

Determination of volatile organic compounds in ambient air

Application Note

Environmental

Authors

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Introduction

The concentration of Volatile Organic Compounds (VOCs) in ambient air is increasing with the growing number of mobile and stationary emission sources. Since many of these compounds behave as precursors to ozone formation and/or have adverse health effects, the monitoring of their presence is important.

EPA Method T0-14 describes the analysis of whole air samples and the determination of sub-ppb levels of VOCs. To obtain sufficient sample for quantitative analysis these components are pre-concentrated on glass beads held at -150°C . This concentrate is then separated on a capillary column and detected by Electron Capture and Flame Ionization Detectors (ECD and FID).

The system described here is an integrated, compact unit with built in cryogenic concentrator. An optional Stream Selector Valve (SSV) allows the unattended analysis of up to 16 samples, blanks or calibration mixtures.



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System Description

Figure 1 shows a schematic of the system, which contains the following:

1. Variable Temperature Adsorption Trap (VTAT) 1/8 in stainless steel tube, 2 in glass bead bed (60/80 mesh)
2. Sampling valve with or without surrogate standard introduction
3. Column: 30m x 0.32mm, 1.8 μm 624-type phase Agilent Equivalent: CP-Select 624 CB, Part no. CP7414
4. Detectors: ECD and FID
5. Electronic Mass Flow Controller (MFC)
6. Optional Stream Selector Valve

Central to this application is the VTAT (Figure 2), which allows the temperature control and programming of the glass bead filled trap from -190 °C to 400 °C with the GC method. The VTAT uses liquid nitrogen as coolant, and its temperature is independently controlled from the column oven or other injector zones in the GC.

The gas sampling valve directs the sample and the carrier to the appropriate paths and allows the introduction of a surrogate sample if desired. The effluent from the 624-type column was divided via a Quick-Seal splitter to the ECD and FID detectors.

Procedure

Initially the surrogate and sample lines are flushed with the gas samples. The sample can be introduced from stainless steel canisters or Tedlar bags. Upon injection the surrogate standard and the sample are deposited onto the trap which is at -150 °C. The duration of this “trapping” time can be varied (programmable through the GC method) and the volume of the sample will change accordingly. The sample flow during trapping is held constant by the mass flow controller (usually 40 mL/min).

After the selected amount of solute is deposited on the trap, the latter is heated to 120 °C and simultaneously backflushed by the carrier gas to the analytical column for separation and subsequent detection. All studies were carried out without a dryer, since humidified ambient air samples were run without plugging the trap.

