**A Different Look at Kinetics**

Chancey, K. , Gordon, J. (2005). “Steel Wool and Oxygen: A look at Kinetics”. Journal of Chemical Education, v82 n7.

**INTRODUCTION**

The purpose of this experiment is to determine how the rate of a reaction depends on the concentration of one of the components. The reaction of interest is between the iron in steel wool and molecular oxygen:



As the reaction proceeds in a test tube, the iron in the steel wool will react with the molecular oxygen and the pressure inside the tube will decrease. In the Vernier pressure sensor’s electrochemical cell, the partial pressure of oxygen is determined. The corresponding voltage is converted to the units of percent oxygen. In this way, the change in concentration of oxygen will be tracked as the change in the percent of gaseous oxygen. The oxygen pressure sensor can be connected to a LabQuest or a Chromebook, if using the GoDirect Pressure Sensor and Graphical Analysis App.

Various percent of oxygen versus time graphs will be made to determine the order of the reaction with respect to the oxygen. One of the following graphs will determine the order of the reaction. As a reminder:

|  |  |  |
| --- | --- | --- |
| **Zero Order** | **First Order** | **Second Order** |
| **General Rate Law:** | **General Rate Law:** | **General Rate Law:** |
| A plot of **percent oxygen vs.** **time** will yield a straight line with a negative slope.  **Integrated Rate Law:**  (%O2)t=-kt + (%O2)o | A plot of In **percent oxygen vs. time** will yield a straight line with a negative slope according to the following equation:  **Integrated Rate Law:**  In(%O2)t=-kt + In (%O2)o | A plot of **1/percent oxygen vs. time** will yield a straight line with a positive slope according to the following equation:  **Integrated Rate Law:**  1/(%O2)t = kt + 1/(%O2)o |

**Materials**

Vernier pressure sensor

LabQuest Steel Wool 4.00 g

Acetone White vinegar (5%; 0.83 M Acetic acid)

Paper towels Test tube (150 x 25)

**SAFETY**

Acetone – CAS #67-64-1

Acetone is an extremely flammable liquid and vapor. The vapor may cause a flash fire. It is harmful if swallowed and causes irritation to the skin, eyes, and respiratory tract and can affect the central nervous system.

Steel Wool- CAS #7439-89-6 (iron 98%)

Steel wool is generally safe but care must be taken to avoid its contact with open flames and electricity as the wool can be a fire ignition source. In contact with mineral acids, steel wool can produce flammable hydrogen gas. It can cause eye irritation and upper respiratory disease.

Vinegar – CAS #64-19-7

Vinegar is generally safe, but exposure can cause irritation to the nose, throat and lungs. It can also cause damage to the corneal membranes of the eyes.

**PROCEDURE**

1. Weigh out a single piece of steel wool that is about 2.0 g. Wash the steel wool in acetone for about 30 seconds. Thoroughly dry the wool and then swirl it in about 50 ml of vinegar for about 30 seconds. Remove the steel wool from the vinegar and THOROUGHLY dry it with a paper towel. Repeat the washing with the dilute vinegar (10 mL of vinegar diluted to 100 mL with deionized water). After drying, QUICKLY place the steel wool into the test tube (150 x 25 mm) ensuring that it is not forced all the way to the bottom of the test tube. It should be spread out as possible to ensure the greatest surface area, which will decrease the reaction time. (NOTE: If the steel wool is not thoroughly dried of the acid, there is a possibility that hydrogen gas will be generated as a result of the reaction of the steel wool with the excess acid rather than the desired reaction with gaseous oxygen. Even thorough drying with paper towels leaves enough residual acid to catalyze the reaction.)
2. Connect the pressure sensor to the LabQuest or directly to the Chromebook if using the GoDirect sensors, and adjust the following settings:
   * Mode: Time Based
   * Rate: 2 samples/ min
   * Interval: 0.5 min/ sample
   * Duration: 30 min

\*A total of 61 samples will be collected

1. Once the steel wool is slid into the test tube, place the pressure sensor into the mouth of the test tube. It should fit very snuggly. Be careful not to press the sensor in so tightly that it breaks the test tube. Press Collect to begin collection.
2. Copy the data from the lists of percent oxygen and time data from the LabQuest. Construct the graphs as indicated in the introduction section. Include the graphs in your lab report.

**DATA/CALCULATIONS**

1. Construct appropriate tables from the data collected with the LabQuest
2. From the data, make 3 graphs: percent oxygen vs. time, in (percent oxygen) vs. time, and 1/ (percent oxygen) vs. time (with time always being the x-axis).

**CONCLUSION**

Write a brief conclusion paragraph indicating the order of the reaction with respect to the oxygen. Be sure to justify your answer using Your graphs.