B157 Quantitative Mapping of Post-Blast Nitroglycerin Residues on Pipe Bomb Fragments Using Total Vaporization-Solid Phase Microextraction-Gas Chromatography-Mass Spectrometry (TV-SPME-GC/MS)

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After attending this presentation, attendees will understand the value of quantitating explosive residue on pipe bomb fragments. A new technique will be used for quantitation, TV-SPME-GC/MS, which has several advantages over other methods. The validity of residue distribution mapping will also be discussed.

This presentation will impact the forensic science community by outlining how quantitating explosive residue using a novel technique and diagramming its dispersal can be valuable to both crime scene investigators and laboratory analysts examining pipe bomb fragments. By knowing the concentration of residue components, the efficiency of analytical techniques can be optimized. This in turn will maximize throughput and evidence turnaround time. In addition, if the dispersal of residue indicates any trends, this information can heighten the understanding of the explosion process, such as the progression of deflagration.

Although residue from the explosive filler in a pipe bomb is routinely found on the post-blast container fragments, the amount of this residue is not quantified. The obvious reason for this is that the legal question at hand is identification of the explosive, not its concentration; however, there is value to understanding the distribution of explosive residue on device components and disseminating that knowledge to crime scene personnel and forensic analysts. In particular, such "residue mapping" would provide general guidance as to what fragments may be more likely to contain high levels of residue. Additionally, the distribution of residues would also shed light on the process by which the explosive filler deflagrates, resulting in the ultimate failure of the device container.

In this study, TV-SPME-GC/MS was used to identify nitroglycerin, diphenylamine, and ethyl centralite, which are components found in Double-Base Smokeless Powder (DBSP). Traditional headspace SPME involves a three-phase system consisting of the sample, either in solid or liquid form, the headspace, and the fiber; however, by completely vaporizing the sample, the partitioning between the liquid and headspace is eliminated, eliminating matrix effects and increasing sensitivity. Another benefit of this technique is minimal sample preparation — any solid and/or non-volatile components do not enter the headspace. Additionally, significantly higher volumes of liquid extracts can be analyzed as compared to liquid injection (e.g., 70µL). Prior to analysis, fragments were extracted under agitation using methylene chloride or acetone. Extracts were then transferred directly to SPME vials for analysis. SPME parameters were optimized using an experimental design with final values of 20 minutes for extraction time and 60°C for extraction temperature. This technique was applied to five devices constructed from galvanized steel pipes as well as three Polyvinyl Chloride (PVC) pipes, all filled with DBSP. Results indicate the majority of nitroglycerin was located on the endcaps for the galvanized devices, which correlates with the portion of the device that fails first during an explosion. On average, 1.0±0.7mg of nitroglycerin was recovered from the galvanized devices. According to manufacturer information, the nitroglycerin content in the DBSP used was between 4% and 40%. This indicates that DBSP is quite efficient, with less than 0.05% of the original nitroglycerin remaining on the container fragments.

SPME, Explosives, Nitroglycerin