

Advances in Oil Spill Forensic Using Biomarkers and Isotope Ratio Technique

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Background/Objectives. Determination of parties liable or guilty in order to recover costs of the cleanup and remediation, has grown dramatically in last decade, environmental forensics has emerged as a discipline directed toward this goal. Traditionally, these studies have been addressed through utilization of techniques such as gas chromatography (GC) and gas chromatography–mass spectrometry (GCMS).

Approach/Activities. Biomarkers play a very important role in characterization, and source identification in environmental forensic investigations of oil spills. Biological markers or biomarkers are one of the most important hydrocarbon groups in petroleum for chemical fingerprinting. Relative to other hydrocarbon groups in oil such as alkanes and most aromatic compounds, biomarkers are more degradation-resistant in the environment. Also biomarkers formed under different geological conditions and ages may exhibit different biomarker fingerprints. Biomarkers can be detected in low quantities in the presence of a wide variety of other types of petroleum hydrocarbons by the use of the gas chromatography/mass spectrometry (GC/MS). Chemical analysis of environmental samples for biomarkers generates great information to environmental forensic investigations in terms of determining the source of spilled oil. This is achieved by differentiating and correlating oils, and monitoring the degradation process and weathering state of oils under a wide variety of conditions.

Results/Lessons Learned. In recent years, stable isotopes, primarily determined through the use of combined gas chromatography–isotope ratio mass spectrometry (GC-C-IRMS), have emerged as an equally important tool in environmental forensics. Determination of stable isotopes is not new, having been around for over 50 years. The ability to determine the isotopic composition of individual compounds in complex mixtures is relatively new and came about with the development and commercial availability of combined gas chromatograph–isotope ratio mass spectrometers (GC-C-IRMS) in the late 1980s and early 1990s. The combined approach of using biomarkers and isotope ratio can lead to accuracy and confidence of the forensic conclusion of the results. As we will see in the presentation, in some cases, the CG-C-IRMS could be the only possible technique for identification. Depending on the samples, GC-C-IRMS can be the only reliable technique for fingerprinting due to lack of biomarkers.

Four different case studies will be presented where the above approach was used for conclusive results.