Separation of a Mixture
Percent Composition

Introduction

Most of the substances that we come in contact with every day – from the air we breathe to the water we drink and the foods we eat – are mixtures. How can the components of a mixture be separated and analyzed?

Concepts

- Mixture vs. pure substance
- Physical properties
- Percent yield
- Physical changes
- Mass percent composition

Background

A mixture is a combination of two or more pure substances that retain their separate chemical identities and properties. Since the amounts of each substance making up a mixture can be changed, the physical properties of a mixture depend on its composition. In contrast, the composition of a pure substance is constant, and thus pure substances have characteristic physical properties that do not change. Examples of physical properties that can be used to describe pure substances include solubility, conductivity, magnetism, density, boiling point and melting point.

By taking advantage of the unique physical properties of individual components within a mixture, it should be possible to separate a mixture into its components. For example, if one component in a mixture of two solids dissolves in water, while a second component does not, the components can be separated by adding water to the mixture and then filtering the residue. Subjecting the mixture to a physical change in this way would change the ratio of components in the mixture. This leads to one of the definitions of a mixture – a substance whose composition can be altered by a physical change. Physical changes that can be used to separate the components of a mixture include filtration, evaporation, crystallization, and distillation.

Mass percent composition is a convenient way to express the actual composition of a mixture in terms of the amount of each component. The mass percentage of each component in a mixture is calculated as follows:

$$\text{Mass \% of component} = (\text{mass of component} \div \text{total mass of mixture}) \times 100\%$$

In order to determine the percent composition of a mixture, it is necessary to separate the components quantitatively – without loss of material – and then measure the mass of each recovered component. The sum of the mass percentage of all components in a mixture equals 100%.

Experiment Overview

The purpose of this experiment is to study the physical properties of salt, sand, and iron and use this information to design and carry out a procedure to separate a mixture of these substances. The mass percent composition of the mixture can be calculated from the masses of the recovered components.

Pre-Lab Questions

1. The Department of Transportation uses a mixture of sand and salt to de-ice roadways in the winter. The mixture contains 8.35 tons of salt and 6.28 tons of sand. What is the mass percent of each component in the mixture?
2. A bakery needs a mixture of flour and sugar to make cookies. The mixture should contain 62.5% flour and 37.5% sugar. You are in charge of ordering the components to make 275 pounds of the mixture. How many pounds of flour and sugar should be ordered?

Materials

Iron, sand, and NaCl mixture sample
Magnet
Büchner funnel rubber stopper
Filter Paper,
Electronic balance
Distilled water
Büchner funnel
Filtering flask
Beaker, 100 mL
Weighing paper, 2 pieces
Stirring rod

Safety Precautions

The materials in this lab activity are considered relatively nonhazardous. Observe all normal laboratory safety procedures. Wear chemical splash goggles whenever chemicals, glassware, or heat are used in the chemistry laboratory.

Procedure

Part A. Physical Properties of Substances

1. Mass the iron, sand, and NaCl mixture sample. Record.
2. Separate the iron from the mixture using the magnet. Mass and record.

3. Place the sand and NaCl mixture into the beaker.
4. Add approximately 40-50 mL distilled water to the beaker. Stir to dissolve the salt.
5. Set up the Büchner funnel apparatus. Mass the filter paper and top portion of the Büchner funnel. Record.
6. Filter the mixture of sand/NaCl.
7. Remove the top portion of the funnel, place on a piece of paper towel, and place in the drying oven. Dispose of the salt water filtrate down the drain.
8. Mass the dried sand/filter paper/funnel. Record.

Post-Lab Calculations and Questions

1. The chemical formulas of iron and salt are Fe and NaCl, respectively. Are these substances elements or compounds?
2. Are any of the substances magnetic? Is magnetism a physical or chemical property?
3. Which substance(s) dissolved in water? Is solubility a physical or chemical property?
4. Is the combination of salt and sand a new compound or a mixture? Explain.
5. Describe the results of the filtration experiment. Which substance remained on the filter paper after filtration? Is the filtrate (the liquid that passed through the funnel) a pure substance? Explain.
6. Calculate the amount of each substance contained in the mixture sample.
7. Determine the mass percentage of each component in the mixture.