# Development of an expedited field study method for PCBs and dioxins in soils using portable GC/MS

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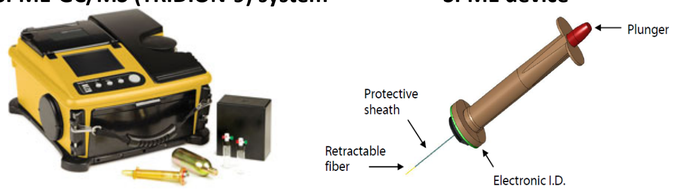
## Introduction

Both Polychlorinated biphenyls (PCBs) and dioxins belong to persistent organic pollutants (POP), which are bioaccumulative and resistant to biodegradation. Gas Chromatography/Mass Spectrometry (GC/MS) is the most commonly used technique to quantify and determine PCBs and dioxins from different matrices. Current procedures for assessing environmental PCB and/or dioxins contamination at the site of the former Portsmouth Gaseous Diffusion Plant (PORTS) in Piketon, OH relies on collecting numerous surface and bore samples and sending all samples to DOE certified laboratories for analysis. This approach is extremely expensive (typically ≥ $1000/sample) and very slow. Here we develop a fast, on-site method to analyze PCBs and dioxins in sediments and soils using a commercial field-portable GC/MS and solid phase microextraction (SPME).

## Instrument and Method

The portable TRIDION-9 GC-MS instrument (Torion Technologies, American Fork, Utah, USA) is a completely stand-alone system with disposable helium cartridge and rechargeable battery. The entire system weighs about 13 kg (28 lb) and is 47 × 36 × 18 cm (18.5 × 14 × 7 in.) in size. It has a touch LCD and the instrument can get ready for injection within 3 min which are very convenient for on-site study. The SPME fiber on the special designed SPME device can be extended from or withdrawn into a protective metal needle just by pushing the plunger on top of the holder. Commercial SPME fibers from Supelco (Bellefonte, PA, USA) can be used in this holder.

**SPME-GC/MS (TRIDION-9) system** **SPME device**

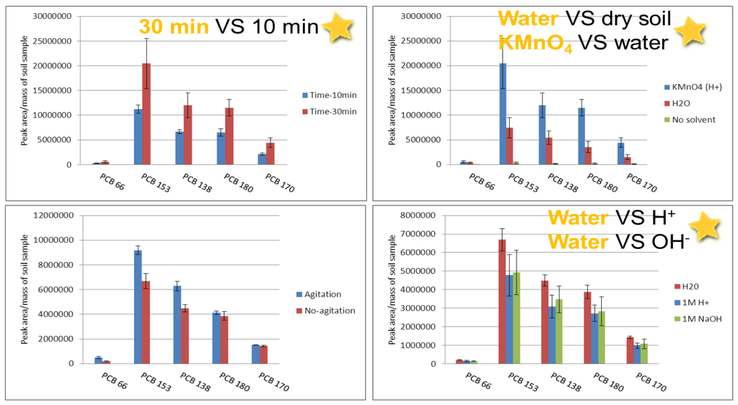



PCB congeners or Aroclor 1260 (trade name of commercial PCB product) were extracted by SPME and analyzed by portable GC/MS. PCBs 66, 153, 138, 180 and 170 were chosen to investigate the extraction conditions for Aroclor 1260, a known contaminant in the region. To achieve the maximum extraction efficiency, the effects of SPME sorption time, agitation, pH, $KMnO_4$ and $H_2O$ were investigated. For quantification purpose, the differences between using peak area and peak height to build calibration curves were studied. Tetrachloro-m-xylene (TCMX) as surrogate was added to all samples before extraction to monitor the method performance. Method development such as extraction conditions were performed on a standard bench top instrument consisting of a trace GC gas chromatograph and a Polaris Q mass spectrometer (Thermo Electron Corporation, San Francisco, CA, USA).

