Isolation Method (Ostwald's Method)

The **Isolation Method**, also known as the **Ostwald Method**, is an experimental method used to determine the order of a reaction with respect to each reactant separately. This method is particularly useful for reactions involving two or more reactants. In this method, the concentration of one reactant is taken in large excess compared to the others so that its concentration remains practically constant throughout the reaction. Under these conditions, the rate of reaction depends only on the concentration of the reactant present in the smaller amount. The order with respect to each reactant is determined separately, and the overall order of the reaction is obtained by adding the individual orders.

Principle

Consider the general reaction

$$aA + bB \longrightarrow \text{Products}$$

whose rate law is

$$\text{Rate} = k[A]^m[B]^n$$

where m and n are the orders of the reaction with respect to reactants A and B, respectively.

Determination of Order with Respect to Reactant A

Suppose reactant B is taken in a very large excess. Since only a very small fraction of B is consumed during the reaction, its concentration remains nearly constant.

$$[B] = \text{constant}$$

Therefore,

$$k[B]^n = k'$$

where k' is called the **pseudo-rate constant**.

The rate law becomes

$$\text{Rate} = k'[A]^m$$

The reaction now behaves as if it contains only one reactant, and the order with respect to reactant A can be determined using any suitable method such as the differential method, integrated method, or half-life method.

Determination of Order with Respect to Reactant B

Next, the experiment is repeated by taking reactant A in large excess.

$$[A] = \text{constant}$$

Hence,

$$k[A]^m = k''$$

where k'' is another pseudo-rate constant.

The rate law becomes

$$\text{Rate} = k''[B]^n$$

The order with respect to reactant B is then determined experimentally.

Overall Order of the Reaction

After determining the individual orders,

$$\boxed{\text{Overall Order} = m + n}$$

Procedure

1. Take one reactant in a very large excess so that its concentration remains practically constant.
2. Measure the reaction rate and determine the order with respect to the other reactant.
3. Repeat the experiment by taking the second reactant in large excess.
4. Determine the order with respect to the second reactant.
5. Add the individual orders to obtain the overall order of the reaction.

Advantages

- Suitable for reactions involving two or more reactants.
- Simplifies complex rate equations into pseudo-first-order or pseudo-second-order equations.
- Provides the order of reaction with respect to each reactant separately.
- Widely used in enzyme kinetics and hydrolysis reactions.

Limitations

- Requires one reactant to be present in a sufficiently large excess.
- The concentration of the excess reactant must remain nearly constant throughout the experiment.
- Not suitable if all reactants are consumed at comparable rates.

Applications

- Determination of reaction order in bimolecular reactions.
- Study of enzyme-catalysed reactions.
- Hydrolysis reactions carried out in excess water.
- Reactions where one reactant can conveniently be maintained at a constant concentration.

Important Points

- The Isolation Method is also known as the **Ostwald Method**.
- One reactant is taken in large excess so that its concentration remains effectively constant.
- The reaction is converted into a **pseudo-order reaction**.
- The overall order is obtained by adding the individual orders of all reactants.
- This method is especially useful for determining the order of reactions involving multiple reactants.