A First Course on Kinetics and Reaction Engineering
Unit 9. Homogeneous and Enzymatic Catalysis

Definitions

homogeneous catalyst - a material that is in the same phase as a reacting mixture and that causes the rate of one or more reactions to increase without being produced or consumed

enzyme - a naturally occurring homogeneous catalyst present within living organisms

enzyme inhibitor - a chemical species that interacts with an enzyme causing its catalytic activity to decrease

enzyme co-factor - a chemical species, often a small molecule, that by binding to an enzyme, causes that enzyme to become catalytically active

Nomenclature

$\nu_{cat,i}$	number of catalyst species in the form originally added to the system that are needed to create one complex of the catalyst with species i
C_{cat}^{0}	equivalent concentration of the catalyst in the form originally added to the system (i. e. before any complexes, etc. are formed)
$C_{cat,i}$	concentration of complexes of the catalyst with species i; $i = free$ indicates the concentration of non-complexed catalyst
C_i	concentration of species i
V_{max}	maximum reaction velocity; a parameter in the Michaelis-Menten rate expression
K_m	Michaelis-Menten constant; a parameter in the Michaelis-Menten rate expression
r	generalized rate of reaction
t	time

Equations

$$C_{cat}^{0} = C_{cat,free} + \sum_{\substack{i=\text{ all catalyst complexing species}}} \nu_{cat,i} C_{cat,i} \tag{9.1}$$

$$\sum_{\substack{p=\text{ all positively charged species}}} C_p q_p = \sum_{\substack{n=\text{ all negatively charged species}}} C_n \left| q_n \right| \tag{9.2}$$

$$\text{E + S} \rightleftarrows \text{E-S} \tag{9.3}$$

$$\text{E-S} \rightarrow \text{E + P} \tag{9.4}$$

$$r = \frac{dC_P}{dt} = \frac{V_{\max} C_S}{K_m + C_S} \tag{9.5}$$

$$\frac{1}{r} = \left(\frac{K_m}{V_{\max}} \right) \frac{1}{C_S} + \frac{1}{V_{\max}} \tag{9.6}$$