OIL BIODEGRADATION IN SOILS: MAXIMIZING INFORMATION BY HPLC-GCXGC/FID AND GCXGC/TOF-MS

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On HTC-10, we presented a novel two-dimensional gas chromatography protocol (*VITO-SOILCARE*^{TM}) for prediction of remediation potential and risks of oil contaminated soils/sediments. The new method demonstrated its superiority to the conventional GC-based methods with respect to predication of water solubility/migration risks, biodegradability and toxicological risks of oil contaminants.

We recently implemented HPLC-GCXGC/FID and GCXGC/ToF-MS as a "3D+3D" analytical technique for studying the aerobic biodegradation of (diesel) oil contamination in soils. The information obtained by the above analysis includes the biodegradability of each defined oil fraction, the effect of biodegradation on leaching potential of the remaining oil contamination, and the evolution of (eco)toxicological risk (for both soil and leaching water) during and after biodegradation. A 20-week biodegradation experiment was conducted with both fresh and weathered oil contaminated soils. With HPLC-GCXGC/FID, the biodegradability of 10 hydrocarbon groups plus 15 representative individual hydrocarbons was obtained. We found that although nutrient amendment may increase TPH removal, it can pose an adverse effect on the reduction of toxicological risks and leaching potential. GCXGC/ToF-MS analysis results of the soil leaching water showed that various oxygenated hydrocarbons were produced during bioremediation. These compounds were observed in the leaching water together with low boiling point aromatic hydrocarbons at the early stages of biodegradation. The intermediate biodegradation metabolites were then further degraded at later stages of the experiment. In general, the leached compounds moved upward and rightward on the GCXGC color plots upon increasing biodegradation time, indicating that more polar and heavier compounds were formed as biodegradation proceeded. Acute ecotoxicity tests (plant seed germination and Microtox$^{®}$) were performed over time for both soil and leaching water to give a direct indication of toxicological risk evolution and to assist interpretation of the "3D+3D" chemical analysis results.

In conclusion, the "3D+3D" hyphenated analytical technique provided comprehensive information regarding oil biodegradation in soils that can not be obtained by any other existing analytical technique. The information obtained can be vital not only for better understanding of oil aerobic biodegradation but also for developing environmentally acceptable concentration levels of petroleum hydrocarbons in bioremediated soils.