Explosives Analysis with Portable Ion-Trap Gas Chromatography-Mass Spectrometry for Battlefield Forensics

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Recent advancements in portable GC-MS instrumentation have enabled the field analysis 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 the 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 backlog. 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 gives clear confirmatory results in a short time frame, which is important when the chemical being searched for may endanger lives.

In this research, twelve 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 270 ^{o}C, a column start temperature of 50 ^{o}C with a hold time of 10 seconds, and a ramp rate of 2 ^{o}C/second, resulting in a total run time of 180 seconds. Eleven of the twelve explosives were detected and identified at amounts of 200 ng. 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.

References Cited:

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Acknowledgments: I would like to thank SURF for allowing this research to be a reality. I would also like to thank Dr. Kammrath and Dr. Pauline Leary for their unwavering support and insight during this project. Lastly, I would like to thank the forensic science department, especially lab manager, Sandra Hartman-Neumann, for the space to conduct research and immense help over the summer.

Biography:

I am a senior Forensic Science and Chemistry major with minors in Chemistry and Math. I am also in the Honors Program here at the university, and will be continuing my research for my honors thesis. I am hoping to pursue a masters or PhD program in analytical chemistry after I graduate in order to further my research experience in the field. When I am not in the library or in class, I am also involved in greek life, in Chi Kappa Rho, am the secretary for the Math & Physics Club, and an Investigator for PIRO, the Paranormal Research Organization here on campus. I also enjoy long walks through the isles of Target and downtime reading or hanging out with friends.