

Stoichiometry and Gravimetric Analysis

You are working for a company that makes water-softening agents for homes with hard water. Recently, there was a mix-up on the factory floor, and sodium carbonate solution was mistakenly mixed in a vat with an unknown quantity of distilled water. You must determine the amount of Na_2CO_3 in the vat in order to properly predict the percentage yield of the water-softening product.

When chemists are faced with problems that require them to determine the quantity of a substance by mass, they often use a technique called gravimetric analysis. In this technique, a small sample of the material undergoes a reaction with an excess of another reactant. The chosen reaction is one that almost always provides a yield near 100%. In other words, all of the reactant of unknown amount will be converted into product. If the mass of the product is carefully measured, you can use stoichiometry calculations to determine how much of the reactant of unknown amount was involved in the reaction. Then by comparing the size of the analysis sample with the size of the original material, you can determine exactly how much of the substance is present.

This procedure involves a double-displacement reaction between strontium chloride, SrCl_2 , and sodium carbonate, Na_2CO_3 . In general, this reaction can be used to determine the amount of any carbonate compound in a solution.

Remember that accurate results depend on precise mass measurements. Keep all glassware very clean, and do not lose any reactants or products during your lab work.

You will react an unknown amount of sodium carbonate with an excess of strontium chloride. After purifying the product, you will determine the following:

- how much product is present.
- how much Na_2CO_3 must have been present to produce that amount of product.
- how much Na_2CO_3 is contained in the 575 L of solution
- the molarity of the Na_2CO_3 solution.

OBJECTIVES

- Observe the reaction between strontium chloride and sodium carbonate, and write a balanced equation for the reaction.
- Demonstrate proficiency with gravimetric methods.
- Measure the mass of insoluble precipitate formed.
- Draw conclusions and relate the mass of precipitate formed to the mass of reactants before the reaction.
- Calculate the mass of sodium carbonate in a solution of unknown concentration.

MATERIALS

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| • balance | • graduated cylinder, 25 mL |
| • beaker, 250 mL | • Na_2CO_3 solution |
| • distilled water | • Erlenmeyer flask, 250 mL |
| • drying oven | • SrCl_2 solution |
| • filter paper | • water bottle |
| • funnel | • dropper |
| • glass stirring rod | |



Always wear safety goggles and a lab apron to protect your eyes and clothing. If you get a chemical in your eyes, immediately flush the chemical out at the eyewash station while calling to your teacher. Know the location of the emergency lab shower and eyewash station and the procedures for using them.



Do not touch any chemicals. If you get a chemical on your skin or clothing, wash the chemical off at the sink while calling to your teacher. Make sure you carefully read the labels and follow the precautions on all containers of chemicals that you use. If there are no precautions stated on the label, ask your teacher what precautions to follow. Do not taste any chemicals or items used in the laboratory. Never return leftovers to their original container; take only small amounts to avoid wasting supplies.

Procedure

1. Put on safety goggles and lab apron.
2. Clean all of the necessary lab equipment with soap and water. Rinse each piece of equipment with distilled water.
3. Obtain about 100 mL of the unknown SrCl_2 solution in a plastic cup.
4. Obtain a piece of filter paper, measure the mass to the nearest 0.001 g, and record this value.
5. Measure about 15 mL of the Na_2CO_3 solution into the graduated cylinder. Record this volume to the nearest 0.5 mL. Pour the Na_2CO_3 solution into a clean, empty 250 mL beaker. Carefully wash the graduated cylinder, and rinse it with distilled water.
6. Measure about 25 mL of the SrCl_2 solution into the graduated cylinder. Pour the SrCl_2 solution into the beaker with the Na_2CO_3 solution. Gently stir the solution and precipitate with a glass stirring rod.
7. Allow the precipitate to settle for 1 minute. Add a drop of SrCl_2 solution to determine if the reaction is complete. If not, add 10 additional mL of SrCl_2 solution. Repeat this step until you are certain the reaction is complete.
8. Obtain the 250 mL Erlenmeyer flask and funnel. Set up the filtration system and moisten the filter paper.
9. Slowly pour the mixture into the funnel. Be careful not to overfill the funnel because some of the precipitate could be lost between the filter paper and the funnel. Once most of the liquid has been filtered, use a wash bottle to rinse the sides and bottoms of the beaker to transfer all of the precipitate to the filter.
10. Rinse the beaker several more times with small amounts of distilled water. Pour the rinse water into the funnel each time.
11. After all of the solution and rinses have drained through the funnel, slowly rinse the precipitate on the filter paper in the funnel with distilled water to remove any soluble impurities.
12. Carefully remove the filter paper from the funnel, and place it on a watch glass. Place the watch glass in the oven to dry.
13. Pour the filtrate in the other 250 mL beaker into the designated waste container. Clean up the lab and all equipment after use, and dispose of substances according to your teacher's instructions. Wash your hands thoroughly after all lab work is finished and before you leave the lab.
14. After 24 hours: Measure and record the mass of the beaker with paper towel, filter paper, and precipitate to the nearest 0.001 g.
15. Dispose of the precipitate in a designated waste container. Clean up the lab and all equipment after use, and dispose of substances according to your teacher's instructions. Wash your hands thoroughly after all lab work is finished and before you leave the lab.

Analysis

1. Create a table for the data collected in the lab.
2. Write a total, balanced equation for the reaction. What is the precipitate?
3. Write the net ionic equation for this reaction.
4. Calculate the mass of the dry precipitate. Calculate the number of moles of precipitate produced in the reaction.
5. How many moles of Na_2CO_3 were present in the 15 mL sample? Calculate the molarity of this solution.
6. How many grams of Na_2CO_3 were present in the 15 mL sample?

7. How many grams of Na_2CO_3 were present in the original 575 L sample? How many moles is this? What was the molarity of the original solution?
8. Why do you not need to know how much SrCl_2 was added in the reaction?
9. Would adding additional distilled water to the Na_2CO_3 have affected the results in the experiment?
10. What affect would not rinsing your precipitate adequately enough have had on the results?
11. What affect would some of the precipitate passing through the filter paper during the filtration step have had on the results?