B7 The Forensic Analysis and Comparison of Mineral Oils Using GC-MS

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After attending this presentation, attendees will learn: (1) how mineral oils can be extracted from forensic samples and analyzed using GC-MS; (2) a scheme for the categorization of mineral oils based on their unresolved peak envelope (UPE); and (3) what types of products could potentially produce similar GC-MS results.

Little work has been published on the GC-MS analysis of mineral oils. This presentation will impact the forensic community and/or humanity by providing an efficient method for identification of mineral oils using GC-MS and also discusses the results of a comparison study carried out between several brands and types of mineral oil products.

Mineral oils are used primarily as lubricants in a wide variety of applications and are derived from crude oil. Because of their comparatively low volatility, it is not possible to analyze mineral oils by the headspace methods most commonly used to analyze volatile ignitable liquids and a separate method of analysis is therefore required.

A gas chromatography-mass spectrometry (GC-MS) method for the analysis and identification of mineral oils in forensic casework is presented. Mineral oil is applied to one surface of samples of wood and is immersed in hexane for approximately ½ hour. The extracts are then filtered and concentrated prior to GC-MS analysis using a DB-1 or equivalent column. Using this technique, mineral oils generate a characteristic unresolved peak envelope (UPE). Identification of mineral oil is based on the presence of a UPE eluting approximately between eicosane (normal C20) and tetracontane (normal C40) with an almost entirely aliphatic composition.

A series of tests was carried out in which pieces of wood were spiked with various quantities of mineral oil and then extracted with hexane. Using this simple extraction, as little as 1 µL of oil spiked onto wood could be detected.

A total of 61 mineral oil products were studied and their chromatograms were compared to assess their differentiability by GC- MS. It was not possible to determine the application type, brand, or grade of oil from the base oil chromatogram; however the oils studied were sorted into nine classifications based on UPE shape. All possible pairs of the 61 oils were compared on the basis of their UPE shapes, resolved peak detail and carbon range. Of the 1830 resulting pair comparisons, only 26 pairs were indistinguishable and only one of these 26 indistinguishable pairs was between oils that were unrelated by brand or manufacturer. In other words, 1804 (approximately 98.6%) pair comparisons had distinguishable UPE.

Oils that had been used, aged, and weathered by flame impingement could still be identified as mineral oil.

Other heavy petroleum-derived products were analyzed to determine whether or not they showed any similarity to mineral oils by this GC-MS analysis. Creosote, roofing tar, and un-evaporated diesel fuel did not produce a UPE characteristic of mineral oils. 50% evaporated diesel fuel was found to produce a UPE similar to mineral oil, however, its earlier UPE retention time range and its predominant normal alkane series (n-C12 to n-C26) provided means of differentiating it from mineral oil.

Petroleum jelly and lubricant greases were also analyzed and it was found that this technique effectively differentiated petroleum jelly, but not greases, from mineral oil. Casework examples will be presented.

This research describes an effective analytical technique for the analysis and comparison of mineral oils in a forensic context.

Mineral Oil, GC-MS, Forensic