EXPERIMENT E4-I

Introduction to Kinetics: Factors that Affect the Rate of Reaction

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Section 5

Group 4

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**Objectives**

* Learn to list and rationalize the factors affecting the rate of reaction
* Explain various scenarios
* Learn how to balance theory with practice

**Introduction**

Chemical reactions occur at various rates. We can make reactions run faster or slower by being familiar with the factors affecting the rate. Chemical kinetics is the study of rates of chemical processes.

**Background**

We view atoms as very small spheres in constant motion to understand the factors affecting the rate of a chemical reaction. Molecules are groups of atoms bonded together and keep bouncing off each other. We’ll study the effect of concentration, surface area, temperature, and catalyst.

1. **Effect of Changing the Concentration of Reactants**

Molecules collide with each other to make chemical reactions occur. The more concentration of the reactants is, the more opportunities for a collision to occur is.

1. **Effect of Changing the Surface Area**

When one of the reactants is solid, if its surface area is increased, the portion of atoms available to collide is larger which lead to higher rate of a reaction.

1. **Effects of Changing the Temperature**

The average molecular kinetic energy of a sample is constant at a given temperature and molecules require activation energy to react. When the temperature is rising, the kinetic energy also goes up, which accelerates the reaction.

1. **Orientation of the Collisions**

To form bonds, atomic orbitals must overlap just right. Complex molecules can have shapes that make it unlikely for this overlapping of orbitals to happen in any collision. The likelihood of a correct spatial relationship is expressed in the constant ‘A’, which we will use later in a mathematical model of reaction rates.

1. **Effect of Adding a Catalyst**

A catalyst is a material that does not permanently change or get used up in a reaction, but helps the reaction run faster. Catalyst provides the alternative, lower energy reaction mechanism.

**Overview**

Each factor that affects the rate of reaction will be demonstrated with a chemical reaction or model. We should know how the changes we make will determine what the atoms are experiencing thereby leading to a change in the rate of reaction.

**Data Processing**

|  |  |  |  |
| --- | --- | --- | --- |
| Concentration effect | | Surface area effect | |
| 1M HCl | 6M HCl | 0.2g Fe Wire | 0.2g Fe Powder |
| Slow | Fast | Slow | Fast |
| Temperature effect | | Adding catalyst effect | |
| Ice Cold | Hot at 800C | 800C in 30-40s | 10ml Ice after 30s |
| Slow | Fast | Slow | Fast |

**Discussion**

**Part A. Effect of changing the concentration of reactants.**

In part A, we examine the effect of changing the concentration of reactants by use HCl solutions of different molarity to react with eggshells. As it’s hard to time how long the reaction takes, we must start two reactions as the same time so we could compare the rate of them easily.

**Part B. Effect of changing the surface area.**

**Case II Reaction between CuSO4 and iron metal.**

In this part, we found iron powder reacts with CuSO4 much more quickly than iron due to its larger surface area. However, our iron wire was longer than 8cm but we couldn’t cut it, which might cause some error. In addition, we consider the change of the color of CuSO4 as the end of the reaction, but in the reaction between CuSO4 and iron wire, theCuSO4 wasn’t green enough. In our theory, the phenomenon might be caused by the small surface area of iron wire. The surface of iron wire was covered by the Cu separated from the solution, which stopped the reaction.

**Part C. Effect of changing the temperature**

**Case II Reaction between CuSO4 and zine.**

In this experiment, we found the hot solution reacted much more quickly than the cold solution. The procedure asked the hot solution should be at 800C, but after we added the zine, the temperature of hot solution might be less than 800C, which might cause some error.

In addition, we forgot to add some water to the beaker constructing the ice bath. We should pay more attention to it.

**Part E. Effect of adding a catalyst**

**Case I Decomposing H2O2**

Part E is quite easy, we found when the temperature is higher, the catalyst would be more useful.

**Conclusion**

The experiment report includes knowledge about how various factors affect the rate of reaction and the result of our experiment. In the experiment, we examined how four factors affect the reaction. When the concentration of reactants is higher, the reaction will proceed more quickly due to the higher opportunities for atoms to collide. When the surface area is larger, there will be more atoms available to collide, accelerating the reaction. When the temperature is higher, the kinetic energy is also higher, which leads to higher rate of reaction. The catalyst will also be more useful under higher temperature. Through the experiment, we formed a clear idea about the rate of reaction .

**References**

Prof. T. Hamade,” Introduction to Kinetics: Factors that Affect the Rate of Reaction”, UM-SJTU JI & SJTU Chemistry Department