A125 Optimization of Explosives Analysis by Gas Chromatography and Liquid Chromatography

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After attending this presentation, attendees will understand how to shorten analysis time and employ GC-MS (gas chromatography-mass spectrometry) using a vacuum - outlet GC column configuration for analyzing explosives. Attendees will also understand how to apply HPLC (high performance liquid chromatography) using a dual column confirmation method for analyzing the same explosives.

The instrument set up and analysis methodology discussed will impact the forensic community by providing two means of processing and analyzing explosives using chromatography.

The analyses of explosives have become increasingly important due to the current threat of both home-made and military-grade explosive devices. Nitroaromatics, nitramines, and nitrate esters are used as explosives, are byproducts of the manufacturing process, and can be degradation products transformed by the explosion. These compounds are of environmental concern and, thus, forensic concern due to their carcinogenic, mutagenic and toxic effects. Traditionally, the expired munitions have been disposed of by combustion, resulting in a significant amount of contamination in soil and groundwater. Two United States Environmental Protection Agency (EPA) methods (EPA 8095, 8330b) have been validated to analyze these toxic compounds and can be used as a guide for forensic analysis.

EPA method 8095 focuses on explosives analysis by gas chromatography (GC). This methodology highlights the use of the electron capture detector (ECD). This type of detector is useful due to its selectivity and low limits of detection for halogenated compounds and for compounds with electronegativity characteristics. However, another powerful detector that can be utilized for this type of analysis is mass spectrometry (MS). In this case, vacuum-outlet GC can be applied to EPA method 8095 using a MS detector. This column configuration solves two of the most prominent problems when analyzing explosives. The first challenge is to move the compounds through the column quickly. This can be alleviated by using a short (6m), wide bore (0.53 mm) analytical column. Another problem that quickly arises is the proper flow conditions (1-4 mL/min) needed for the mass spectrometer. By attaching a short (50-100 cm) narrow bore (0.1 mm), guard column, flow rate can be reduced significantly eliminating this problem. The vacuum-outlet GC column configuration reduces the analysis time from approximately 25 minutes to 3 minutes. In addition, the mass spectra produced by this analysis can undisputably identify the explosives of interest.

High performance liquid chromatography (HPLC) analysis of explosives is highlighted in EPA method 8330b. This methodology HPLC employs analysis with a dual wavelength (210 and 254 nm) UV detector and using a dual column set up. This dual column confirmation analysis is typically done on a C18- type column as the primary column and with a cyano or phenyl-based stationary phase as the confirmation column. By using two columns with different stationary phase selectivity, analysts can more accurately identify or confirm the compounds of interest. In this study, various stationary phases were evaluated for retention and selectivity of all method analytes, and a column pair was identified for this analysis.

In conclusion, the methods developed in this study can benefit analysts by providing two fast and reliable chromatographic methods for the analysis of explosives, GC-MS and HPLC.

Explosives, GC-MS, HPLC