Volatile (VOC) and Semi-Volatile (SVOC) Compounds in One Air Sample

Lee Marotta, Principal Field Application Scientist, PerkinElmer

PerkinElmer
For the Better

1 Introduction

Historically, the target investigation of air was in the volatile range from the boiling point of nC3 through nC12 Now, there is agreement that semi-volatile components are contaminating our air, for example soil gas or super fund sites. This research explains how to analyze both VOC and SVOCs in a single air sample

2 Validated Sorbent Tubes to Accommodate Range

2010: Soil Vapor Intrusion (SVI) Tube (patented)

- Boiling point range of nC3 to nC26
- VOC & SVOC from seven gases to phenanthrene

2011: Extended Range Organics (XRO) 660

- Boiling point range of nC6 to nC44
- VOC & SVOC from BTEX to benzo(g,h,i)perylene

2013: Extended Range Organics (XRO) 440

- Boiling point range of nC4 to nC44
- VOC & SVOC from 1,3-butadiene to benzo(g,h,i)perylene

3 Field Site Experiments (SVI and MGP)

Site	Investigating (Research)	Sample Volume
Indoor Air (SVI)	Comparing PAHs in Sub-Slab to Indoor Air	1 liter
Industrial Sub-Slab	2-Methyl Naphthalene main compound of interest compared recovery of TO-15 to TO-17 (XRO–440	1 liter
Industrial Sub-Slab	Same site sampling onto SVI tube and XRO-440 tube	1 liter
Manufactured Gas Plant (MGP)	Comparing TO-15 and TO-13 to TO-17 (XRO-440 and XRO-640 tubes)	50 liters

4 Analytical Performance XRO-440 Tube

Compound	Calibration range 0.2 to 50 ng on tube	Reporting Limit $\mu g/m^3$ (sample)	Precision %RSD (n=6)
1,3-Butadiene	0.9981	0.0111	1.89
Benzene	0.9993	0.0044	0.9
Toluene	0.9994	0.0044	0.94
Ethyl Benzene	0.9991	0.0044	0.77
m,p-Xylenes	0.9994	0.0044	0.95
o-Xylene	0.9998	0.0044	1.57
Ave 19 PAHs	0.9990	0.0044	1.48

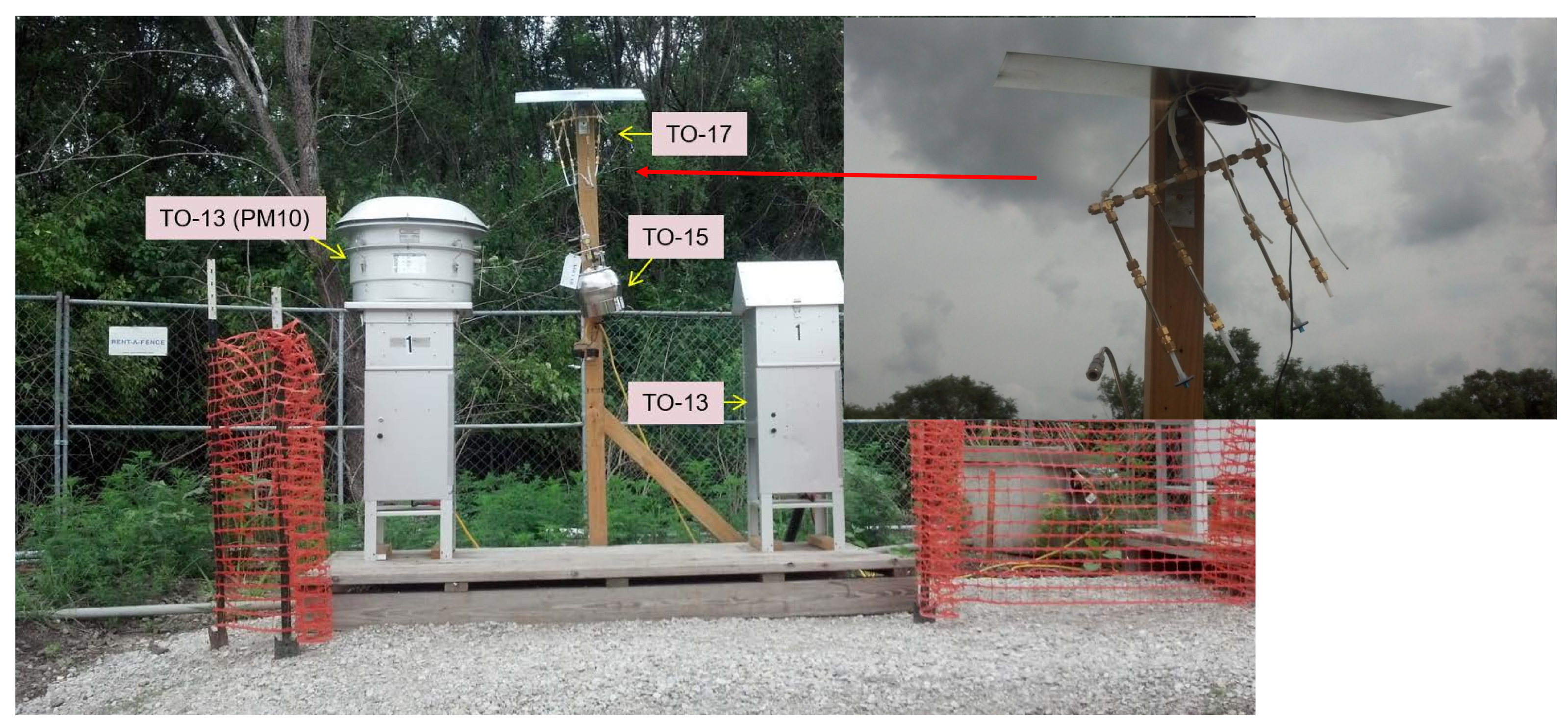
5 Soil Vapor Intrusion (SVI) Tube Analytical Performance: Reporting Limits: 1-liter Sample Volume

