Introduction

The Clean Air Act requires US EPA to set National Ambient Air Quality Standards. Air Toxics, also known as "hazardous air pollutants (HAP)", are of particular interest due to their threat to human health. As thermal desorption technology improves, the EPA Method TO-17 replaced earlier sorbent based EPA Methods TO-1 and TO-2 and provides an alternative to canister-based EPA Method TO-14 and TO-15 for Air Toxics measurement.

The Tube Style 2 mentioned in EPA Method TO-17 is the default configuration of the Air Toxics Tube. From a historical point of view, its functionality combines that of EPA TO-1 and TO-2. The tube can be used independent of canisters, or in conjunction with.

Air Toxics Tube Configuration

- Standard/Default: 35 mm Carbograph™ 1 plus 10 mm of Carbosieve™ SIII
- Options: Carbosieve™ SIII may be replaced by Carboxen™ 1000 or Carboxen™ 1003
- Sorbents are separated by 3 mm glass wool
- Carbograph™ 1 is equivalent to Carbopack™ B

Volatility Range C2/C3~C12/C14

Volatility Range – Continue

- C2/C3 ~ C12/C14 (Compendium Method TO-14 air toxics) for air volumes of 2 L at relative humidity levels below 65% and temperatures below 30°C. At humidity levels above 65% and ambient temperatures above 30°C, either air volumes should be reduced to 0.5 L, or the user should choose Carboxen™ 1003 over the other two carbon molecular sieve sorbents. Air volumes may be extended to 5 L or more for species ranging in volatility from C4.

Temperatures

Maximum Temperature:	400°C
Conditioning Temperature:	350°C
Desorption Temperature:	325°C

Pros

- "Air Toxics Tube" is a very popular tube defined by EPA TO-14 to handle volatility ranging from propene to Hexachloro-1,3-butadiene.
- Choice of Carbosieve™ SIII, Carboxen™ 1000 or Carboxen™ 1003 gives the user some flexibility.
- Very low background suitable for trace analysis.

Cons

- Doesn't cover high boilers (C12+), and may be contaminated by the presence of C12+

Technical Guide

Air Toxics Tube

- Air Toxics Tube is a dual-bed tube suitable for active/pumped sampling.
- Camsco's Air Toxics Tubes feature two circumferential bands for easy identification (Camsco part number: SU60501).
- Choose your second sorbent according to the order of increasing hydrophilicity: Carboxen™ 1003 < Carbosieve™ SIII < Carboxen™ 1000.
- The user can choose Carboxen™ 1000 (Camsco part number: SU60545) or Carboxen™ 1003 (Camsco part number: SU60562) instead of the standard Carbosieve™ SIII for their specific analytes or sampling environment. Generally speaking, Carbosieve™ SIII is mostly hydrophobic while Carboxen™ 1000 is significantly hydrophilic, and Carboxen™ 1003 is very hydrophobic.
- At high humidity, even Carbosieve™ SIII adsorbs significant amount of water. A dry purge procedure or a large split ratio must be used during analysis when humid air has been sampled on Air Toxics Tubes.

VOC's in Rural-Residential Ambient Air Captured by an Air Toxics Tube

Figure (1): courtesy of Leeder Consulting. The Chromatogram shows the Volatile Organic Compounds in rural-residential ambient air captured by an Air Toxics Tube. The peaks include benzene, toluene and other VOCs plus a range of volatile essential oils such as limonenes and pinenes from the nearby vegetation. Concentrations are in the range of 0.1-1 ppb.

