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The Floating Tin Sponge

Chemical Demonstration

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Introduction

Create a floating tin sponge that rises to the surface upon reaction of an acidic stannous chloride solution with zinc. Two distinct single replacement reactions are clearly visible in this demonstration of the activity series of metals and the reactivity of metals with hydrochloric acid.

Chemical Concepts

- Single replacement reaction
- Oxidation–reduction
- Activity series of metals

Materials (for each demonstration)

Hydrochloric acid, 3 M, HCl, 200 mL
Stannous chloride, $SnCl_2 \cdot 2H_2O$, 23 g
Zinc, mossy, Zn, 15 g
Distilled water
Beaker, 500-mL
Forceps or tweezers
Graduated cylinder, 100- or 250-mL
Narrow-mouth reaction vessel (beaker or graduated cylinder)

Safety Precautions

Stannous chloride is moderately toxic; it is a skin irritant and is corrosive. Hydrochloric acid solution is toxic by ingestion or inhalation and is corrosive to skin and eyes. Zinc metal dust may be present at the bottom of the bottle of mossy zinc sponge. Zinc dust can be flammable. Please review the enclosed Material Safety Data Sheets for safety information and proper handling and disposal information. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron.

Pre-Lab Preparation

To 22.5 g of stannous chloride dihydrate in a 500-mL beaker add 65 mL of distilled water followed by 135 mL of 3 M hydrochloric acid solution. Mix thoroughly to dissolve. The solution will be cloudy and milky-white. Filter the solution through filter paper. (The solution is approximately 0.5 M in $SnCl_2$ and 2 M in HCl.)

Procedure

1. Pour 200 mL of the stannous chloride solution into a tall and fairly narrow reaction vessel.
2. Add 20–30 pieces (15–20 g) of mossy zinc—enough to cover most of the bottom of the reaction vessel.
3. Observe the formation of finely divided tin crystals on the zinc surface and the evolution of hydrogen gas bubbles generated by reaction of zinc with hydrochloric acid.

4. As the reaction proceeds the tin begins to resemble a steel-wool sponge. The tin sponge rises slowly to the surface, buoyed by the hydrogen gas bubbles and the presence of pockets of air. This phase of the demonstration may take between 10–30 minutes.
5. After the reaction is complete remove the tin sample from the solution using forceps or tweezers. Rinse the tin under running water and allow to air dry on paper towels.
6. In contrast to mossy zinc, which is very hard, the tin is soft and spongy and easily compressed.

Teaching Tips

- It is desirable, although not essential, to filter the acidic stannous chloride solution before use. The cloudy solution will eventually turn clear on its own as the reaction proceeds.
- Avoid stirring or agitating the tin sponge—the tin metal will compact and not float.
- Physical variables have a noticeable effect on the time needed for the tin sponge to float. Small, flat, and irregularly shaped zinc pieces provide a large surface area for the buoyancy effect of hydrogen gas bubbles and give the best result. A narrow reaction vessel traps gas bubbles more effectively and provides the maximum buoyancy effect as well.
- It may be convenient to prepare a reference demonstration: during pre-lab preparation carry out the reaction using one half of the recommended amounts of reagents. This reference demo will then be ready ahead of time to illustrate to the class the fact that the tin sponge floats in water.
- Floating tin forms instantaneously if granular zinc is used in place of mossy zinc. Granular zinc poses a relatively greater safety and health hazard.

Discussion

Addition of mossy zinc to acidic stannous chloride solution results in two separate single replacement reactions. The zinc pieces are coated immediately with tin crystals that look like shiny steel wool. The solution begins to effervesce with bubbles of hydrogen gas; as hydrogen gas continues to evolve the tin sponge bobs and floats to the surface.

Two oxidation–reduction reactions take place simultaneously. In the first reaction (Equation 1) metallic zinc is oxidized to Zn^{2+} by reaction with stannous chloride in solution; Sn^{2+} is correspondingly reduced to tin metal. This reaction is classified as a single replacement reaction in which the more reactive zinc metal replaces tin(II) ions to give tin, a less active metal. Single replacement reactions of metals with metal salt solutions are used to demonstrate the activity series of metals. Only metals that are more reactive than the other metal in the metal salt solution will react in this manner.

The second reaction (Equation 2) illustrates the oxidation of a metal by reaction with acid and is accompanied by reduction of H^+ to hydrogen gas. This reaction is also classified as a single replacement reaction in which zinc ion formally replaces H^+ ion.

$$Zn(s) + SnCl_2(aq) \longrightarrow Sn(s) + ZnCl_2(aq) \qquad \textit{(Equation 1)}$$

$$Zn(s) + 2\,HCl(aq) \longrightarrow H_2(g) + ZnCl_2(aq) \qquad \textit{(Equation 2)}$$

Disposal

Consult your current *Flinn Chemical and Biological Catalog/Reference Manual* for general guidelines governing disposal of laboratory waste. The elemental tin sponge can be rinsed thoroughly under cold running water, dried, and discarded in the trash. The remaining acidic stannous chloride solution can be disposed of according to Flinn Suggested Disposal Method #24b.

Reference

Summerlin, L. R. and Ealy, Jr., J. L., *Chemical Demonstrations: A Sourcebook for Teachers;* American Chemical Society: Washington, D.C., 1988; Vol. 1.

Materials for *The Floating Tin Sponge* are available from Flinn Scientific, Inc.

Catalog No.	Description	Price/Each
S0120	Stannous Chloride, 100 g	Consult Your Current *Flinn Catalog/Reference Manual.*
H0034	Hydrochloric Acid Solution, 3 M, 500 mL	
Z0003	Zinc, Mossy, 500 g	
AP4425	The Floating Tin Sponge Chemical Demonstration Kit	

