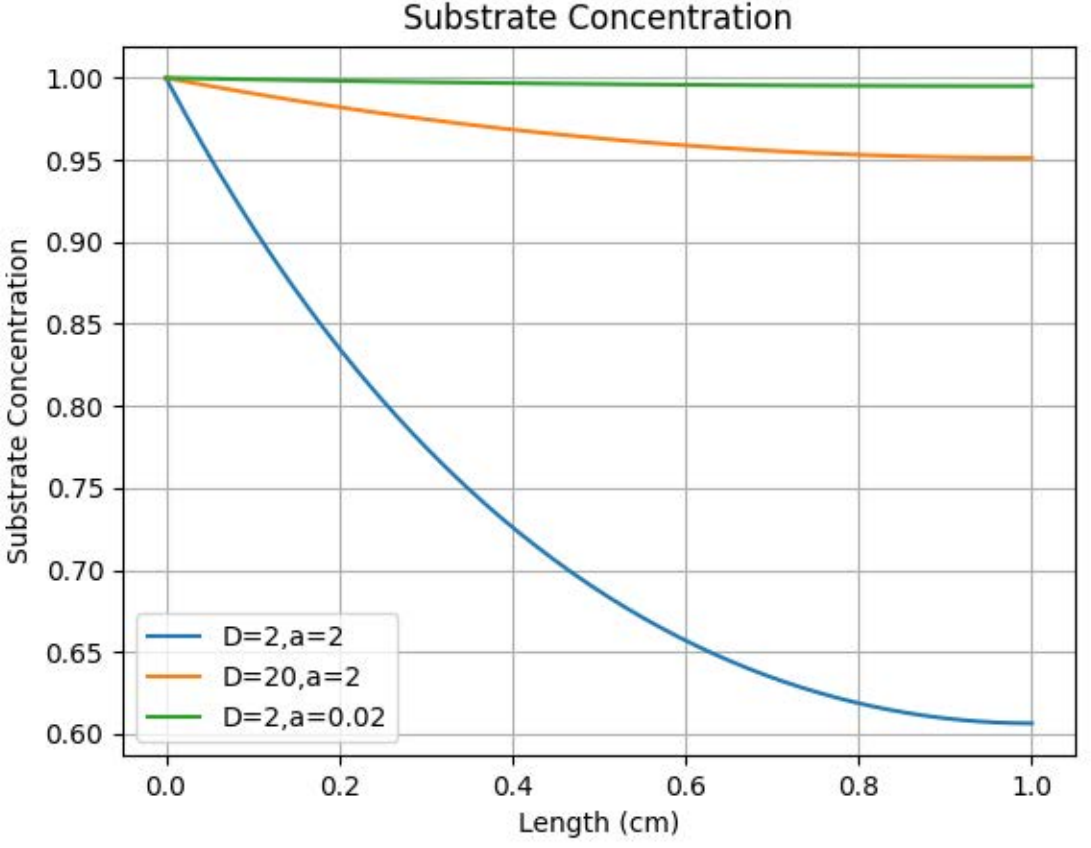
$\rightarrow \frac{dS}{S} = \frac{a}{D}(y-1)\,dy$

$\rightarrow \ln(S) = \frac{a}{D}\left(\frac{y^2}{2} - y\right) + C_2$

@ $y = 0$, $S = 1\,\frac{mL}{mL}$

$\therefore C_2 = 0$

$$S = \exp\left(\frac{a}{D}\left(\frac{y^2}{2} - y\right)\right)$$


Substrate Concentration
Substrate Concentration
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.0
0.2
0.4
0.6
0.8
1.0
Length (cm)
D=2,a=2
D=20,a=2
D=2,a=0.02