

5.5 Oxidation of Sugar or Gummi bear with potassium chlorate

Subjects: Oxidation/reduction, thermodynamics

Description: Oxidation of sugar or a Gummi bear by potassium chlorate. This demonstration illustrates the amount of energy available in carbohydrates, such as sugar and candy. If you do not want to perform the reaction in class, links of videos of the reaction are provided below.

Materials for procedure A:

2g sucrose
6g Potassium chlorate[‡]
1 drop concentrated sulfuric acid[‡]
Disposable pipet
Spatula
50 mL beaker (for holding acid)
Watch glass or crucible
Weigh boats (next to balance)

[‡]Potassium chlorate is stored on the oxidizer shelf in the cabinets. Sulfuric acid is located in the cabinet under the hood.

Procedure A: Perform the demo in the hood!

1. Carefully mix the sugar and potassium chlorate with the spatula.
2. Place mixture on the base of the ring stand or in a crucible.
3. Make a small depression in the pile.
4. Add the drop of concentrated sulfuric acid and stand back.
5. The reaction takes a few seconds to start. Smoke will evolve and then the mixture will burst into flame.

Alternatively, you can start the reaction with a flame.

Materials for procedure B:

Gummi bear (or other sugary candy)
Potassium chlorate[‡]
Pyrex test tube (25mm x 200mm)
Tongs
Test tube clamp
Ring stand*
Burner- use burner in hood in lecture hall

*Shared item. Rings stands are located on the shelf above the bench.

Procedure B: Perform in the Hood!

1. Place a small amount (~5g) of potassium chlorate in the test tube (~1 cm in depth)
2. Securely clamp the test tube with opening pointed in safe direction.
3. Heat the potassium chlorate with the burner until molten.
4. Remove heat source and turn off.
4. With tongs, add a Gummi bear to the molten KClO_3
5. Stand back. The reaction will be immediate, producing large amounts of smoke, sparks, fire, and noise..

Discussion:

The thermal decomposition of potassium chlorate produces potassium chloride and an excess of oxygen, which is sufficient to ignite the Gummi bear. The heat produced continues to decompose the potassium chlorate resulting in a very rapid combustion reaction.



In the reactions above, 2 grams of sugar are burned (assume a Gummi bear weighs 2 g too). The energy evolved as heat is calculated below:

$$2.0 \text{ g-sucrose} \times 1 \text{ mol sucrose}/324.3 \text{ g-sucrose} = 5.8 \times 10^{-3} \text{ mol sucrose}$$

$$\Delta_r H^\circ = 5.8 \times 10^{-3} \text{ mol-sucrose} \times (1 \text{ mol-rxn}/1 \text{ mol-sucrose})(-5645 \text{ kJ}/1 \text{ mol-rxn})$$

$$\Delta_r H^\circ = -32.7 \text{ kJ}$$

Safety:

Potassium chlorate is an extremely strong oxidizer. Goggles and proper protective equipment should be worn while performing the experiment. Experiment should be performed in a hood. Keep all flammable or combustible materials clear of the reaction.

Do not store mixtures of sugar and potassium chlorate. Concentrated sulfuric acid is a strong dehydrating agent and should be handled carefully. Spills should be neutralized and wiped up.

Disposal:

Allow test tube and reaction products to cool. Soak in water and scrub to remove residue. Residues can be flushed down the drain with water.

References:

1. B.Z. Shakhshiri. *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; Wisconsin; 1983; Volume 1; p. 77-78
2. Woodrow Wilson National Fellowship Foundation Website:
<http://www.woodrow.org/teachers/ci/1988/gummybear.htm>

Note: If you don't feel comfortable performing the demonstration in class, use either one of following links to show the oxidation between a gummi bear or other sugary candy and sodium or potassium chlorate:

-Lee Marek, University of Illinois at Chicago:

<http://www.chem.uic.edu/marek/cgi-bin/vid7b.cgi>

-Use link from class website: ChemistryNow Screen 5.2