Class of Compound*	# of analytes per group	Linear range 0.05 to 250 $\mu g/m^3$ r^2	Precision (n=10)	Signal to Noise at Reporting Limit 0.05 µg/m3
Gases	7	0.9994	7.39	530:1
Aliphatic Hydrocarbons (halogenated)	35	0.9996	4.80	560:1
Aromatics (halogenated)	9	0.9997	2.58	1350:1
Aromatics (non-halogenated)	14	0.9996	1.91	1220:1
Polynuclear Aromatic Hydrocarbons	7	0.9997	3.56	570:1
Others	13	0.9996	3.19	560:1

6 Data Acquisition

- All data was collected in simultaneous Full Scan/Single Ion Monitoring (SIM) modes on a single quadrupole mass spectrometer
- Only the full scan data was used because the reporting limits attained in Full Scan outperformed requirements. SIM was unnecessary; however, if there is a requirement to attain lower detection levels, 100 times enhancement is easily attainable

7 MGP Site Set-up: TO-13 / TO-15 / TO-17



- Goal: to eliminate a two sampling analysis which uses TO-13 and TO-15. Replace this with a one step analysis using TO-17
- Both XRO-440 and XRO-640 tubes were investigated
- Sampling was performed in duplicate
- One of the duplicates had filter attached. Filters had non detection (ND) of PAHs
- A breakthrough tube was attached to every tube sampled. The secondary (breakthrough) tube was non-detect
- Samples were collected for 72 hours over 6 weeks at three locations at the site; therefore, 43 sampling events

8 Results from Two Different Site Studies: MGP and Soil Vapor Intrusion

Target	Manufactured Gas Plant Single Site Results: Site One (MPG) TO13 & 15	Site One (MPG) TO17	Soil Vapor Intrusion Site Results: Stock Room Sub-slab	Stock Room Indoor Air	Sewing Room Sub-slab	Sewing Room Indoor Air
Benzene	nd	0.38	The laboratory investigated the SVOCs which were more of a focus in this experiment			
Ethyl Benzene	nd	0.15				
Toluene	2.43	1.33				
m,p-Xylene	nd	0.44				
o-Xylene	nd	0.14				
Naphthalene (TO15)	1.38	3.12				
Naphthalene (TO13)	0.68	3.12	0.251	3.96	0.286	1.15
2-Methylnaphthalene	0.25	0.62	0.345	0.802	0.414	0.252
1-Methylnaphthalene	0.12	0.26	0.284	0.408	0.234	0.138
Acenaphthylene	0.0058	0.066	0.0773	nd	nd	nd
Acenaphthene	0.13	0.30	0.157	nd	nd	nd
Fluorene	0.070	0.12	0.170	0.124	0.166	0.210
Phenanthrene	0.076	0.055	0.158	0.111	nd	1.40
Anthracene	0.0039	0.080	nd	0.0335	nd	0.240
Fluoranthene	0.0092	0.0040	0.0208	nd	0.0336	0.145
Pyrene	0.0050	0.0032	0.0286	0.0192	nd	0.238
Benzo(a)anthracene	0.0006	0.0067	nd	nd	nd	0.0334
Chrysene	0.00089	0.0046	nd	nd	nd	0.0315
Benzo(b+k)fluoranthene	0.00092	nd	nd	nd	nd	nd
Benzo(e)pyrene	0.00051	0.0044	nd	nd	nd	nd
Benzo(a)pyrene	0.00048	0.0074	nd	nd	nd	nd
Indeno(1,2,3-cd)pyrene	nd	nd	nd	nd	nd	nd
Dibenz(a,h)anthracene	nd	nd	nd	nd	nd	nd
Benzo(g,h,i)perylene	0.00050	0.0081	nd	nd	nd	nd

9 Summary

- The empirical data from these sites demonstrates that there are high boiling PAHs making their way into air, and successfully analyzed using thermal desorption or TO-17. The two ring PAHs were consistently lower in TO-13. The speculation is that during the concentration step, these are being lost.
- The ability to attain accurate data using TO-17 instead of a two sampling event using TO-13 and TO-15 is immensely beneficial. The cost saving in labor and solvent use is significant. Another benefit is the reduction of analyst exposure to solvent and an environmentally friendlier approach
- The groupings of the PAHs in table 4 and the grouping of classes of compounds in table 5 were performed to make the tables smaller for the poster. All components in the classes performed essentially the same. All component data is available upon request
- The ability to retain the important seven (7) gases and recover all regulated PAHs will enable us to attain a better scientific understanding of air in addition to improving public health

10 Acknowledgement (thank you)

- CARO Analytical Services, Richmond, BC. Stephen Varisco, Patrick Novack, Luba Tsurikova
- Pace Analytical Services, Minneapolis, MN. Roberta Provost
- InnoTech Alberta, Edmonton, AB. Dave Murray, Tom Kosik, Jodi Johnston, Chris Goss, Dan Wispinski
- PerkinElmer, Miles Snow, Tom Kwoka, James Day, Ryan Sieber

PerkinElmer, 710 Bridgeport Avenue, Shelton, CT, 06484 USA