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SIMIODE Systemic Initiative for Modeling Investigations and Opportunities with Differential Equations

STUDENT VERSION
SUCROSE REACTION CHEMISTRY

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STATEMENT

At room temperature sucrose is hydrolyzed by the catalytic action of the enzyme sucrase as follows:

$$\text{sucrose} \xrightarrow{\text{sucrase}} \text{products}\,. \tag{1}$$

Starting with a sucrose concentration of $C_A(0) = 1.0$ millimol/liter and an enzyme concentration $C_{E0} = 0.01$ millimol/liter, the kinetic data in Table 1 are obtained (and plotted in Figure 1) in a batch reactor (concentrations calculated from optical rotation measurements):

t	0	1	2	3	4	5	6	7	8	9	10	11
$C_A(t)$	1	0.84	0.68	0.53	0.38	0.27	0.16	0.09	0.04	0.018	0.006	0.0025

Table 1. Data from batch reactor on hydrolysis of sucrose, first time t in hour and then $C_A(t)$ in millimol/liter.

Consider each of the following models and decide if they are appropriate. For one appropriate model find the estimates of the parameters and confirm the model is a reasonable model for this reaction. Furthermore, explain or confirm the significance and units of each of the parameters.

1. Exponential:
$$C_A'(t) = -k\,C_A(t)$$
where k is the reaction rate.
2. Effected Limited:
$$C_A'(t) = -k_1 e^{-k_2*(C_{E0}-C_A(t))}$$
where k_1 and k_2 are the reaction rates.

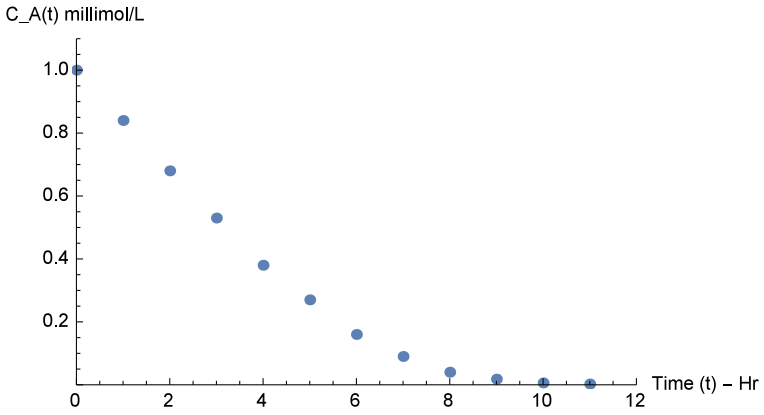

Figure 1. Plot of data (from Table 1) from batch reactor on hydrolysis of sucrose, first time t in hour and then $C_A(t)$ in millimol/liter.

3. Michaelis-Menten
$$C'_A(t) = -k\, C_A(t) \frac{C_{E0}}{C_A(t) + C_M}$$
where k is the reaction rate and C_M is the concentration of sucrose at which the reaction occurs at one half it maximum rate.
4. Logistic:
$$C'_A(t) = -k\, C_A(t) \frac{K - C_A(t)}{K}$$
where k is the reaction rate.