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STUDENT VERSION
SUCROSE REACTION CHEMISTRY

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Abstract: We offer data on the hydrolysis of sucrose in the presence of catalyst sucrase. We present students with several models and ask which model is best. Additionally, we ask students to estimate parameters for the best model and to validate the model and explain the significance of one of the parameters in the best model.

SCENARIO DESCRIPTION

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:

$$C_A'(t) = -k\,C_A(t)$$

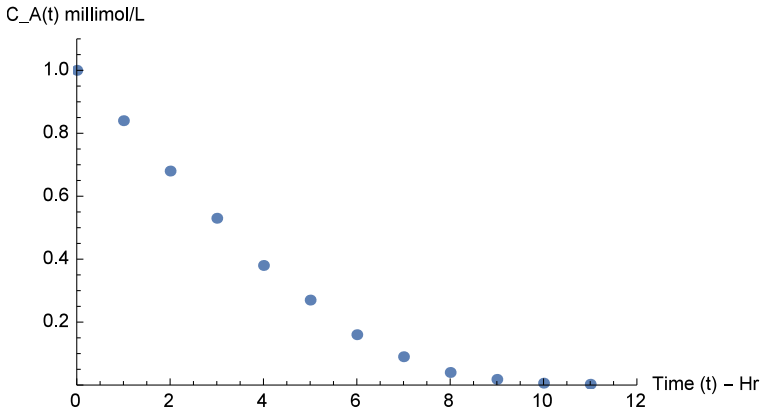

Figure 1. Plot of data (from Table 1) from batch reactor on hydrolysis of sucrose, first time t in hour and then $C_A(t)$ in millimol/liter.

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.

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.