

Combustion of Acetylene

Welcome to Chemistry



Introduction

Use this demonstration at the start of the school year or in your unit on chemical reactions. The safe, controlled explosion allows you to say “Yes” to a question that chemistry students often ask, “Are we going to blow something up today?”

Concepts

- Combustion
- Exothermic reaction

Materials

Calcium carbide, CaC_2 , 2.5 g	Forceps or spatula
Water, tap	Matches
Corks to fit flask, 2	Paper towel, wet
Filter flask, 250-mL	Safety shield

Safety Precautions

Calcium carbide is corrosive to eyes and skin. Calcium carbide must be kept dry since exposure to water or moisture generates flammable acetylene gas. Carry out this demonstration on the scale provided and in a well-ventilated lab. Avoid contact of chemicals with eyes and skin and follow all laboratory safety guidelines. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. A safety shield is recommended. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Fill a 250-mL filter flask with tap water to a depth of approximately 2 cm.
2. Using forceps, add about three chunks of calcium carbide to the water and quickly place the cork on the flask. **Immediately** (within a few seconds) bring a lit match to the sidearm. A small explosion occurs, blowing the cork off the flask.
3. Add three more pieces of calcium carbide to the flask, and again place the cork on the flask.
4. Wait several seconds before bringing the lit match to the side arm. Instead of an explosion, a small flame burns steadily at the side arm.
5. Immediately squelch the reaction by bringing a wet paper towel to the side arm to extinguish the flame. Then pour out the water, and check for any remaining calcium carbide.

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. After calcium carbide has reacted with the water, a basic solution is produced. Neutralize the solution with 3 M hydrochloric acid and check with pH paper according to Flinn Suggested Disposal Method #24b. Decant the neutral solution and rinse it down the drain with at least a 20-fold excess of water. Make sure there is no unreacted calcium carbide in the mixture.

Discussion

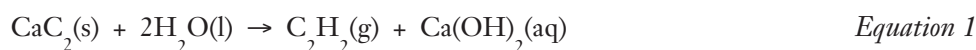
Calcium carbide, CaC_2 , is primarily used as a source of acetylene gas, which is produced by reacting calcium carbide with water. This reaction was utilized in original carbide (miners’) lamps—water was slowly dripped on the carbide producing acetylene gas, which was then ignited. Carbide lamps were commonly used in slate, copper and tin mines. Since acetylene

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gas is highly flammable, the carbide lamps were not used in coal mines, where they would be a serious hazard. Most carbide lamps have been replaced today by electric LED lamps.

Acetylene, $\text{H}-\text{C}\equiv\text{C}-\text{H}$, consists of two hydrogen atoms and two carbon atoms joined by a triple bond. Acetylene is often found as the fuel in torches—it burns brilliantly in air with a very hot flame due to its very high heat of combustion (1300 kJ/mole).

The reaction of calcium carbide and water produces acetylene and a chalky suspension of calcium hydroxide.

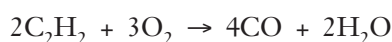


When a lit match is brought up to the side arm of the flask, the combustion of the acetylene occurs inside the flask. The resulting rapid expansion of the gaseous products followed by air rushing into the flask causes a controlled explosion.



If more calcium carbide is then added to the flask and a lit match is brought to the sidearm of the flask after several seconds, combustion of the acetylene takes place outside the flask due to the lack of available oxygen in the flask.

The balanced chemical reaction in Equation 2 represents the *complete combustion* of acetylene to produce carbon dioxide and water. Complete combustion of a hydrocarbon occurs when oxygen gas in the surrounding air mixes completely and is present in the stoichiometric mole ratio to react completely with the amount of hydrocarbon. For acetylene, the mole ratio is five moles of oxygen per two moles of acetylene, or 2.5:1. If a hydrocarbon is burned in a confined area, such as indoors, the amount of oxygen is insufficient for complete combustion. When this happens, incomplete combustion results in the dangerous build-up of poisonous carbon monoxide gas, shown in the following equation for acetylene.



In practice, combustion of charcoal, natural gas, gasoline, etc. often generates some carbon monoxide as a by-product. That's why it's so important to remember the vital consumer safety rule: NEVER use a generator, charcoal grill, hibachi, lantern, camp stove or other gasoline or charcoal-burning device inside your home, basement or garage, or near a window.

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 9–12

Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, chemical reactions, motions and forces, conservation of energy and increase in disorder, interactions of energy and matter

Flinn Scientific Teaching Chemistry™ eLearning Video Series

A video of the *Combustion of Acetylene* activity, presented by Kathleen Dombrink, is available in *Welcome to Chemistry* and in *Reactions of Calcium Carbide—Combustion of Acetylene*, part of the Flinn Scientific Teaching Chemistry Video Series.

Materials for *Combustion of Acetylene* are available from Flinn Scientific, Inc.

Catalog No.	Description
C0346	Calcium Carbide, 100 g
GP4072	Filtering Flask, 250-mL
AP8314	Cork, Size 14, Pkg of 100
AB1018	Forceps, Polypropylene

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