**Specific PCB congeners that are major components in common Aroclors**

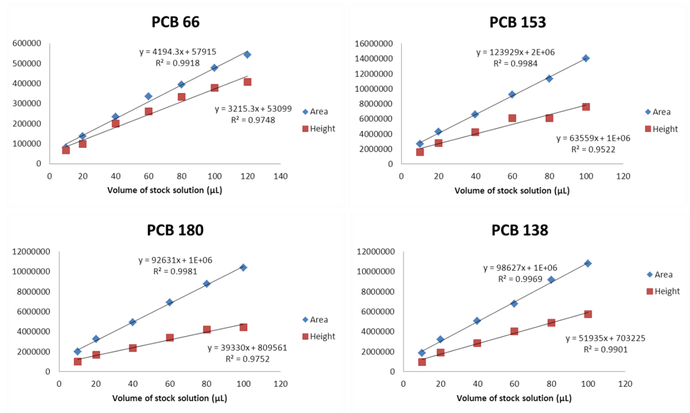
| Congener | IUPAC Number | Aroclor 1016 | 1221 | 1232 | 1242 | 1248 | 1254 | 1260 |
|---|---|---|---|---|---|---|---|---|
| Biphenyl | -- | | X | | | | | |
| 2-CB | 1 | X | X | X | X | | | |
| 2,3-DCB | 5 | X | X | X | X | X | | |
| 3,4-DCB | 12 | X | | X | X | X | | |
| 2,4,4'-TCB | 28 | X | | X | X | X | X | |
| 2,2',3,5'-TCB | 44 | | | X | X | X | X | X |
| 2,3',4,4'-TCB | 66 | | | | | X | X | X |
| 2,3,3',4',6-PCB | 110 | | | | | | X | |
| 2,3',4,4',5-PCB | 118 | | | | | | X | X |
| 2,2',4,4',5,5'-HCB | 153 | | | | | | | X |
| 2,2',3,4,4',5'-HCB | 138 | | | | | | | X |
| 2,2',3,4,4',5,5'-HpCB | 180 | | | | | | | X |
| 2,2',3,3',4,4',5-HpCB | 170 | | | | | | | X |

## Results



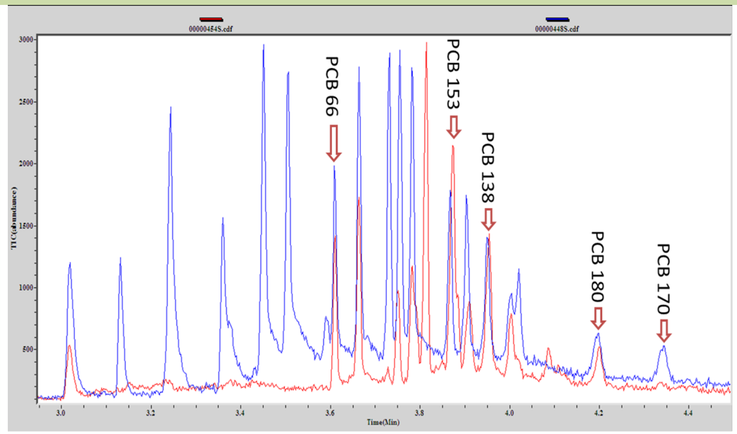

**Effects of SPME sorption time, agitation, addition of $KMnO_4$ and $H_2O$ and addition of acid and base on extraction efficiency of PCB 66, PCB 153, PCB 138, PCB 180 and PCB 170.**

Paired t-test results show significant difference




**Calibration curves using peak area (blue) and peak height (red) for PCB 66, PCB 153, PCB 138, and PCB 180 in Aroclor 1260 solutions.**

** The data above are collected on bench-top instrument (Thermo Polaris Q GC/MS)*




**Comparison of TIC of Aroclor 1260 (red, 7500 ng in 10 mL vial) and 8082A (blue, 500 ng in 10 mL vial) standard solutions on the portable GC-TMS.**

## Conclusion

Longer extraction time, addition of water and KMnO4 can improve the extraction efficiency. Using water as extraction solvent is better than using acid or base to extract. No significant differences were found between agitation and no-agitation groups, or between acid and base groups for SPME extraction. The portable GC/MS showed the possible capability to identify and even quantify the Aroclor 1260 in soil samples.

## References

1. EPA, Polychlorinated Biphenyls (PCBs) by Gas Chromatography. *EPA Method 8082a* 2000.

2. Derouiche, A.; Driss, M. R.; Morizur, J. P.; Taphanel, M. H., Simultaneous analysis of polychlorinated biphenyls and organochlorine pesticides in water by headspace solid-phase microextraction with gas chromatography-tandem mass spectrometry. *Journal of Chromatography A* 2007, 1138 (1-2), 231-243.

## Future Work

- SPME-GC-TMS performance on determination of PCBs in soil samples
- Method validation
- Field analysis of PCBs in soil samples
- Method development for dioxins

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