



### TO-17 Tube Style 3



## Introduction

Global anthropogenic VOC (volatile organic compounds) emissions are estimated about 142 teragrams of carbon per year and growing, even though the majority of total VOC is still produced by plants. The United States is the largest contributor with 21% of the total global VOC emissions. The Clean Air Act, which was last amended in 1990, requires US EPA to set National Ambient Air Quality Standards.

US EPA Method TO-17: "Determination of volatile organic compounds in ambient air using active sampling onto sorbent tubes" describes a TD-GC/MS based monitoring method for VOC in ambient air at 0.5 to 25 parts per billion (ppbv) concentration levels. The method is based on multi-sorbent tubes carefully selected for the suitable target compounds, and allows some flexibility in tube design to fit individual needs. However, three tube styles (called Tube Style 1, 2, and 3) are recommended and specified in TO-17.

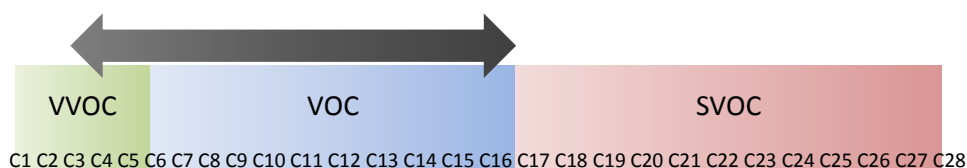


This method replaces earlier sorbent based EPA Methods TO-1 and TO-2 and provides an alternative to canister-based EPA Method TO-15. The target compound list is the same as TO-15 (i.e., subsets of the 97 VOCs listed as hazardous air pollutants in the Clean Air Act Amendments of 1990).

## Tube Style 3 Configuration

- 13mm Carbograph™ 2, 25mm Carbograph™ 1 plus 13mm of Carbosieve™ SIII or Carboxen™ 1000 all separated by 3mm plugs of glass wool
- Carbograph™ 2 is equivalent to Carbopack™ C; Carbograph™ 1 is equivalent to Carbopack™ B

## Volatility Range C3~C16



## Volatility Range - Continued

C3 ~ C16 for air volumes of 2 L at relative humidity's below 65% and temperatures below 30°C. At humidity levels above 65% and ambient temperatures above 30°C, air volumes should be reduced to 0.5 L. Air volumes may be extended to 5 L or more for compounds ranging in volatility from C4.

## Temperatures

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

## Pros

- This tube extends the volatility range of TO-17 Tube Style 2
- Choice of Carbosieve™ SIII or Carboxen™ 1000 gives the user some flexibility
- Very low background suitable for trace analysis

## Cons

- Does not cover SVOC

## Technical Guide

### TO-17 Tube Style 3



- TO-17 Tube Style 3 is a tri-bed tube suitable for active/pumped sampling
- The user can choose Carbosieve™ SIII or Carboxen™ 1000 for their specific analytes or sampling environment. Generally speaking, Carbosieve™ SIII is mostly hydrophobic while Carboxen™ 1000 is significantly hydrophilic. In humid environments, Carbosieve™ SIII will retain less water, which interferes with the detector. However, Carboxen™ 1000 has larger surface area and better desorption efficiency than Carbosieve™ SIII (Carbosieve™ SIII Camsco Part Number: **SU605300**)
- At high humidity, even Carbosieve™ SIII adsorbs a 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 these tubes.

## Comparison to other Tubes

- TO-17 Tube Style 3 is named “Carbotrap 300” by Supelco’s™ nomenclature.
- We look at TO-17 Tube Style 3 as an “Extended TO-17 Tube Style 2”. While TO-17 Tube Style 2 only covers part of the VOC range up to C12, the TO-17 Tube Style 3 covers the entire VOC spectrum which is defined from C6 (n-hexane) to C16 (n-hexadecane).
- Replace Carbosieve™ SIII or Carboxen™ 1000 with Carboxen™ 1003, and you get a Soil Vapor Intrusion (SVI) Tube (Camsco Part Number **SU60519**), which is more moisture-proven.
- Or, replace Carbograph™ 2 with Tenax® TA, and you get the “Universal Tube” (Camsco Part Number **SU60529**), which extends the volatility range up to C26 but limits the desorption temperature down to 300°C.

## 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

Piccot, S., J. Watson, AND J. Jones\*. A Global Inventory of Volatile Organic Compound Emissions from Anthropogenic Sources. Journal of Geophysical Research 97(D9):9897-9912, (1992)

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

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.

Ciccioli, P., Brancaleoni, E., Cecinato, A., DiPalo, C., Brachetti, A., and Liberti, A., "GC Evaluation of the Organic Components Present in the Atmosphere at Trace Levels with the Aid of Carboxen™ B for Preconcentration of the Sample," J. of Chrom., 351, pp 433-449, 1986.

