When two or more *reversible* reactions of the same reactants compete under a given set of conditions, the system is said to be under thermodynamic control, and the major product is the more stable product, which is called the thermodynamic product. The conditions that ensure that the system is under thermodynamic control is called thermodynamic conditions.

\[
K_1, K_2 = \text{equilibrium constants}
\]

\[
K_1 = \frac{[C]}{[A][B]}, \quad K_2 = \frac{[D]}{[A][B]}
\]

\[
\frac{K_1}{K_2} = \frac{[C]}{[D]}
\]

If C is more stable than D, given that the two reactions have the same reactants,

\[
K_1 > K_2, \quad [C] > [D]
\]

C = major product, D = minor product

eg: Reaction of 1,3-butadiene (1) with HCl at high temperature

Two products were isolated:

\[
\begin{align*}
2 & : \quad \text{Cl} \\
3 & : \quad \text{Cl}
\end{align*}
\]

2 is more stable than 3 because it has the more highly substituted, therefore, stronger double bond. Experimentally, 2 is the major product, implying that the system is under thermodynamic control, i.e., the reactions leading to products 2 and
are reversible. The conditions used to ensure reversibility of the reactions, namely, high temperature, are thermodynamic conditions.

see also kinetic control

Contributors

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