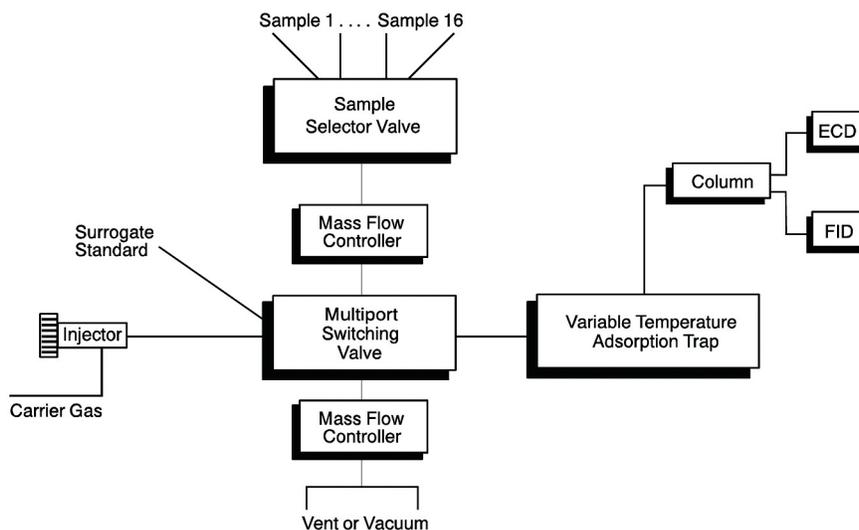


Figure 1. Schematic of the System

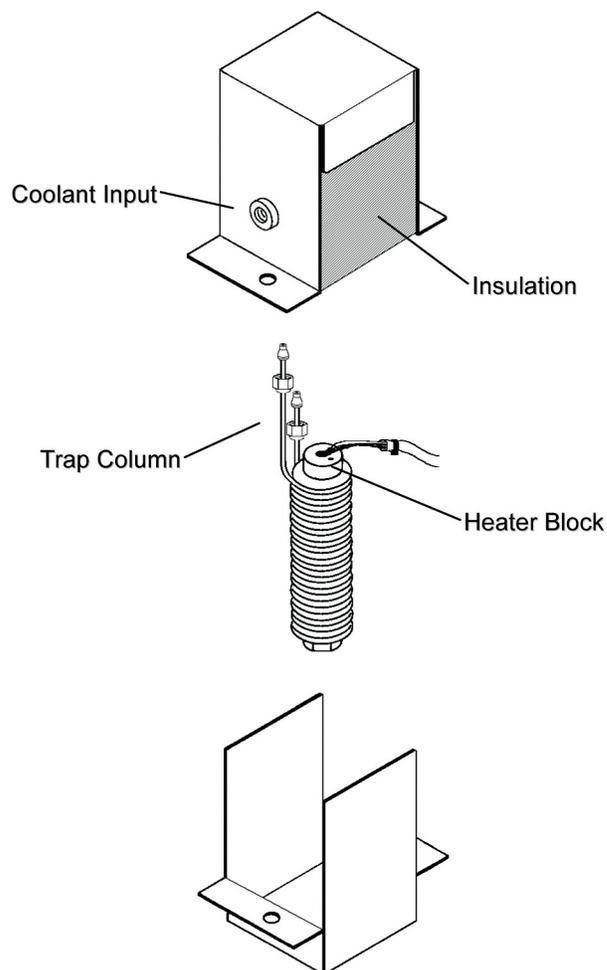


Figure 2. Variable-Temperature Adsorption Trap

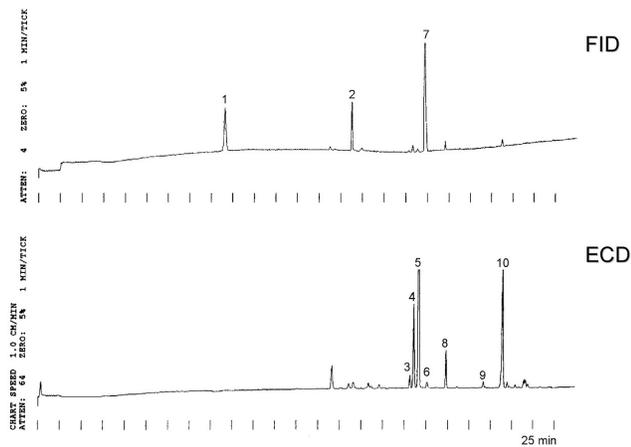


Figure 3. 400 mL VOCs Standard

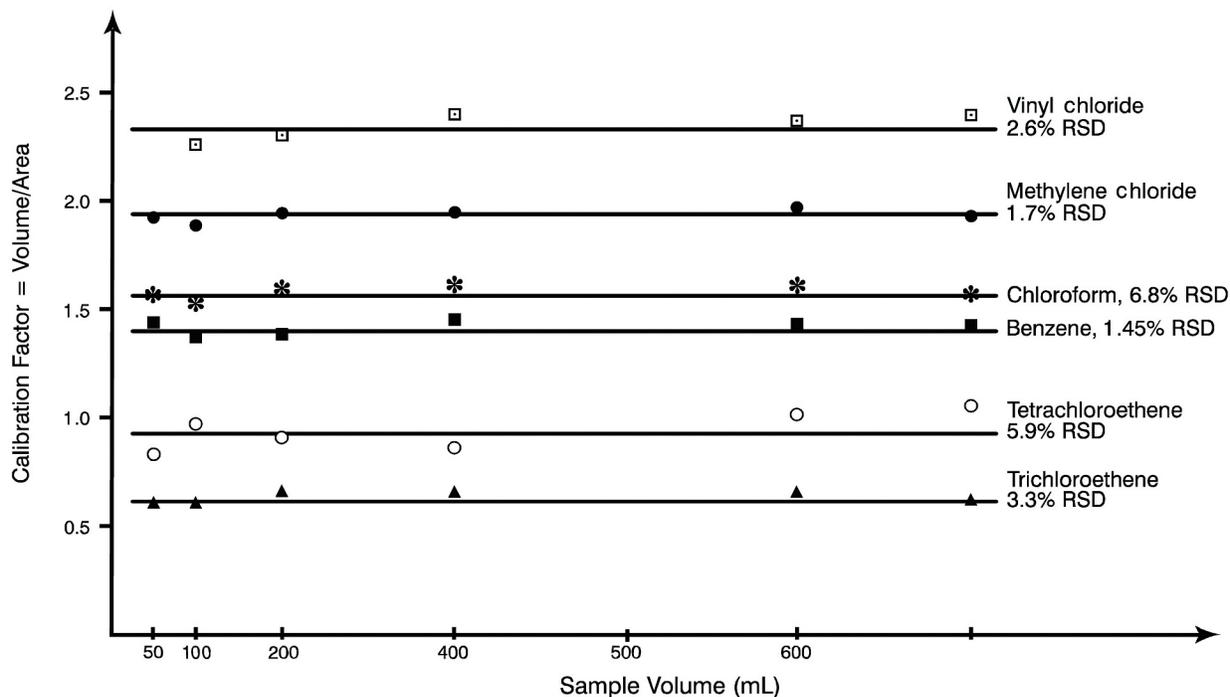
Results

A chromatogram of a standard mixture of VOCs with concentrations ranging from 0.2 ppb to 5 ppb is shown in Figure 3. Volumes of 50 mL to 1000 mL of this standard were introduced to the system to check recovery linearity (Figure 4). The calibration factors were constant (% RSD) in the studied volume range. The precision of these factors demonstrates the linearity of recovery and solute response over the volumes sampled. Therefore, wide ranges of VOC concentrations may be detected by simply adjusting the volume passing through the VTAT. Repetitive analyses of 400 mL standard resulted in 0.9% - 6% RSD for the peak areas.

Peak identification

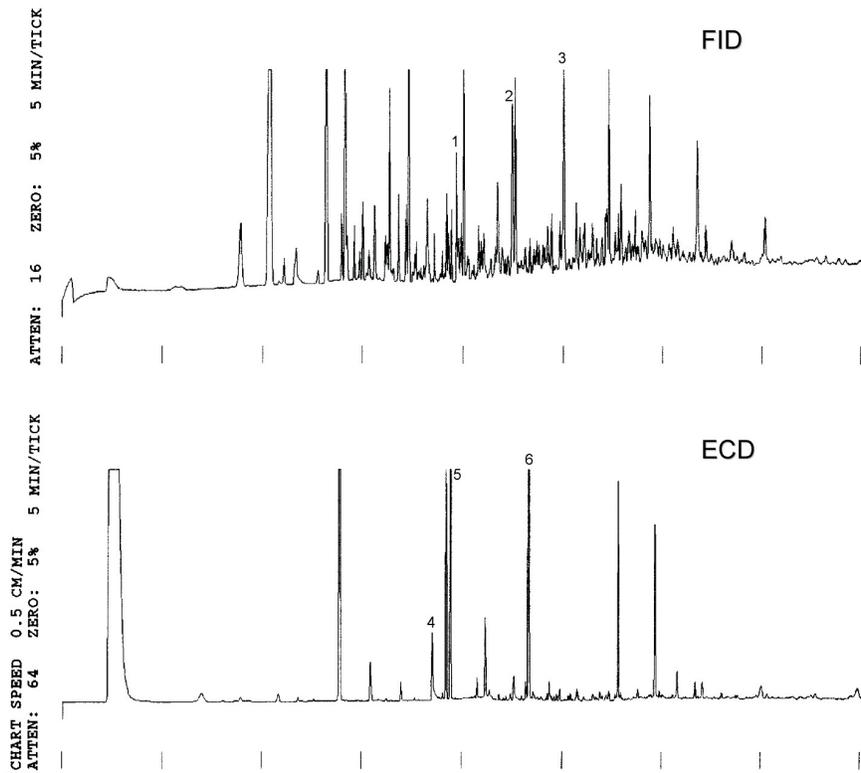
	ppb
1. Vinyl chloride	5.0
2. Methylene chloride	6.0
3. Chloroform	0.2
4. 1,1, 1-Trichloroethane	0.4
5. Carbon tetrachloride	0.5
6. 1,2-Dichloroethane	2.0
7. Benzene	5.0
8. Trichloroethylene	0.5
9. 1-2,-Dibromoethane	0.2
10. Perchloroethylene	0.5

Column: -50 °C/2 min, 8 °C/min to 150 °C



Concentrations:	Vinyl chloride	5 ppb	Chloroform	0.2 ppb
	Benzene	5 ppb	Perchloroethylene	0.5 ppb
	Methylene chloride	2 ppb	Trichloroethene	0.5 ppb

Figure 4. Recovery Linearity



The chromatogram shown in Figure 5 was obtained analyzing ambient air while a neighboring house was re-roofed. Several aromatic and chlorinated hydrocarbons were detected coming from the hot tar used for insulation.

Peak identification

	ppb
1. benzene	5.0
2. toluene	4.0
3. m-xylene	6.0
4. 1,1, 1-trichloroethane	0.6
5. carbon tetrachloride	0.4
6. perchloroethylene	1.0

Figure 5. 400 mL Air, sampled near roofing project

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