Introduction

Tenax® TA is the most popular sorbent for thermal desorption. The registered trademark "Tenax" is held by its manufacturer Buchem B.V., and "TA" means "Trapping Agent". This sorbent was originally named Tenax GC as a sorbent for packed GC columns, and some old literature still has it that way. Buchem B.V. changed its name as the applications expanded.

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).

Some properties set Tenax® TA apart from other polymeric sorbents:

- High thermal stability ensures a wide range of volatility from C6 to C26, or VOCs with boiling point from 100 to 400 °C
- Low inherent artifacts (<1ng) for a porous polymer
- Highly inert surface protects labile compounds
- Highly hydrophobic surface minimizes the retention of water
- Moderate surface area ensures efficient desorption and conditioning
- Reliable for both active and passive sampling

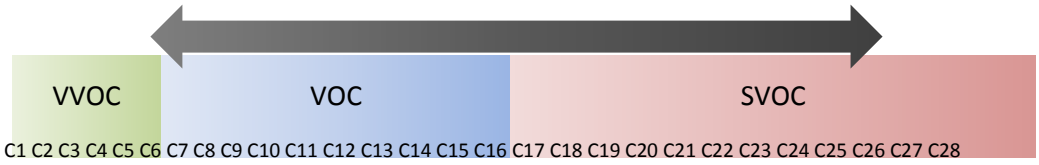
Fresh Tenax® TA has a color that is close to white. The color darkens as the sorbent ages through thermal cycles, and can serve as an indicator of tube life. Some users prefer glass tube instead of stainless steel for Tenax® TA (shown below), so that they can watch the color of the sorbent bed changing from lightly yellow to dark brown, which indicates the tube needs to be replaced.

Tenax® TA based tube sampling is supported by EPA TO-1, EPA IP-1B, and ISO 16000-6:2011; Tenax® TA is also the sorbent of choice for most stock cold traps inside thermal desorption instruments.

Tenax® TA Tube Configuration:

- Camsco's Tenax® TA tube comes standard with 200 mg of sorbent **(Camsco Part Number: SU60520-60; Tenax® TA 60/80)**. A custom amount is available at no extra cost.
- Passive sampling tubes doesn't have glass wool plug on the sampling end of the tube.

Volatility Range C6~C26



- Covers a wide range from C6 to C26

Temperatures

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

Tenax TA Tube

- The chemical name of Tenax® TA is Poly(2,6-diphenyl-p-phenylene oxide) or PPPO. The polymer was originally patented by General Electric Co. in 1969, and later on developed by Akzo Research Laboratories as a packing material for GC columns.
- The first time Tenax® TA was utilized as an adsorbent for preconcentration of volatile organic compounds (VOCs) was by the National Aeronautics and Space Administration (NASA) for monitoring cabin atmosphere in Skylab-4; since then the applications of Tenax® TA in the air monitoring arena have grown tremendously.
- Camsco's Tenax® TA Tubes feature three circumferential bands for easy identification.
- Although the background of Tenax® TA is low among porous polymer sorbents, it is not as low as carbon-based counterparts such as Carbotrap™ B. Figure 2 shows a comparison of baselines from these two sorbents.

