The Reaction of Potassium Permanganate with Glycerin

Introduction

In this demonstration, a drop of glycerin is added to a pile of solid potassium permanganate causing purple flames and white smoke to be given off. The effect of surface area on reaction rate is then studied by comparing the results using finely ground potassium permanganate versus larger crystals of potassium permanganate.

Concepts

- Redox reactions
- Spontaneous combustion
- Effect of surface area on reaction rate
- Exothermic reactions

Materials

Glycerin, $C_3H_5(OH)_3$, 3 mL
Potassium permanganate, $KMnO_4$, 18 g
Beral-type pipets or medicine droppers, 2
Evaporating dishes or ceramic tiles, 3
Mortar and pestle
Safety shield
Spatula

Safety Precautions

This activity requires the use of hazardous components and/or has the potential for hazardous reactions. Potassium permanganate is a powerful oxidizing agent that can explode on sudden heating. Make sure the mortar and pestle are clean and dry before grinding the potassium permanganate. Potassium permanganate is a common cause of eye accidents. Potassium permanganate is a strong skin irritant and is slightly toxic by ingestion with an LD50 of 1090 mg/kg. Some people are allergic to glycerin and may experience irritation to the skin or eyes. Sparks, flames, and solid potassium permanganate may be expelled from the evaporating dish. Make sure all students are wearing safety goggles. Use of a safety shield is recommended. This demonstration should be performed outside, in a well-ventilated room, or in a fume hood and only by teachers. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

Part A. The Reaction Between Potassium Permanganate and Glycerin

Warning: This demonstration should only be performed outside, in a very well-ventilated room, or in a fume hood. Use of a safety shield is also recommended.

1. Grind 6 g of potassium permanganate into a fine powder with a mortar and pestle. Place the powder in a mound in an evaporating dish or on a ceramic tile. Make an indentation in the top of the mound with a spatula.
2. Place a safety shield in front of the experimental setup. Make sure that all students, chemicals, and flammable materials are at least 1 meter away from the reaction area.
3. Add 5 drops of glycerin to the indentation in the mound of potassium permanganate. Immediately step back and observe. The reaction will start in just a few seconds and will last only a few seconds. Sparks and solid potassium permanganate may be expelled violently from the reaction. A purple flame and white smoke will also be produced.

Part B. The Effect of Surface Area on Reaction Rate

4. Grind 6 g of potassium permanganate into a fine powder with a mortar and pestle. Place the powder in a mound in an evaporating dish or on a ceramic tile. Make an indentation in the top of the mound with a spatula.
5. Place 6 g of *non-ground* potassium permanganate in a mound in another evaporating dish or on another ceramic tile. Make an indentation in the top of the mound with a spatula.
6. Place a safety shield in front of the experimental setup. Make sure that all students, chemicals, and flammable materials are at least 1 meter away from the reaction area.

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7. Add 5 drops of glycerin to each mound simultaneously using two pipets or medicine droppers. Immediately step back and observe. The glycerin should react faster with the finely ground potassium permanganate due to the increased surface area from grinding.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. To remove any insoluble material stuck to the evaporating dish, prepare a paste of ferrous ammonium sulfate and dilute sulfuric acid and brush the dish with this paste. Dispose of any excess potassium permanganate according to Flinn Suggested Disposal Method #12a. Dispose of the products of the reaction according to Flinn Suggested Disposal Method #26a.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions, interactions of energy and matter

Discussion

The oxidation of glycerin by potassium permanganate is an example of spontaneous combustion—combustion that occurs at or even below room temperature. The reaction proceeds relatively slowly at first; however, the rate of the reaction begins to increase as the heat produced in this exothermic reaction accumulates. Eventually, enough heat is generated to initiate combustion.

The complete reaction mechanism is not known, although the primary reaction involves generation of white potassium carbonate, K_2CO_3, and black manganese(III) oxide, Mn_2O_3.

$$14KMnO_4(s) + 4C_3H_5(OH)_3(l) \rightarrow \underset{white}{7K_2CO_3(s)} + \underset{black}{7Mn_2O_3(s)} + 5CO_2(g) + 16H_2O(g) + \text{heat}$$

The solid residue that remains after the reactionis complete contains a green crystalline solid in addition to the products listed above. This indicates that other products besides those listed in the chemical equation must be produced in the reaction. If water is added to the residue, a green solution that contains a dark precipitate results. Shakashiri suggests that the green solution is potassium manganate, K_2MnO_4, and the dark precipitate is manganese(III) oxide and/or manganese dioxide, MnO_2.

References

Shakashiri, B. Z. Chemical Demonstrations: A Handbook for Teachers of Chemistry; University of Wisconsin: Madison, 1983; Vol. 1, pp 83–84.

Materials for *The Reaction of Potassium Permanganate with Glycerin* are available from Flinn Scientific, Inc.

Catalog No.	Description
P0077	Potassium Permanganate, 100 g
G0007	Glycerin, 500 mL
AP1273	Evaporating Dish, 80-mL
AP8257	Mortar, 50-mL
AP8260	Pestle, for Mortar AP8257

Consult the Flinn Scientific website for current prices.