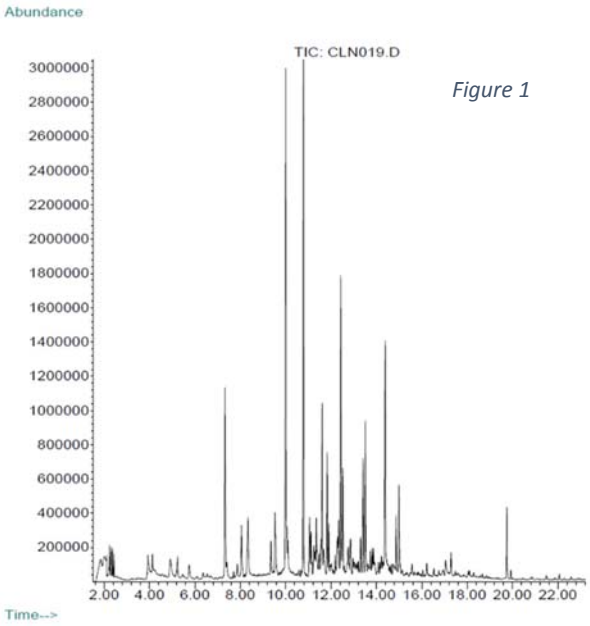

Figure 1

Duplicate Ambient Standards introduced onto two Air Toxics Tubes

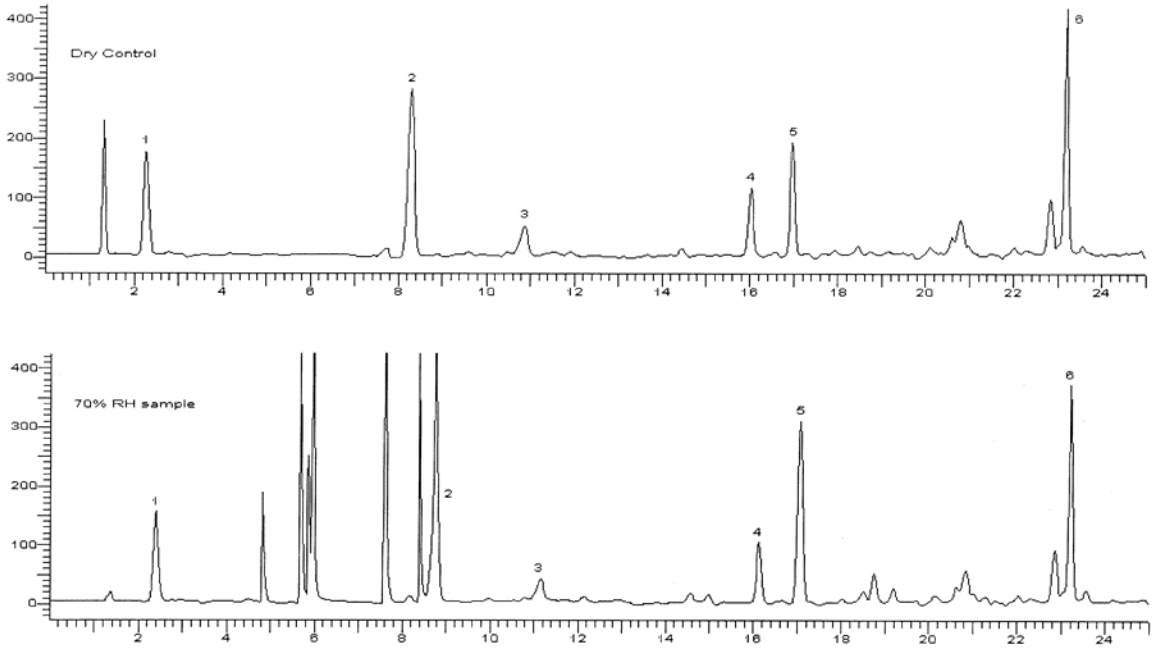

Figure (2): courtesy of Karbiwnyk et. al. The same ambient standards introduced onto an Air Toxic Tube by dry air (top) and by air with 70% relative humidity without dry purge (bottom). Peak 2 (chlorofluorocarbon) has shifted from the dry retention time, and noise spikes distorts the shape of the peak.

