B128 Discrimination of C-4 Plastic Explosives by GC/MS Analysis of Impurities Associated With the Manufacturing Process of RDX

Michael E. Sigman, PhD, Katie L. Steele, BS, and Charles D. Clark, BA, National Center for Forensic Science at the University of Central Florida, PO Box 162367, Orlando, FL 32816-2367*

After attending this presentation, attendees will understand a method that allows for discrimination of different C-4 plastic explosive samples by examining the relative amounts of selected impurities that are associated with the manufacturing process of RDX, the main component in C-4.

This presentation will impact the forensic community and/or humanity by providing improved explosives analysis and sourcing methods.

RDX is the basis for many military explosives worldwide. It is currently the most important military high explosive in the United States, and the second most widely used explosive by the U.S. military behind TNT. Rarely used alone, RDX is a common component in plastic explosives, detonators, high explosives in artillery rounds, Claymore mines, and demolition kits. RDX can be synthesized by several different processes; however, two methods have commonly been used for mass production; the Woolwich process and the Bachmann process. The first involves direct nitrolysis of hexamine, yielding between 70-75% RDX and trace amounts of HMX. In the latter process, hexamine is reacted with an ammonium nitrate and nitric acid mixture at 75°C with acetic acid and acetic anhydride. This process produces about 79 percent RDX initially with 6-8% HMX, and trace amounts of 1,3,5-Triazine (TAX), 1,3,5,7-Tetrazocine (SEX), and other impurities. These differences in product/by-product compositions can serve as a basis for discrimination between C-4 samples.

C-4 is a putty-like explosive mixture made up of finely powdered RDX and plasticizers having similar malleability to that of modeling clay. C-4 has prevailed as the popular composition of plastic explosives by the United States military, and is comprised of RDX (91%), Plasticizer (5.30%), Polyisobutylene (2.10%), and Motor oil (1.60%). In work done by Reardon and Bender, composition of oil components were examined to discriminate between C-4 samples.[1]

In this study, RDX was extracted in triplicate from several different C-4 samples following a modified version of the extraction procedures published by Keto.[2] The extracts were then analyzed by GC/MS, using negative chemical ionization (NCI) and selective ion monitoring (SIM) to detect RDX and associated impurities. The ratios of impurities to RDX were calculated. Ratios were also calculated from LC mass spectral data collected by negative ion electrospray ionization (ESI). The samples were directly injected and infused with a 0.1 mM solution of sodium chloride to promote the formation of chlorine adducts.[3] An Analysis of Variance followed by a Tukey Honstely Significant Difference (HSD) Post-test was performed on the pair-wise C-4 comparisons from.

References:

1 Reardon MR, Bender EC. Differentiation of Composition C-4 Based on the Analysis of the Process Oil. J. Forensic Sci 2005;50(3):564-70.

2 Keto RO. Improved method for the analysis of the military explosive composition C-4. J. Forensic Sci. 1986;31(1):241-49.

3 Sigman ME, Armstrong PA, MacInnis JM, Williams MR. Equilibrium Partitioning Model Applied to RDX-Halide Adduct Formation in Electrospary Ionization Mass Spectrometry. Anal. Chem. 2005;77:7737-7441.

C-4, GC/MS, Explosives

 ** Presenting Author*