

Kinetics of a Reaction

Introduction:

The speed of a chemical process can determine the usefulness of a process. A very slow reaction speed may not be practical, a very quick reaction speed may be dangerous. Measuring and controlling reaction rates makes it possible for chemists and engineers to make a variety of products, from antibiotics to fertilizers, in a safe and efficient manner. We will investigate how the rate of a reaction can be measured and how reaction conditions affect reaction rates.

Background:

This experiment is designed to study the kinetics of a chemical reaction. The reaction involves the oxidation of iodide ions by bromate ions in the presence of acid:



The reaction is somewhat slow at room temperature. As we have studied, reaction rate depends on the concentration of the reactants and the temperature of the system. The rate law for this reaction is a mathematical expression that relates the reaction rate to the concentration of the reactants. If the reaction rate is expressed as the rate of decrease in concentration of bromate ion, the rate law has the form:

$$\text{Rate} = \frac{-\Delta[\text{BrO}_3^-]}{\Delta t} = k[\text{I}^-]^x[\text{BrO}_3^-]^y[\text{H}^+]^z \quad (\text{equation 1})$$

The rate is equal to the change in concentration of the bromate ion divided by the change in time for the reaction to occur. The rate constant will change depending upon the temperature of the system. The concentration of each substance will be shown to affect the reaction rate as a function of its reaction order, represented by the exponents x , y , and z . The total rate law for the process is determined by measuring the rate, evaluating the rate constant, and determining the reaction order for each reactant in the process.

To find the rate of reaction a method is needed to measure the rate at which one of the reactants is consumed, or the rate at which one of the products is formed. In this experiment, the rate of reaction will be measured based on the rate of iodine formation. The reaction will be carried out in the presence of thiosulfate ions, which react with iodine as follows:



Reaction 1 is somewhat slow. Reaction 2 is extremely fast, meaning that as soon as the iodine is formed in reaction 1, it is consumed by reaction 2. Reaction 2 will proceed until all the thiosulfate is consumed, after which an increase in iodine concentration may be observed in the solution. The addition of a starch indicator can reveal the presence of

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