The Synthesis of Gun Cotton

- Learn about the Synthesis of "Energetic" Materials.
- Learn about the Safe Handling of Caustic Substances.

In this laboratory exercise, we will synthesize Gun Cotton; a well-known energetic material. This material is "energetic" in the sense that it contains considerable chemical energy which can be released explosively via combustion. It is generated using extremely caustic reagents that must be HANDLED WITH EXTREME CARE. So, all appropriate pre-cautions must be observed when preparing these materials.

Nitrocellulose is a product of the nitration of Cellulose and is highly flammable or explosive depending on the ignition and reaction conditions employed. Used as a propellant or explosive, Nitrocellulose is referred to as Guncotton.

Cellulose itself is a polysaccharide composed of numerous 6-Carbon sugar units linked together in a long polymeric strand.

![Cellulose structure diagram]

This is a major component of cotton, lignin, wool and paper.
When treated with Nitric Acid, several of the –OH groups of the Cellulose molecule are nitrated to –ONO₂ units. The longer the treatment, the more complete the nitration; with complete nitration leading to Cellulose Trinitrate.

When ignited in the open, Nitrocellulose decomposes non-explosively according to:

$$\text{Cellulose Trinitrate} \rightarrow (9/2) n \text{CO}(g) + (3/2) n \text{CO}_2(g) + (7/2) n \text{H}_2\text{O}(g) + (3/2) n \text{N}_2(g)$$

Note the decomposition results in completely gaseous products. (“n” represents the number of sugar units bound together in the original Cellulose molecules.)
Pre-Lab Safety Questions

1. What is an oxidizing acid and why are oxidizing acids particularly nasty?

2. What particular hazards are associated with handling concentrated Sulfuric Acid? What measures should be taken in cleaning up concentrated Sulfuric Acid spills?

3. Consult a SDS for Nitrocellulose. What special precautions should be taken when storing Gun Cotton?
Procedure

Nitric and Sulfuric Acid are Strong Oxidizing Agents, which can cause severe burns. Sulfuric Acid is also a powerful Dehydrating Agent. Mixing conc. Nitric and Sulfuric Acids produces considerable heat. When working with these agents, you must:

- You must wear safety goggles.
- You must wear gloves.
- It is recommended that you wear an apron.

All spills must be neutralized with Sodium Bicarbonate.

If any should get on your skin, initially flush the area with Ice-Water followed by plenty of Tap-Water. The area should then be treated with Baking Soda.

1. Prepare 3 400 mL Water Baths and a 250 mL 1M NaHCO₃ Bath. This must be done before proceeding to the next part of the lab.

2. A mixture of 70 mL Conc. Sulfuric Acid and 30 mL Conc. Nitric Acid has been prepared and is available in an ice-bath the Fume Hood.

3. Under the supervision of a laboratory instructor, use tongs to immerse a standard Cotton Ball in the acid mixture for a few minutes.

4. Once the nitration is complete, rinse the Cotton Ball is three successive baths of 500 mL of fresh Water. Allow the Cotton Ball to stand in each bath a few minutes.

5. Immerse the Cotton Ball in 250 mL of 1M NaHCO₃; Sodium Bicarbonate. This will react with any excess Acid to produce gaseous Carbon Dioxide:

\[ H^+(aq) + HCO_3^-(aq) \rightarrow H_2CO_3(aq) \]
\[ H_2CO_3(aq) \rightarrow CO_2(g) + H_2O \]

If excess bubbling occurs, repeat the process of rinsing the Cotton Ball. Otherwise, continue rinsing in the Bicarbonate solution until the bubbling ceases.

6. Squeeze dry the Cotton Ball and spread it out to dry.

7. Place the Nitrated Cotton Ball into a small Dixie Cup and allow it to dry until next week.

_____________ Remainder to be Completed at the Next Laboratory Session ______________
8. Place the Nitrated Cotton Ball on the base of a Ring Stand in the Fume Hood. Using a long match, or a match attached to a metal rod, ignite the Nitrated Cotton Ball.
Data Analysis

No Data Analysis.

No Lab Report is Due for this Laboratory Exercise.
Post Lab Questions

No Post Lab Questions

No Lab Report is Due for this Laboratory Exercise.