B126 An Explosives Analysis With Portable Ion-Trap Gas Chromatography/Mass Spectrometry (GC/MS) for Battlefield Forensics

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After attending this presentation, attendees will better understand how portable ion-trap GC/MS with Solid-Phase Microextraction (SPME) sampling is used to detect explosive residue for applications in the area of battlefield forensics.

This presentation will impact the forensic science community by evaluating the method parameters used by the portable GC/MS to determine the most efficient mode of explosives testing in the field.

Recent advancements in portable GC/MS instrumentation have enabled the field analyses of explosives and explosive residues by emergency responders, the military and law-enforcement organizations. For battlefield forensics, portable GC/MS instruments are used for the detection and confirmatory identification of threats pre- and post-explosion to provide intelligence, investigation, and adjudication information. Traditional analysis for explosives involves sample selection, collection, packaging, transport, laboratory analysis, and data interpretation; however, there are many challenges to this type of analysis, and if there are any errors in the process, such as incorrect sampling or packaging, the results may be meaningless. Time is also important. The ability of a commander to make decisions in near real-time with data collected and interpreted at the scene can be critical. Additionally, because many explosives readily decompose or evaporate, it is imperative that analysis be completed in a short time frame, which is not always possible due to remote military locations or laboratory backlogs. Although the on-scene detection and analysis of explosives by portable Ion Mobility Spectrometry (IMS) has been used for years, this is a presumptive test that suffers from both false positive and false negative results. Using modern, portable GC/MS instruments in the area of battlefield forensics is crucial as it provides an easy user interface that provides clear confirmatory results in a short time frame, which is important when the chemical being searched for may endanger lives.

The portable GC/MS system used in this research uses a Low Thermal Mass (LTM) resistively heated capillary column directly linked with a miniaturized toroidal ion trap mass spectrometer. The LTM capillary GC column enables fast separation and thermal recovery, resulting in rapid consecutive runs of approximately five minutes. Sample collection was performed using Solid-Phase Microextraction (SPME) with direct injection via thermal desorption from the SPME into the GC/MS inlet. SPME is especially useful in field-portable settings because it provides an easy, small, lightweight, and solvent-free method for sample collection. Using SPME for explosives analysis removes the need to perform extensive extraction procedures that significantly complicate the analysis and is thus difficult to perform in the field.

In this research, 12 different explosives covering both military (e.g., PETN, RDX) and homemade (e.g., TATP, HMTD) explosives were deposited onto the SPME fiber and separately injected into the GC/MS. Various parameters (e.g., injection port temperature, column temperature, and ramp rate) were adjusted to determine an optimal method for detection and identification of the explosive. This method development is important because there is a need for a cooler-temperature method than the standard test method employed to test for dangerous toxic industrial chemicals and chemical warfare agents. Many explosives degrade at higher temperatures, which can make their analysis challenging. The current standard method for the portable GC/MS employs an inlet temperature of 270ºC, a column start temperature of 50ºC with a hold time of ten seconds, and a ramp rate of 2ºC/second, resulting in a total run time of 180 seconds. Eleven of the 12 explosives were detected and identified at amounts of 200ng. Explosive compounds that have traditionally been difficult to identify, such as TATP, were readily detected using all methods tested. RDX was the only non-identified explosive, which was not surprising given that it is notoriously difficult to detect by GC/MS due to its rapid thermal decomposition. It was concluded that a lower temperature method than what is currently implemented is a superior alternative for the detection of explosives in the field by portable GC/MS because it yields less degraded results.

Portable GC/MS, Explosives, Battlefield Forensics

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