Duplicate Ambient Standards introduced onto two Air Toxics Tube (even higher humidity)

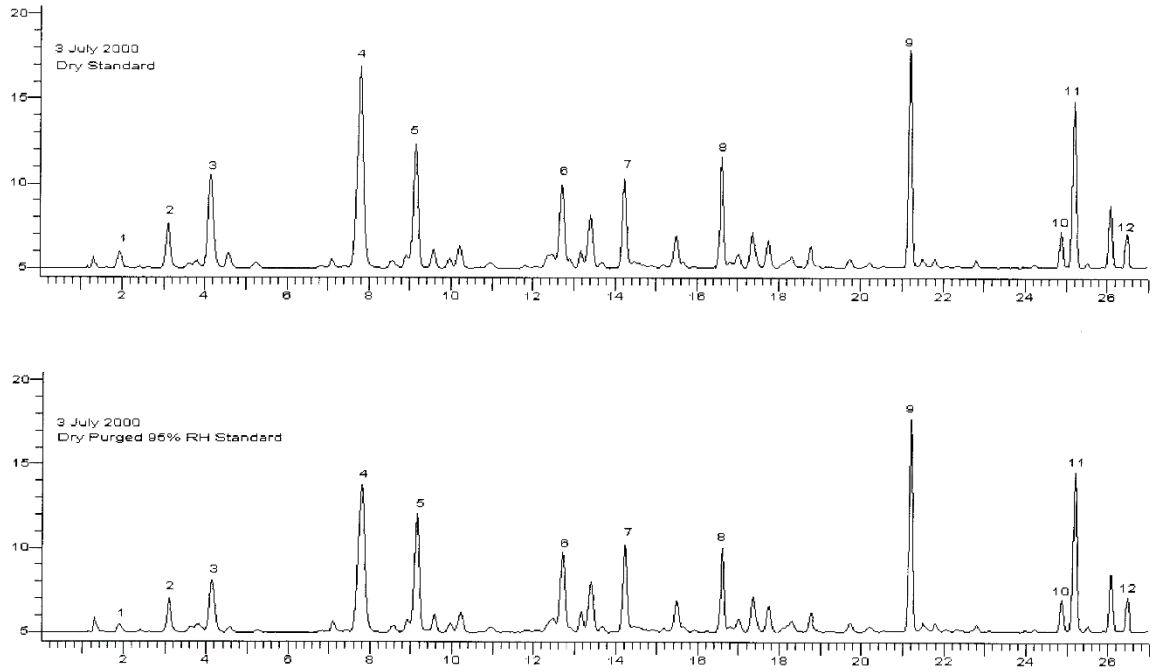

Figure (3): courtesy of Karbiwnyk et. al. The same ambient standards introduced onto an Air Toxic Tube by dry air (top) and by air with 95% relative humidity with dry purge (bottom). Peaks look almost identical in two chromatograms.

Comparison to other Tubes

- Air Toxics Tubes are very popular thanks to the seamless integration of volatility ranges handled by Carbograph™ 1 and Carbosieve™ SIII. There's hardly a better choice for VOC analysis, especially used in conjunction with canisters.
- One way to modify this tube for better hydrophobicity is to replace Carbosieve™ SIII or Carboxen™ 1000 with Carboxen™ 1003, which retains even less water.

References

US EPA Method TO-17: Determination of volatile organic compounds in ambient air using active sampling onto sorbent tubes. EPA/625/R-96/010b, 1999

US EPA Methods TO-14 Second Supplement: Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. 600/4-89-018, 1989

US EPA Air Toxics Website: http://www.epa.gov/ttn/atw/allabout.html

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Christine M. Karbiwnyka, Craig S. Millsb, Detlev Helmigc, John W. Birksa, M inimization of water vapor interference in the analysis of nonmethane volatile organic compounds by solid adsorbent sampling. Journal of Chromatography A, 958 (2002) 219–229

UK Health and Safety Executive MDHS 72 (Volatile Organic Compounds in Air), "Laboratory Method Using Pumped Solid Sorbent Tubes, Thermal Desorption and Gas Chromatography," Methods for the Determination of Hazardous Substances (MDHS), Sheffield, UK.

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