

Catalytic Oxidation of Acetone by Copper

Catalysis



Introduction

Visual evidence for what a catalyst does in the intermittent glow of a copper penny!

Concepts

- Catalysts
- Oxidation–reduction

Materials

| | |
|---------------------------------------------|---------------|
| Acetone, CH_3COCH_3 , 25 mL | Bunsen burner |
| Copper wire, Cu, #16 gauge, 15 cm | Glass rod |
| Copper penny, pre-1982 | Matches |
| Beaker, borosilicate glass, 250-mL | Wire gauze |
| Beaker, borosilicate glass, 600-mL | |

Safety Precautions

Acetone is a flammable solvent and a dangerous fire risk. It is slightly toxic by ingestion and inhalation. The reaction products are toxic by inhalation. Perform this demonstration in a well ventilated room or a fume hood. Use only borosilicate glassware (e.g., Pyrex) in 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

Drill a small hole in a pre-1982 penny. Tie the copper wire to the penny, leaving about 10 cm of the wire above the penny. Wrap the wire around a glass rod so that the penny will hang $\frac{1}{2}$ cm above the level of acetone liquid in the flask.

Procedure

1. Put approximately 25 mL of acetone into a 250-mL borosilicate glass beaker. Cap the bottle of acetone and remove the bottle from the area where flames will be used.
2. Remove the beaker from the area of the Bunsen burner. Light the burner and heat the penny until it glows red.
3. Set the penny in the beaker so that it sits *above* in the liquid level.
4. The penny will alternately glow and dim. The reaction will continue for several minutes.
5. Students should observe vapors wafting across the penny where it glows red.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The used acetone may be disposed of according to Flinn Suggested Disposal Method #18a.

Tips

- If the penny is too near the acetone, there is a chance the acetone will ignite. If so, smother the flame by covering the 250-mL beaker with a larger 600-mL beaker.
- Before doing the demonstration in front of the class, adjust the temperature of the penny and its height above the acetone to get the optimum reaction time.

Discussion

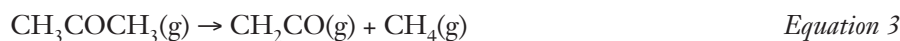
The copper surface of the hot penny catalyzes the oxidation of acetone. Hot copper reacts with oxygen in the air to produce a coating of copper oxide, CuO.



Once formed, the copper oxide reacts with acetone, producing ketene and methane and regenerating copper metal.



The overall reaction is:



The regeneration of the original copper metal, as well as the speed at which the oxidation occurs, illustrate the action of copper as a catalyst. The penny must be heated to a high temperature to overcome the activation energy barrier for the heterogeneous, gas-phase reaction. The penny alternately cools down and then glows again.

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

Constancy, change, and measurement

Content Standards: Grades 5–8

Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy

Content Standards: Grades 9–12

Content Standard B: Physical Science, structure of atoms, structure and properties of matter, chemical reactions

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of *Catalytic Oxidation of Acetone by Copper* activity, presented by Lee Marek, is available in *Catalysis* and *Reactions of Organic Compounds*, part of Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Catalytic Oxidation of Acetone by Copper* are available from Flinn Scientific, Inc.

| Catalog No. | Description |
|-------------|-----------------|
| A0009 | Acetone, 500 mL |
| C0182 | Copper Strips |

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