The Chef

Endothermic and Exothermic Reactions

Introduction

When water is added to calcium oxide, the amount of heat produced is enough to fry an egg. This is an ideal demonstration when discussing exothermic reactions and heats of reaction, but it is also a fun attention-getter to use anytime.

Concepts

- Exothermic reactions
- Heat of reaction

Materials

Calcium oxide lump, CaO, 200 g
Chef's hat
Cooking oil or Pam® cooking spray
Egg, small, 1 (medium or large eggs do not work as well)
Oven mitt or hot pad
Pie pans, small aluminum, 2
Spatula
Wash bottle for water
Water, distilled

Safety Precautions

Calcium oxide is a corrosive material and a severe body tissue irritant. Avoid all body tissue contact. Reaction of calcium oxide and water will produce large amounts of heat and skin burns are possible. A lump of calcium oxide may disintegrate violently and splatter when water is added. Wash hands thoroughly when finished. This should be a teacher demonstration only. Do not allow students to perform this procedure. Once food grade items are brought into the laboratory they are considered chemicals and should not be consumed. Do not eat the egg after it is cooked. Wear chemical splash goggles, chemical-resistant gloves and apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Place about 200 g of calcium oxide lumps in one of the aluminum pans. The amount depends on the size of the lumps. The calcium oxide should form a single, tightly-packed layer on the bottom of the pan.
2. Add 50–100 mL of water to the calcium oxide (a little practice will help determine the right amount of water). Using a wash bottle will distribute the water more evenly. *Warning:* The CaO lumps may splatter; wear goggles and gloves.
3. Add a small amount of cooking oil or Pam to the second pan and then place the pan directly on top of the calcium oxide.
4. When the second pan and cooking oil are hot, break open a small egg into the top pan.
5. Cook the egg to order.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The calcium oxide solution (calcium hydroxide after the demonstration) should be diluted with excess water, neutralized with a hydrochloric acid solution, and then flushed down the drain with excess water according to Flinn Suggested Disposal Method #10.

Tips

- Flinn Scientific's calcium oxide, lump, is a special formulation that has a lower surface area of calcium oxide and thus reduces the amount of calcium hydroxide present before adding the water. Fresh calcium oxide lump should be hard pebbles that will crack and become soft when exposed to water. The shelf life for calcium oxide is poor—always use fresh calcium oxide for best results.

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- Use an oven mitt or hot pad to hold the pans when cooking the egg. Place the aluminum pans on a heat-resistant surface—the bottom pan will get very hot. This reaction generates a lot of heat; use proper care handling the pans.

Discussion

Calcium oxide is also known as lime or quicklime and is used to make plaster, mortar, bricks, and many other construction materials. Calcium oxide is produced by heating limestone (calcium carbonate) in air. However, calcium oxide readily absorbs and reacts with carbon dioxide and water to form calcium carbonate ($CaCO_3$) and calcium hydroxide [$Ca(OH)_2$], respectively. When water is added to calcium oxide, an exothermic reaction occurs, producing calcium hydroxide and a large amount of heat. Calcium hydroxide is used to treat acidic soils, soften water, and prepare many building materials such as plaster, mortar, and bricks. The solubility of calcium hydroxide in water is very low, about 1.6 g/L. The product of the reaction of CaO and H_2O is thus $Ca(OH)_2(s)$, not $Ca(OH)_2(aq)$.

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s) + \text{heat}$$

$$\Delta H = \Delta H_f(\text{products}) \rightarrow \Delta H_f(\text{reactants})$$

$$\Delta H = \Delta H_f[Ca(OH)_2(s)] - \{\Delta H_f[CaO(s)] + \Delta H_f[H_2O(l)]\}$$

$$\Delta H = -986.1 \text{ kJ/mole} - [-635.1 \text{ kJ/mole} + (-285.8 \text{ kJ/mole})] = -65.2 \text{ kJ/mole}$$

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation

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 and properties of matter, chemical reactions, interactions of energy and matter

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *The Chef* activity, presented by DeWayne Leineman, is available in *Endothermic and Exothermic Reactions* and *Synthesis Reactions*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *The Chef* are available from Flinn Scientific, Inc.

Materials required to perform this activity are available in *The Chef—Chemical Demonstration Kit* available from Flinn Scientific. Materials may also be purchased separately.

Catalog No.	Description
AP6468	The Chef—Chemical Demonstration Kit
C0264	Calcium Oxide, Lump, 100 g
C0028	Calcium Oxide, Lump, 500 g

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