Carbide Cannon

Introduction

The double replacement reaction of calcium carbide with water produces acetylene gas and calcium hydroxide. Ignite the mixture to catalyze the combustion of acetylene and you have take-off! Oxygen is the limiting reactant in this exciting combustion reaction.

Concepts

- Chemical reactions
- Combustion
- Double replacement reaction
- Stoichiometry

Materials

Calcium carbide, CaC_2, pellets, 6 g
Water, distilled, about 600 mL
Bandanas or socks, 2
Beaker, borosilicate glass, 600-mL
Empty sports drink bottles, 20-oz, 2
Lighter
Piezoelectric igniter
Spatula

Safety Precautions

Calcium carbide is corrosive to eyes and skin and generates flammable acetylene gas when exposed to water or moisture. Perform this demonstration in a well-ventilated area only. Make sure there are no flames in the area. Warn observers that this is a loud explosion and demonstrate the proper way to cover ears. Keep a fire extinguisher on hand and do NOT overload the bottle with calcium carbide. Do not attempt to launch any object heavier or harder than a sock. Take care not to aim the cannon at yourself or students. Avoid contact of all chemicals with eyes and skin. Wear chemical splash goggles and chemical-resistant gloves. Please review current Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

Bore a small hole into each of two empty 20-oz sports drink bottles, about one-half to one-third up the side of the bottle. The hole must be above the water level when 60–70 mL of water is added to each bottle for the "carbide cannon."

Procedure

Part A. Combustion of Acetylene

1. Pour approximately 400 mL of distilled water into a 600–mL beaker.
2. Add about 5 g of calcium carbide to the water and let the reaction bubble for 15–20 seconds.
3. Bring a lighter to the top of the water and ignite the acetylene gas that is produced. It should burn for a few seconds with a small "popping" sound.

Part B. Carbide Cannon

1. Add approximately 60–70 mL of distilled water to each of two empty sports drink bottles with the holes in the sides.
2. Roll up an old bandana or sock so that it fits snugly into the mouth of the bottle without falling into the water. Do NOT cap the bottle.
3. Add about 0.5 g (1–2 pellets) of calcium carbide to the water in one of the bottles and place the bandana or sock into the mouth of the bottle.
4. Let the reaction bubble for 15–20 seconds, then bring the sparking portion of a piezoelectric igniter or piezo lighter near the hole in the side of the bottle and spark the mixture. The bandana will be violently ejected from the mouth of the bottle.

Publication No. 11272
061616

5. Add about 5 g of calcium carbide to the water in the second bottle and replace the bandana or sock in the mouth of the bottle. Let the reaction bubble for 15–20 seconds.
6. Again, spark the mixture at the hole in the side of the bottle using a piezoelectric igniter or piezo lighter. The bandana will not explode out of the mouth of the bottle.

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 residual mixture remaining in the bottles contains calcium hydroxide and is basic. It may be neutralized according to Flinn Suggested Disposal Method #10.

Tips

- Any old cloth or sock can be used as the projectile. However, it is important not to launch anything combustible out of the cannon. Do not launch anything harder or heavier than a sock.
- Use only a piezoelectric igniter or piezo lighter in this demonstration. NEVER use matches or butane lighters. For directions on how to modify an empty butane lighter to make a piezoelectric igniter, please contact Flinn Scientific.

Discussion

Calcium carbide, CaC_2, is primarily used to produce acetylene (ethyne) gas, which is a product of the reaction of calcium carbide and water according to the following equation (Equation 1).

$$CaC_2(s) + 2H_2O(l) \rightarrow C_2H_2(g) + Ca(OH)_2(s) \qquad \textit{Equation 1}$$

Acetylene is a hydrocarbon consisting of two hydrogen atoms and two carbon atoms attached by a triple bond, making it very reactive and combustible. It is often used in welding torches because of the extremely high temperature at which it burns, about 3300 °C (6000 °F). The complete combustion of acetylene produces carbon dioxide gas and water vapor according to the following equation (Equation 2).

$$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g) \qquad \textit{Equation 2}$$

In the "carbide cannon," acetylene and oxygen are mixed in a closed system and then ignited. The mixture burns and produces a fairly loud explosion. In this demonstration, oxygen is the limiting reagent in the combustion of acetylene gas. Complete combustion occurs in the presence of the proper 5:2 mole ratio of oxygen to acetylene according to the balanced chemical equation (see Equation 2).

In the first bottle, the small amount of calcium carbide reacted was just sufficient to produce enough acetylene to react with the oxygen that remained inside the bottle. This is evidenced by the explosion that occurred after the first bottle was ignited. However, the second bottle contained so much calcium carbide that too much acetylene gas was produced, which caused all of the oxygen originally present in the bottle to be flushed out. Therefore, only acetylene was present in the bottle, and in the absence of oxygen, there is neither combustion nor an explosion.

Reference

A video of the *Carbide Cannon* activity, presented by Bob Becker, is available in *Stoichiometry in Combustion Reactions* and in *Double Replacement Reactions*, part of the Flinn Scientific—Teaching Chemistry Video Series.

Materials for *Carbide Cannon* are available from Flinn Scientific, Inc.

Catalog No.	Description
C0346	Calcium Carbide, CaC_2, 100 g
AP8960	Butane Safety Lighter
AP1576	Piezo Lighter

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