The Repetitive Exploding Flask

Introduction

Demonstrate the exothermic combustion of ethyl alcohol using platinum as a catalyst.

Concepts

- Catalysts
- Thermochemistry

Materials

Copper wire, Cu, 15 cm
Ethyl alcohol, CH_3CH_2OH, 50 to 75 mL
Platinum or Palladium wire, Pt or Pd, 30 cm
Bunsen burner
Damp cloth
Erlenmeyer flask, 1000-mL
Heat-resistant pad
Hot plate
Steel divider (see diagram)

Safety Precautions

Ethyl alcohol is flammable and it is a dangerous fire risk. Addition of denaturants makes the ethyl alcohol poisonous. Be very cautious when heating the coil with a flame. Keep the flame well away from the mouth of the flask. If the ethyl alcohol in the flask is ignited, smother the flame with a damp cloth. Handle with damp cloth. Be aware that an initial explosion often occurs when the coil is lowered into the flask. This demonstration should be done in a very well ventilated room. 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

1. Set up the apparatus as shown in Figure 1. Place a steel divider into the Erlenmeyer flask. The divider should be a piece of sheet metal—as wide as the mouth of the flask and a few centimeters taller than the flask.
2. Wind the platinum wire into a loose coil. The coil should be about 3 to 5 mm in diameter and 2 to 4 cm long. Winding the wire around a pencil lead works very well.
3. Attach the coil to a suspended copper wire.

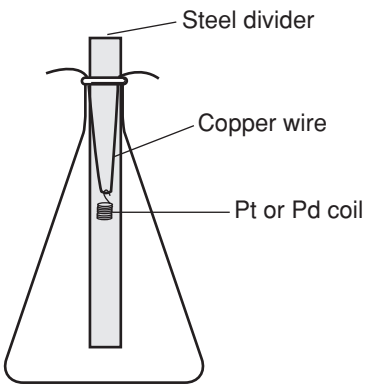

Figure 1.

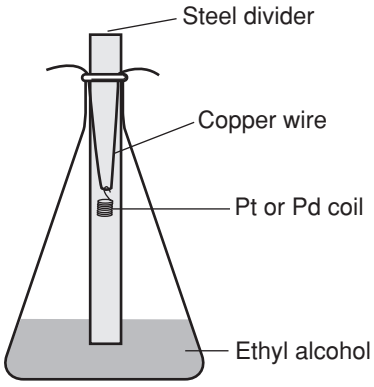

Figure 2.

Procedure

1. Pour 50 to 75 mL of ethanol into the Erlenmeyer flask. Set up the flask so that the coil will be about 4 cm above the surface of the ethyl alcohol (see Figure 2). Heat the flask to boiling to boiling on a hot plate. *Caution:* Do not heat the flask with the Bunsen burner!
2. Using the damp cloth, remove the Erlenmeyer flask from the hot plate and set the flask on a heat-resistant pad.
3. Remove the copper wire and platinum coil assembly from the flask.
4. Away from the flask, hold the copper wire with the damp cloth and heat the platinum coil to red-hot using a Bunsen burner or a butane lighter. Quickly place the wire into the flask.
5. An initial explosion (pop) may occur but it will be followed by successive explosions. The explosions will continue until the coil is removed from the system.

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Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Excess ethyl alcohol may be disposed of according to Flinn Suggested Disposal Method #18a.

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

Tips

- If repetitive explosions are not occurring, you may need to reheat the solvent if there is not enough vapor in the flask. It may also be that there is not enough oxygen in the flask. If this is the case, simply forcing some fresh air with a piece of tubing into the flask will alleviate that problem. Finally, you may simply need to reheat the coil because it has become too cool to initiate the reaction. Heat the ethyl alcohol only on a hot plate.
- Turn out the lights to increase the effect of this demonstration.
- If the vapor ignites as the coil is placed in the flask, place the damp cloth over the top of the flask to extinguish the flame.

Discussion

In this demonstration, ethyl alcohol vapor is calatylically oxidized by the platinum wire on its surface.

$$2CH_3CH_2OH(g) + O_2(g) \xrightarrow{Pt} 2CH_3CHO(g) + 2H_2O(g) \quad \Delta H^\circ = -156.3 \text{ kJ/mol} \qquad \textit{Equation 1}$$

The reaction is exothermic and the energy released heats up the wire. The increasing temperature of the wire eventually triggers the exothermic combustion of ethyl alcohol.

$$CH_3CH_2OH(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l) \quad \Delta H^\circ = -675.7 \text{ kJ/mol} \qquad \textit{Equation 2}$$

This combustion causes an explosion in the flask. The rush of gases out the neck of the flask around the divider creates a draught allowing a resupply of air into the flask after each explosion. The process then repeats itself.

References

Battino, R.; Letcher, T. M. J.Chem. Ed., 1993, 70, pp 1029–1030.

Gross, G. R.; Bilash, B.; Koob, J. K. *A Demo A Day;* Flinn Scientific: Batavia, IL, 1995; pp 190–191.

Materials for *The Repetitive Exploding Flask* are available from Flinn Scientific, Inc.

Catalog No.	Description
P0147	Platinum Wire, 30 gauge
E0012	Ethyl Alcohol, 500 mL

Consult the Flinn Scientific website for current prices.