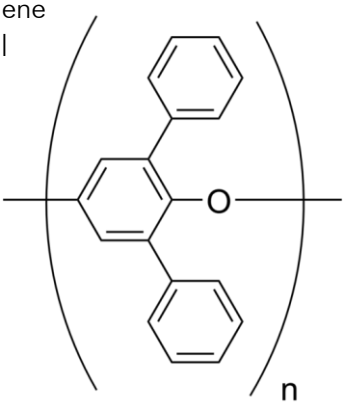


Figure 1, Chemical structure of Tenax® TA

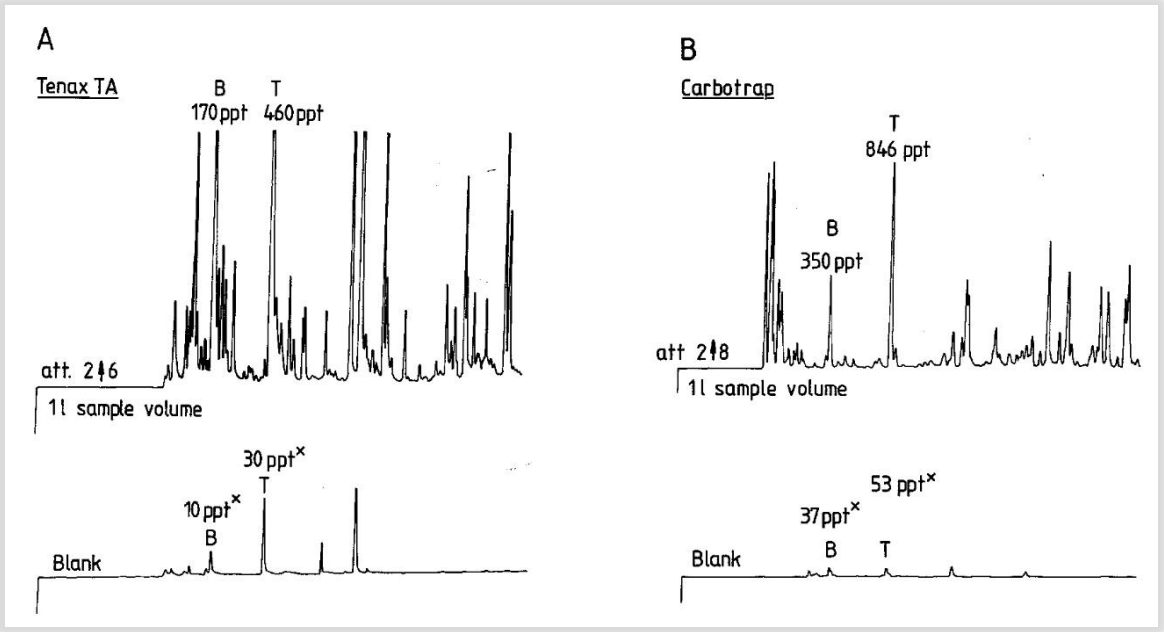


Fig. 2 (A), (B). Gas chromatograms of ambient air samples and adsorption tube blanks for Tenax (A) and Carbotrap (B). The blank was obtained by desorbing clean tubes from the same batch after the same storage time (24 h) as for the sampling tubes. A sample volume of only 1 liter was taken and the blank was calculated for the same volume.

Technical Guide - Continued

- Strong oxidative agents, such as chlorine, ozone, nitric oxides, and sulfur oxides, react with Tenax® TA and form artifacts. The formation of artifacts from oxidative degradation of Tenax® TA is widely discussed in literature—the main degradation products are known as benzaldehyde, acetophenone, phenol, benzoic acid and to a minor extent benzene, toluene and xylenes. Other artifacts include aldehydes (Hexanal, Heptanal,
- Temperature greatly affect the longevity of Tenax® TA tubes. Although the published maximum temperature is 350°C, it is highly recommended that Tenax® TA tubes be used at no more than 325°C. Repeated heating at higher temperature easily leads to irreversibly heightened background noise caused by thermal/oxidative degradation of the sorbent.
- Tenax® TA can be used to capture benzene (EPA TO-1), but it is not the best sorbent for such tasks. The safe sampling volume of benzene on Tenax® TA is only ~1 liter; Carbograph 5TD, however, is a sorbent optimized for BTEX analysis via active or passive sampling (See CAMSCO Application Note "BTEX Tube").
- Tenax® TA cannot reliably capture organic molecules smaller than benzene, for example, low-molecular weight hydrocarbons (C4 and below) and mid-range (C5~12) highly polar compounds often suffer from breakthrough. To capture those compounds, a stronger sorbent such as Carboxen™ can join Tenax® TA to form a multi-bed tube (See CAMSCO Application Note "Universal Tube").

Figure 3, A Passive Sampling tube with Tenax® TA

Tenax® TA and Tenax® GR

- Tenax® GR = Tenax® TA + graphitized carbon (23%). The main advantages of Tenax® GR over Tenax® TA:
  - Lower adsorption of water vapors, which makes Tenax® GR more popular in purge-and-trap experiments
  - Much higher packing density means more sorbent can be packed in the same tube, thus higher breakthrough volumes for low molecular compounds
- Tenax® GR and Tenax® TA are more similar than different when used as TD sorbent
- Tenax® GR extends the upper range of Tenax® TA
- Tenax® GR has a dark grey color while Tenax® TA looks off-white
- Tenax® GR is more hydrophobic and more inert than Tenax® TA

References

Standard Methods: EPA TO-1, EPA IP-1B, and ISO 16000-6:2011

Klenø, J.G.; Wolkoff, P.; Clausen, P.A.; Wilkins, C.K.; Petersen, T. Degradation of the adsorbent Tenax TA by nitrogen oxides, ozone, hydrogen peroxide, OH radical and limonene oxidation products. Environ. Sci. Technol. 2002, 36, 4121-4126

N. Schmidbauer and M. Oehme; Comparison of solid adsorbent and stainless steel canister sampling for very low ppt-concentrations of aromatic compounds in ambient air from remote areas. Fresenius Z Anal Chem (1988) 331:14-19

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