Steely Wools of Fire

Introduction

Burning steel wool demonstrates the rapid oxidation of metals, the importance of surface area to combustion, and the conservation of mass.

Concepts

- Combustion
- Surface area
- Combustion of metals
- Conservation of mass

Materials

Steel wool, very fine, 1 g
Acetone, 50 mL
Analytical balance
Beaker, 150-mL
Plastic weighing dish
Matches or Bunsen burner
Tongs, crucible, utility or test tube type

Safety Precautions

Acetone is flammable, a dangerous fire risk, and toxic by inhalation and ingestion. Use only with proper ventilation and keep away from any open flame or ignition source. Remove all flammable material from demonstration area. Have an ABC dry chemical fire extinguisher on hand during the demonstration. 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.

Preparation

Place steel wool in a beaker, cover it with acetone, and allow the steel wool to soak in the acetone for 15 to 20 minutes. Remove the steel wool and allow it to dry inside a fume hood. The acetone removes the oil or plastic coating that is usually present on steel wool to prevent rust or oxidation. Be sure all the acetone has evaporated before igniting the steel wool.

Procedure

1. Accurately determine the mass of about one gram of steel wool using an analytical balance. Use a plastic weighing dish to weigh the steel wool and to capture all the reaction products from the demonstration.
2. Unwrap the steel wool, pulling the strands apart as far as possible to get maximum surface exposure.
3. Hang the pulled-apart steel wool from a clamp on a ring stand or hold it with tongs.
4. Ignite the steel wool using a match, lighter or Bunsen burner. It will burn readily, which surprises most students. Some steel wool strands will break off from the bulk. However, if the combustion is done over the plastic weighing dish, most of the residue can be captured.
5. After about two minutes, the steel wool should be cool enough to handle. Return it to the weighing dish and determine its mass.
6. Ask students to predict if the mass of the combusted steel wool will be greater or less than the starting steel wool. They will usually say less, thinking about the ash from combustion of organic materials. Someone might predict no change due to conservation of mass. The mass actually increases due to the addition of oxygen.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The steel wool can be discarded in the trash according to Flinn Suggested Disposal Method #26a. The excess acetone can be evaporated in a fume hood according to Flinn Suggested Disposal Method #18a.

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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 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions, interactions of energy and matter

Discussion

Many students don't associate combustion as an oxidation process and don't realize that many elements, particularly metals will burn. Finely-divided metals, especially iron, magnesium, and zinc dusts are extremely flammable. The key to burning metals is the surface area of the metal and the amount of oxygen available. Airborne metal dusts or fine strands of metals have large surface areas where rapid oxidation can occur. For iron, two possible combustion reactions are possible.

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$$

$$3Fe(s) + 2O_2(g) \rightarrow Fe_3O_4(s)$$

Iron(III) oxide (Fe_2O_3) has a rust color, similar to the typical rust color of iron(III) hydroxide $Fe(OH)_3$, which is produced when iron is oxidized in the presence of water. Ferrosoferric oxide (Fe_3O_4) is a bluish-gray color.

If complete combustion occurs, the net gain of mass should be about 43% (M.W. Fe_2O_3/M.W. 2Fe = 159.7/111.7). However, due to incomplete combustion and losses due to the uncollected residue, mass increases around 20% are more common.

Reference

Bilash, B. B., Gross, G. R., Koob, J. K. *A Demo A Day;* Flinn Scientific: Batavia, IL 1995; p 201.

Materials for *Steely Wools of Fire* are available from Flinn Scientific Inc.

Catalog No.	Description
S0128	Steel Wool, 1-lb pkg.
A0009	Acetone, 500 mL

Consult the Flinn Scientific website for current prices.