Rapid Field Sampling Solutions for On-Site Analysis Using Field Portable GC/MS

Information at the Source

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Taking the Laboratory to the Field – Why?

- Sample vs Information

- Reasons to have the information:
  - Time critical information (biggest driving factor)
  - Making decisions that will effect safety and health
  - Positive economic impact
  - Guide further sampling activities
  - Sample can change during transport to a laboratory

- GC/MS provides for detection of target compounds and identification of unknowns
TRIDION™-9 GC/MS

- Dimensions: 38cm x 39 cm x 23 cm
- Weight: < 14.5 kg or 32 lbs
- Power: 24 volts DC, line or battery
- Sample Introduction: SPME or Needle Trap
- GC: MXT-5,5 m x 0.1 mm x .04um High Speed High Resolution (HSHR)
- Temperature Programmable 120°C/sec
- Electronic Pressure Control
- Ion Trap: Toroidal Ion Trap MS
- Mass Range: 43 to 500 Daltons
- Vacuum: turbo, molecular/diaphragm pumps
Rapid Identification HSHR GC/MS
Lessons Learned

Environmental Applications

- The field is not the lab!
- Conditions vary greatly
  - temperature, humidity, dust
- Laboratory methods don’t necessarily work in the field
  - Performance based methods
  - Site specific methods
- Adapting Laboratory equipment to the field
  - Needs to be more than rugged
- It is important to understand data quality objectives
The Laboratory Model

Standard operating procedures

- SW-846
  - Methods
  - Instrument configurations
    - A wide range of concentrations, analytes, volatility are generally not run on a single GC - MS
  - Sample collection methods
  - Sample Preparation Methods and Instrumentation
What is the Purpose of Field Analytical Data

• Meet all the criteria of SW-846 and provide the same level of QA/QC and data quality?
  ○ Not the primary role played by field analytical

• Provide data that meets the specific objectives of the site?
  ○ It is important to understand data quality objectives a set criteria that meet the site requirements

• Provide information when and where it is needed to make informed decisions?
  ○ Understanding the role of sampling and having the right tools
The Challenge of Sampling

- Two classes of samples
  - Volatile
  - Semi-Volatile
- Multiple Matrix
  - Air
  - Water
  - Soil
  - Sludge
- Sample prep needs to be adapted to the field
  - Varying atmospheric conditions
  - Undefined concentrations
The Challenge of a Universal Sampler

- Concentrations ranging from parts per trillion to percent
- Wide boiling point range
- Sample matrix
- Chemical activity
**CUSTODION™-NT (Needle Trap)**

- Gas Phase Sampling
- Manual or Battery operated pump
- Detection Limits 10 – 50 ppb/v
TO-15/17 Volatiles (VOCs) in Air

Results for 34 Compounds from an Air Calibration Mix

100 ppb/analyte
DL (5 min): ~50 ppb
BTEX in Water

< 1 ug/L BTEX
Design of a Field Sample Prep Station

- Capable of multiple quantitative sample preparation techniques
  - Air
  - Water
  - Soil
- Operates on battery power
- Capable of covering a wide concentration range
- Provides easy mechanism for quantitative analysis
- Ideal if VOC and SVOC sample types can be run
Three Functions

Thermal Desorption

Headspace/P&T

Internal Standard
Internal Standard Curve Methylene Chloride

28 to 442 ppb/v

$R^2 = 0.99576$
Thermal Desorption Extraction of SVOC

- Teflon silicone septum
- O-ring
- SLS PDMS tube
- 1000 mL Container
- 500 mL Container
- SPE holder
- Vacuum
RIC 1 ppt Geosmin in Water

GC conditions:
Injector: 290°C
column: 50°C initial, hold 10 s; 10°C/s rate;
290°C final hold 10 s
Inlet pressure: ~26 psi
Splitless mode: 50:1/40-60 s; 10:1/20-40 s
Sample Preparation Steps

1. Transfer to 20 mL vial
2. Transfer to 2 mL vial (pre-concentration if necessary)
3. Use vacuum pump or leave the tube in air to evaporate the solvent.
4. Use glass empty tube or glass wool packed glass tube.

Micro Extraction Thermal Desorption

Mixture of dichloromethane and water (5+15 mL) With IS addition

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PAH Extracted from Gravel

0.25 ppm Spiked Sample

Anthracene

Phenanthrene

Fluoroanthene

Pyrene

Benzo(a)anthracene

Chrysene
Advances in Solid Phase Extraction TFME

- **SPME** is a Universal Sampler that covers broad analyte range and multiple matrix
  - Limited Surface area

- Thin Film Membranes work on the same principle as SPME
  - Larger Surface Area

- **Current Design**
  - 25 X more analyte during sampling
  - 14 X at equilibrium
Coupling TFME with portable GC-MS:

- Portable GC-MS instrumentation offers an inherent advantage in generating immediately available results with no need for sample transport.
- By coupling with more sensitive sampling technologies such as TFME, sensitivity can be increased.
- Highly sensitive, inexpensive samplers can be deployed in a wide variety of locations simultaneously.
Demonstration of detection capability: Pesticide mixture at 100 ppt on T-9
10 ug/L Pesticide Mixture

Fonofos
Summary

- Sampling remains a major challenge in accurately defining the state of our environment.
- The combination of Field Portable GC/MS with rapid sampling tools for VOC and SVOC analysis provides data to make informed decisions at the site/source of the pollution.
- The pace of development for in-field sampling technologies must equal or exceed the development of instruments.