Decomposition of Sodium Chlorate
Mass, Moles, and the Chemical Equation

Introduction

Sodium chlorate is used as a source of oxygen in emergency oxygen generators. So-called oxygen canisters or oxygen candles are found on airplanes, submarines, even the space station – anywhere oxygen might be in short supply in case of an emergency. Sodium chlorate decomposes upon heating or in the presence of metals to give oxygen gas. What is the chemical equation for the decomposition of sodium chlorate?

Concepts

- Moles
- Molecular formula
- Balanced chemical equation
- Stoichiometry

Background

Sodium chlorate, $NaClO_3$, is a colorless, odorless, white solid that melts at 248°C. When heated above 300°C, it begins to lose oxygen. The ultimate products of the thermal decomposition of sodium chlorate are oxygen gas and a white solid. Based on the molecular formula of sodium chlorate, three possible reactions will account for the loss of oxygen gas upon heating (Equations 1-3). Note that equations 1-3 are not balanced.

$$NaClO_{3(s)} \rightarrow NaClO_{2(s)} + O_{2(g)} \qquad \textit{Equation 1}$$

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What is the actual chemical equation for the thermal decomposition of sodium chlorate? All of the possible sodium-containing products in Equations 1-3 are real compounds: sodium chlorite, $NaClO_2$, sodium hypochlorite, NaClO; and sodium chloride, NaCl. All are white solids at room temperature. It is possible to determine the chemical equation for the decomposition of sodium chlorate by applying the principles of Stoichiometry to the masses of the reactants and products.

Experiment Overview

The purpose of this inquiry-based experiment is to design a small-scale procedure to determine the chemical equation for the thermal decomposition of sodium chlorate.

Pre-Lab Questions

1. Rewrite and balance Equations 1-3 for the thermal decomposition of sodium chlorate.
2. For each reaction 1-3, determine the mole ratios of reactants to products.
3. Calculate the molar masses of sodium chlorate and the three possible solid products in reactions 1-3.
4. For each reaction 1-3, calculate the amount of solid product that would be obtained from the thermal decomposition of 1.00 grams of sodium chlorate.
5. Explain how the information obtained in Question #4 can be used to determine the chemical equation for the decomposition of sodium chlorate.

Materials

Balance	Bunsen burner
Sodium Chlorate (0.5 – 0.75 g)	Spatula
Test tube	Test Tube clamp

Safety Precautions

Sodium chlorate is a strong oxidizing agent and a dangerous fire risk; it is slightly toxic by ingestion. Contact with metal powders or combustible organic compounds may cause fires. Keep away from contact with organic materials, including rubber stoppers, rubber tubing, etc. Avoid contact with eyes and skin. Do NOT dispose of excess sodium chlorate in the trash.

Procedure

1. Obtain a clean, dry test tube. Measure and record the mass of the test tube.
2. Using a spatula, add approximately 0.2-0.4 grams of sodium chlorate to the test tube.
3. Measure and record the combined mass of the test tube and sodium chlorate.
4. Place the test tube in a test tube clamp. Holding the test tube in an almost horizontal position, gently tap the test tube to distribute the solid sodium chlorate evenly along the bottom one-third of the test tube.
5. Light a Bunsen burner.
6. Slowly move the Bunsen burner back and forth across the test tube and solid to gently heat the solid. The solid should begin to melt and bubble slightly. Caution: Do not aim the opening of the test tube at anyone.
7. If a white smoke begins to fill the test tube, remove the Bunsen burner and allow the smoke to dissipate before continuing to heat. The smoke represents a loss of starting material due to evaporation of molten sodium chlorate and will reduce

the yield of product. A small amount of smoke may be inevitable and should not interfere with the accuracy of the results.

8. Continue to heat the test tube in the burner flame until no more bubbling is observed and the material in the test tube has solidified.
9. Allow the test tube to cool completely.
10. When the test tube has cooled completely, measure the combined mass of the test tube and its solid content.
11. Reheat the test tube for an additional three minutes.
12. Cool the test tube completely. Measure the mass a second time.
13. If the second mass differs from the first mass by more than 0.02 grams, repeat the heating cycle one more time.

Post-Lab Calculations

1. Find the initial mass of sodium chlorate and calculate the number of moles of sodium chlorate.
2. Based on the molar masses of the three possible solid products in Equations 1-3, and the number of moles of reactant in each case, calculate the expected masses of the three possible products.
3. Compare the actual mass of product obtained with the calculated or expected masses. What is the balanced chemical equation for the decomposition of sodium chlorate?
4. Use the following equation to determine the percent error in the mass of solid obtained.

$$\text{Percent error} = \left| \frac{(\text{actual mass} - \text{expected mass})}{\text{Expected mass}} \right| \times 100\%$$

5. Consider the following potential sources of error in this experiment. Explain whether they would have caused the actual mass of solid product to be lower or higher than the expected value.
   a. The sodium chlorate did not decompose completely.
   b. The sodium chlorate was heated too fast, allowing considerable white smoke to escape from the test tube.
   c. The sodium chlorate absorbed some moisture from the air before the experiment began and was not completely dry.