2.7.1 Introduction

Chemical reaction overpressure devices (aka "bottle bombs" or "MacGyver Bomb) have become a frequently encountered explosive device that uses common commercial products which react to form a gas in a sealed container. Common chemical reactions are $2Al + 6\ HCl \rightarrow 2\ Al\ Cl_3 + 3\ H_2\uparrow$ or $2Al + 2NaOH + 6H_2O \rightarrow 2NaAlO + 3H_2$.

The following are some common formulations:

- Liquid Muriatic Acid (HCl) and Aluminum Foil.
- Sno-Bowl Toilet Bowl Cleaner (HCl) and Aluminum Foil.
- "The Works" Toilet Bowl Cleaner (HCl) and Aluminum Foil.
- Crystal Drano (NaOH "lye"), water and Aluminum Foil.
- Crystal Red Devil Lye (NaOH), water and Aluminum Foil.

2.7.2 Safety Considerations

- Do not permit the liquid and metal to be stored together in a sealed container.
- Do not store this evidence in a metal container.
- Avoid skin contact with the evidence liquid and metal.

2.7.3 Preparations

- pH paper or pH meter
- 5% Silver Nitrate Reagent - Dissolve 5 g silver nitrate in 100 milliliters distilled water
- 5% Calcium Chloride Reagent - Dissolve 5 g of Calcium Chloride in 100 milliliters distilled water.

2.7.4 Instrumentation

Scanning Electron Microscope/Energy Dispersive X-Ray

Fourier Transform Infrared Spectrometer

X-Ray Fluorescence

2.7.5 Refer to Trace 7.0 Instrument Standards and Controls

2.7.6 Procedure or Analysis

- If liquid is present, check vapors and/or liquid with pH paper or meter to determine if acidic or basic.
- If acidic, place a sample in the FTIR gas cell and collect a vapor phase IR spectra.
    - If unable to identify by vapor phase IR, add conc. NH_4OH to 5 drops of sample until pH is 8-9. Add acetone until precipitate forms, filter through cotton or filter paper (quickly as precipitate may start to dissolve). Collect precipitate, dry, run on FTIR, compare to NH_4Cl std, NH_4SO_4 std, etc. (shows presence of HCl, H_2SO_4, etc.).
- Dry small amount of sample as much as possible. Wash multiple times with acetone (discard). Dry until sample is a white power, run on FTIR, compare with aluminum chloride hexahydrate

($AlCl_3.6H_2O$) standard. If the spectra is not similar, compare with aluminum sulfate, etc., run on SEM/EDS.

- To check for free aluminum, filter sample through cotton, wash with H_2O, dry, SEM/EDS on insoluble material.
- If no liquid present, moisten sample with water then perform pH check. Wash inside of bottle with water. Evaporate liquid on hot plate and run on FTIR. Compare to known reaction products.

Additional tests:

- Place sample in a H_2O solution and dilute to a minimum of 1 milliliter.
- If acidic, add a few drops of the $AgNO_3$ Reagent. Then add conc. HNO_3, a white precipitate indicates chlorine. Note the color of any precipitate and perform one or more of the following: FTIR, XRF and SEM/EDX for the chemical identification of the precipitate. The presence of silver chloride indicates the chemical reaction: $AgNO_3 + HCl \rightarrow AgCl + HNO_3$ occurred.
- If basic add a few drops of the $CaCl_2$ solution. Note the color of any precipitate and perform one or more of the following: XRF, FTIR and SEM/EDX for the chemical identification of the precipitate. The presence of a precipitate indicates the following chemical reaction $2NaOH + CaCl_2 \rightarrow 2NaCl + Ca(OH)_2$
- Test for iron by adding a few drops of the KSCN solution to an aqueous questioned sample. The presence of a blood-red solution indicates the presence of iron.
- A metal found or residue which may be a chemical reaction product should be analyzed by one or more of these techniques (XRF, SEM/EDX, FTIR) for identification. A microchemical test for aluminum is to place a small bit of the metal in three spots in a spot plate. Add HCl to one, NaOH to the second and HNO_3 to the third. Aluminum will bubble or evolve gas in the HCl and the NaOH but not in the HNO_3.
- Record all observations, findings and conclusions on the worksheet.

2.7.7 References

Brinex, J. Presented at International Association of Bomb Technicians and Investigations on Chemical Reaction Bombs.

Cardosi, P. "Case Study - Aluminum Foil and Hydrochloric Acid Sealed into Liter Plastic Bottle = Boom"; ISP Trace memo: 90-TRACE-15.

FBI; "Acid Bombs", F.B.I. Bulletin: 90-1 and 8-12.

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