B20 An Examination of Hypergolic Mixtures Involving Potassium Permanganate and Select Fuels

Stephanie R. Harrold, BS, 601 Vairo Boulevard, Apt 822, State College, PA 16803; and Wayne Moorehead, MS, 329 Whitmore Laboratory, University Park, PA 16802*

After attending this presentation, attendees will better understand what types of chemicals can be used to create hypergolic mixtures, the types of evidence that a hypergolic reaction may leave at a crime scene, and how changing a single variable, such as the type of fuel added to the mixture, can change both the reaction and the post-combustion material (residue).

This presentation will impact the forensic science community by providing a framework for the examination and analysis of specific hypergolic mixtures, the threat they present to the public, and possible avenues of analysis to obtain as much relevant information as possible from hypergolic residues.

Bombings due to criminal and terrorist activities are in the news on a weekly or daily basis. The heightened alertness of law enforcement and security personnel does not seem adequate to prevent the destructive actions of terrorists when explosive materials are so easily obtained. Hypergolic mixtures are chemicals useful for retail or commercial purposes but, when mixed, create a type of oxidation-reduction reaction that results in spontaneous combustion, without the need for external ignition. Hypergolic mixtures can be created with a number of different oxidant and fuel combinations. Based on a literature search, little research has been published exploring the time to reaction, temperature, and the variety of commercial products involved in initiating these reactions. These mixtures are very simple to construct and are made with materials that are readily available for purchase, such as pool chlorine, pool shock, water softening chemicals, and fuels, such as brake fluid or antifreeze.

Typically, a delay in the combustion reaction occurs after the reactants are mixed. This delay can allow a person to leave the area before the reaction occurs. After combustion, the post-burn products may include the remnants of the containment vessel and the post-burn hypergolic products. Original ingredients may also be present.

This study involves the creation and examination of the hypergolic mixture of potassium permanganate (a strong oxidizer) and selected fuels, including polyethylene glycol, ethylene glycol, and glycerin. Potassium permanganate can be found in select water softening chemicals. Polyethylene glycol has several uses in cosmetics, pharmaceuticals, commercial products, and industry. Ethylene glycol can be used as antifreeze and in the fiber industry in the manufacture of polyester fibers. Glycerin has uses in the food, pharmaceutical, and chemical industries.

Hypergolic mixtures were created and recovered on a small scale (approximately 0.5g of powdered potassium permanganate and approximately 0.25mL of a chosen fuel) in open Pyrex® glass petri dishes (100mm x 15mm) in a fume hood (with a flow of at least 100fpm) to explore the reactions and analyze the residues. After a brief period, typically less than one minute, a small flame with white smoke occurred that moved across the mixture. After the reaction, the resulting products were examined visually, with the aid of a stereo light microscope, with a diamond-attenuated total reflectance Fourier Transform Infrared (FTIR) spectrometer and by a Gas Chromatograph with a Mass Spectrometer (GC/MS) detector.

The small-scale reactions were varied to determine optimal ratios. The resultant ratio of 2:1 weight/volume (g/ml) of potassium permanganate to liquid fuel consistently produced combustion. Still images and video recordings

captured the reactions. The video recordings showed differences in both the speed and duration of combustion.

Preliminarily, the results of hypergolic mixture residues analyzed by FTIR, which has been used as a discriminatory technique for explosive residues on other types of explosives, may not have the discriminating power necessary to identify post-combustion products to determine original reactants. The GC/MS data will also be presented.

Hypergolic, Potassium Permanganate, Alkyl Glycols