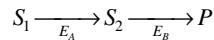


- 3.15.** The enzyme, urease, is immobilized in Ca-alginate beads 2 mm in diameter. When the urea concentration in the bulk liquid is 0.5 mM the rate of urea hydrolysis is  $v = 10$  mmoles/l-h. Diffusivity of urea in Ca-alginate beads is  $D_e = 1.5 \times 10^{-5}$  cm<sup>2</sup>/sec, and the Michaelis constant for the enzyme is  $K_m' = 0.2$  mM. By neglecting the liquid film resistance on the beads (i.e.,  $[S_o] = [S_s]$ ) determine the following:
- Maximum rate of hydrolysis  $V_m$ , Thiele modulus ( $\phi$ ), and effectiveness factor ( $\eta$ ).
  - What would be the  $V_m$ ,  $\phi$ , and  $\eta$  values for a particle size of  $D_p = 4$  mm?
- Hint:* Assume  $\eta = 3/\phi$  for large values of  $\phi$  ( $\phi > 2$ ).
- 3.16.** Decarboxylation of glyoxalate (S) by mitochondria is inhibited by malonate (I). Using the following data obtained in batch experiments, determine the following:

Glyox,S (mM)	Rate of CO <sub>2</sub> evolution, $v$ (mmoles/l-h)		
	I = 0	I = 1.26 mM	I = 1.95 mM
0.25	1.02	0.73	0.56
0.33	1.39	0.87	0.75
0.40	1.67	1.09	0.85
0.50	1.89	1.30	1.00
0.60	2.08	1.41	1.28
0.75	2.44	1.82	1.39
1.00	2.50	2.17	1.82

- What type of inhibition is this?
  - Determine the constants  $V_m$ ,  $K_m'$ , and  $K_i$ .
- 3.17.** Urea dissolved in aqueous solution is degraded to ammonia and CO<sub>2</sub> by the enzyme urease immobilized on surfaces of nonporous polymeric beads. Conversion rate is controlled by transfer of urea to the surface of the beads through liquid film, and the conversion takes place on the surfaces of the beads. The following parameters are given for the system.
- $k_L = 0.2$  cm/s;  $K_m = 200$  mg/l  
 $V_m' = 0.1$  mg urea/cm<sup>2</sup> support surface -s.  
 $S_b = 1000$  mg urea/l
- Determine the surface concentration of urea.
  - Determine the rate of urea degradation under mass transfer controlled conditions.
- 3.18.** Two enzymes are both immobilized on the same flat, nonporous surface. For enzyme A the substrate is  $S_1$ . For enzyme B the substrate is  $S_2$ . The product of the first reaction is  $S_2$ . That is:



- Figure 3.P1 depicts the rate of the first reaction on the surface as a function of local concentrations of  $S_1$ . If the bulk concentration of  $S_1$  is 100 mg/l and the mass transfer coefficient is  $4 \times 10^{-5}$  cm/s, what is the rate of consumption of  $S_1$  for a 1 cm<sup>2</sup> surface? What is the surface concentration of  $S_1$ ?
- The rate of the second reaction is:

$$-d[S_2]/dt = d[P]/dt = \frac{V_m'' S_{2,surface}}{K_m + S_{2,surface}}$$