



The "Universal" Tube



Introduction

The "Universal" Tube is named this way because it handles the widest range of volatility, and serves as a start point when people don't know what to expect from unknown air sample.

- Synthetic Polymers (SP) tend to be weak sorbents, and Tenax® TA is the most popular SP.
- Graphitized Carbon Black (GCB) is a group of weak/medium strength sorbents, among which Carbograph™ 1 is the most popular.
- Carbon Molecular Sieve (CMS) consists of very strong sorbents, and Carbosieve™ SIII is the most popular CMS for thermal desorption.



The design philosophy is to combine the most popular SP/GCB/CMS sorbents in a single tube, and cover the whole range of WOC/VOC/SVOC

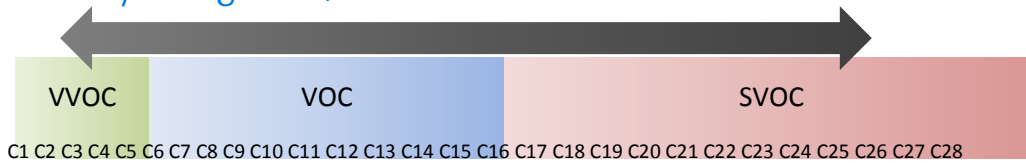
Or, the "Universal" Tube can be perceived as the fusion of a Tenax® TA tube and an Air Toxics Tube, which are the two most popular thermal desorption tubes we manufacture. In that sense, please read our application notes for Tenax® TA tube and Air Toxics Tube, respectively.

For those who want to further extend the coverage from C26 to C40, the universal tube may be ordered with a 10mm glass wool/bead in front of the Tenax®. Glass wool/bead is an even weaker sorbent than Tenax® and only retains very heavy SVOC.

Universal Tube Configuration:

- Tenax® TA plus Carbograph™ 1 plus Carbosieve™ SIII
- Carbosieve™ SIII may be replaced by or Carboxen™ 1003 in case hydrophobicity is desired
- Sorbents are separated by 3 mm glass wool.
- Carbograph™ 1 is equivalent to Carbopack™ B

Volatility Range C2/C3~C26



- C2/C3 ~ C26 for air volumes up to 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 CMS sorbents.

Temperatures

Maximum Temperature:	350°C
Conditioning Temperature:	320°C
Desorption Temperature:	300°C

Pros

- Covers a wide range from C3 to C26, and offers much more information than whole air sampling by canisters or air bags
- Choice of Carbosieve™ SIII, Carboxen™ 1000 or Carboxen™ 1003 gives the user some flexibility
- Is the tube of choice for complex/unknown air analysis

Cons

- Tenax® TA limits the desorption temperature and background noise of the tube
- Not good for passive sampling, even though all three sorbents are popular choices for passive samplers when packed individually in a tube.

Technical Guide

The "Universal" Tube



- The "Universal" Tube is a tri-bed tube suitable for active/pumped sampling
- Choose your CMS sorbent according to the order of increasing hydrophilicity: Carboxen™ 1003 < Carbosieve™ SIII < Carboxen™ 1000
- At high humidity, a dry purge procedure or a large split ratio must be used during analysis when humid air has been sampled on these tubes

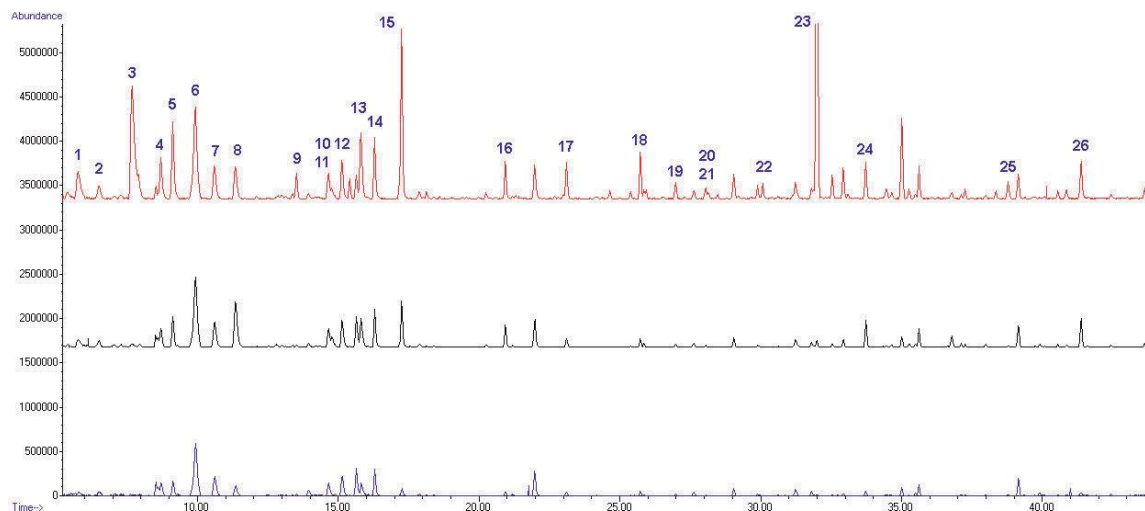


Figure (1): courtesy of Markes International. Chromatograms from three 1 L real air samples collected using 'Universal' sorbent tubes. The Red chromatogram on top is office air, the black chromatogram in the middle is laboratory air, and the blue chromatogram down the bottom is semi-rural outdoor air.

1 Methanol	8 Hexane	15 1-Methy-2-propanol	22 Alpha-myrcene
2 2-Methyl butane	9 Ethyl acetate	16 Toluene	23 D-limonene
3 Ethanol	10 2-Methyl hexane	17 Hexanal	24 Phenol
4 Acetone	11 Cyclohexane	18 Xylene	25 Menthol
5 Isopropyl alcohol	12 3-Methyl Hexane	19 Xylene	26 2-Phenoxy ethanol
6 2-Methyl pentane	13 Heptane	20 Alpha-pinene	
7 3-Methyl pentane	14 Acetic acid	21 Cyclohexanone	

Comparison to other Tubes

- The “Universal” Tube covers a wider range than all other tubes. Consider it a Tenax® TA tube with strengthened sorbents to extend its range all the way to C2~C3; or an Air Toxics tube aided by Tenax® TA to pick up SVOC.
- For applications that try to cover all the volatiles from their air sample, the “Universal” Tube offers a broad-range consensus, based on which simpler tube designs can be derived.
- Compared to EPA TO-17 Tube Style 3, the “Universal” Tube replaces the weakest carbon-based sorbent with Tenax TA to extend the SVOC coverage to C26, however, the tradeoff is limited desorption temperature and higher background noise.

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

E. Hunter Daughtrey, K. D. Oliver, J. R. Adams, K. G. Kronmiller, W. A. Lonneman, W. A. McClenny, A comparison of sampling and analysis methods for low-ppbC levels of volatile organic compounds in ambient air, J. Environ. Monit., 2001, 3, 166-174

Markes International Thermal Desorption Technical Support Note 86a: EPA Method TO-17 for monitoring ‘air toxics’ in ambient air using sorbent tubes and automated, cryogen-free thermal desorption

