Fuel Cells in Eggshells

Synthesis Reactions

Introduction

What better way to teach students about reactivity and stoichiometry of gases than an Eggsplosion demonstration! This highly entertaining and effective activity is done by filling a blown-out eggshell with hydrogen gas. A combustible mixture of hydrogen and oxygen is added to the egg, which is then exploded by igniting the gases with an electrical spark from a piezoelectric igniter.

Concepts

- Reactivity of hydrogen
- Stoichiometry of gases
- Balancing chemical equations
- Activation energy

Materials

Chicken eggshell
Hydrochloric acid, HCl, 2.0 M, 40 mL
Hydrogen peroxide, H2O2, 3%, 40 mL
Yeast, baker's, 0.1 g
Zinc, mossy, 3.5 g
Brass tubing 9 cm (5/32") diameter
Bottle, dropping, 60-mL, 2
Ear protection
Electrical tape
Piezoelectric igniter
Pipet, wide stem, 2
Plastic soda bottle cap
Rubber stopper, size 5, 1-hole
Safety goggles
Safety shield
Scissors
Support stand
Utility clamp

Safety Precautions

Hydrochloric acid is toxic by ingestion and inhalation. It is severely corrosive to skin and eyes. Hydrogen peroxide, 3%, is very weak but is still considered an oxidizer and a skin and eye irritant. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Demonstrators should warn students to cover their ears when performing this demonstration. A safety shield should be used to minimize the chances of harm from the exploding eggshell. Demonstrators should wear and ear protection as well. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. Assemble the apparatus by wiring the piezoelectric igniter.
2. Drill a 5/32″ hold through the center of a soft drink bottle cap.
3. Insert the brass tubing through the rubber stopper and bottle cap. *Note:* The open face of the bottle cap will allow the egg to rest on the stand as shown in Figure 1.
4. Insert the speaker wire through the brass tubing so that it extends through the top of the tube.
5. Test that the Piezoelectric igniter is working properly by pressing the ignition button. When working properly, an electrical spark should be visible at the exposed ends of the two wires.

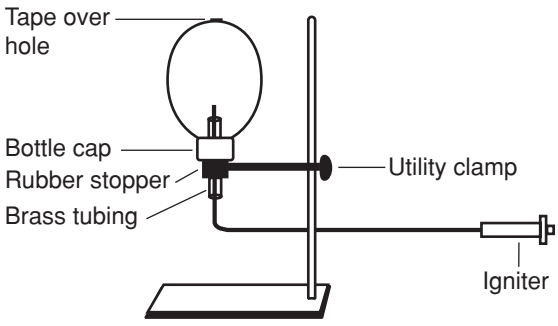

Figure 1. The assembled explosion apparatus.

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Procedure

1. Generate hydrogen gas by adding 40 mL of 2.0 M HCl to a 60-mL bottle containing about 3.5 g of mossy zinc.
2. Add the stem of a cut-off pipet to serve as a chimney from the bottle to the egg.
3. After approximately 15 seconds, the desired volume of hydrogen will be produced to fill a large-sized eggshell with the stoichiometric quantity of hydrogen gas.
4. Generate oxygen gas by adding 40 mL of 3% hydrogen peroxide to a second 60 mL bottle.
5. Add 0.1 g of Baker's yeast to the bottle containing 3% hydrogen peroxide.
6. Add the stem of a cut-off pipet to serve as a chimney from the bottle to the egg.
7. After approximately 15 seconds, the desired volume of oxygen will be produced to fill a large-sized eggshell with the stoichiometric quantity of oxygen gas.
8. Quickly place the fully charged egg onto the eggsplosion apparatus as shown in Figure 1.
9. Press the button on the piezoelectric igniter from behind a safety shield. The eggshell is immediately shattered into many small pieces.

Tip

- An Egg-Blower like the one used in the video may be found and purchased at hearthsong.com.

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 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Reference

Becker, R. *J. Chem. Educ.* **1992**, *69*, 229–230.

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Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Fuel Cells in Eggshells* activity, presented by Jeff Bracken, is available in *Synthesis Reactions* and in *Activation Energy*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Fuel Cells in Eggshells* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP6609	Piezoelectric Igniter, Basic
AP2305	Rubber Stopper, Size 5, One-Hole
Y0008	Yeast, Baker's
AP1222	Bottle, Dropping, Polyethylene with Push-On Cap
AP2253	Beral-type Pipet, Wide-Stem
AP8779	Hearing Protector
SE261	Safety Shield

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.