

Organic Explosive and Gun Shot Residues Analyzed By Capillary Electrophoresis

Introduction

The data obtained from the analysis of organic explosive constituents and gun shot residues (GSRs) provide the forensic scientist with valuable information for potential use in courtroom proceedings. This formulated data helps investigators identify criminals and the explosive materials involved in a specific crime.¹ Organic GSRs have been primarily analyzed by HPLC,² GC/MS,³ and SFE/SFC⁴ methodology. Thermally stable organic explosive constituents are generally analyzed by GC/MS⁵ and the more thermally labile compounds are commonly analyzed by GC/MS,⁶ LC-EC,⁷ and LC-TEA.⁸ Added to this analytical arsenal, capillary electrophoresis (CE) provides a fast, cost effective, and reproducible method for the analysis of organic explosive and GSR constituents. The BioFocus[®] capillary electrophoresis system was used for identification and baseline resolution of 15 analytes (Figure 1).

Sample and Buffers

The standard was analyzed by the Los Angeles Police Department Criminalistics Laboratory and contained: nitroglycerin, 2,4-dinitrotoluene, 2,6-dinitrotoluene, 3,4-dinitrotoluene, 2,3-dinitrotoluene, 2-naphthol, diethyl phthalate, diphenylamine, N-nitrosodiphenylamine, methylcentralite, 2-nitrodiphenylamine, 4-nitrodiphenylamine, ethylcentralite, dibutyl phthalate, and styphnic acid. 2-Naphthol was used as the internal standard for this analysis. The standard solution was prepared in ethanol and diluted to 1×10^{-4} M in run buffer. The run buffer was 25 mM sodium dodecyl sulfate, 10 mM sodium borate, and 10 mM boric acid at pH 8.5.

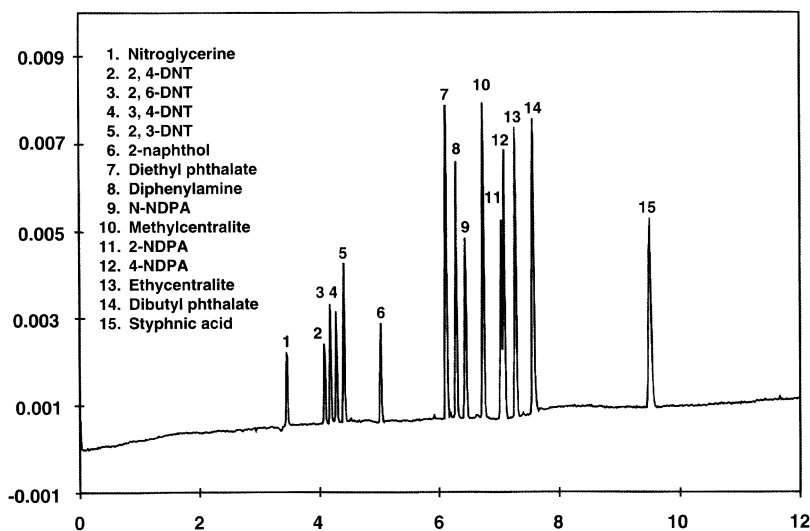


Fig. 1. Data provided by William Moore, Los Angeles Police Department Criminalistics Laboratory.

Analysis Conditions

Instrument	BioFocus [®] 3000 system
Polarity	positive to negative
Capillary	72 cm x 75 μ m uncoated (148-3061)
Run buffer	25 mM sodium dodecyl sulfate + 10 mM sodium borate + 10 mM boric acid, pH 8.5
Injection	electrophoretic, 2.0 kV for 5 seconds
Run voltage	30 kV
Capillary temperature	35 $^{\circ}$ C
Carousel temperature	20 $^{\circ}$ C
Detection	UV, 200 nm

Capillary Electrophoresis

The capillary used for the separation was a 72 cm x 75 μm ID uncoated BioCap™ capillary. The carousel and capillary temperature was kept constant at 20 °C and 35 °C, respectively, using liquid cooling. The sample was loaded onto the column by electrophoretic injection at 2.0 kV for 5 seconds. Voltage for the analysis was set at 30.0 kV.

Results and Discussion

Baseline separation of the organic explosive and GSR constituents was achieved by micellar electrokinetic capillary chromatography (MEKC). The addition of the negatively charged SDS detergent to the run buffer yields selective partitioning of charged and neutral analytes. Since SDS is anionic, the micelles migrate electrophoretically counter to the direction of the electroosmotic flow (EOF). However, the magnitude of the EOF is greater than the electrophoretic mobility of the micelles, causing all analytes to pass through the detection window. Compared to HPLC, MEKC provides high efficiency with greater mobile phase - micellar phase mass transfer kinetics and a decrease in band broadening due to a flat rather than laminar flow profile of EOF (Figure 2).

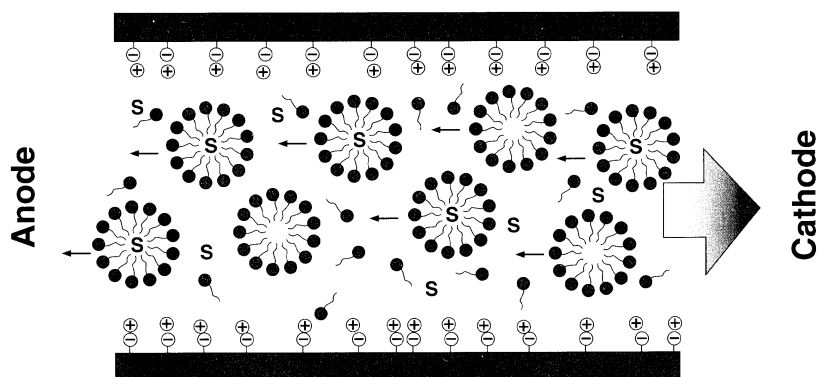


Fig. 2. MEKC—The magnitude and direction of EOF causes the micelles to travel in a + to - direction past the detection window.

Baseline separation of the explosive and GSR constituents was achieved in less than 10 minutes. MEKC provides forensic investigators with a powerful tool used for the identification of collected sample residues from materials and individuals involved in a crime. Baseline resolution of these organic constituents can be achieved in minutes, providing valuable information with faster and more cost effective analyses than that of other conventional analytical methods.

References

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