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Field Concentration of Toxic Organics in Air

M. Bruns and F. Li (MTI Analytical Instruments)

This guest article describes analysis of airborne organics using MTI's new Trapper 2000 portable sample concentrator and custom adsorbent traps developed by Supelco. The Trapper 2000 concentrator, combined with the MTI high-speed micro gas chromatograph, allows for field concentration and analysis for on-site environmental assessment and remediation. This system accommodates two adsorbent traps with simultaneous operation, allowing for analytical duplication and increased sample throughput. The traps, with integral heaters, rechargeable 12-volt battery, and refillable purge gas supply, are field replaceable. The battery provides 6 hours of operation.

The recent enactment of the 1990 Amendments to the US Clean Air Act and stricter enforcement of environmental regulations worldwide have challenged the development of portable instrumentation capable of field concentration (collection) and analysis of toxic organics in air (1). In response to this challenge, MTI Analytical Instruments (Fremont, CA, USA), along with the technical, manufacturing, and product support of Supelco, has developed a high-throughput, field-portable sample concentrator for use in conjunction with a portable gas chromatograph.

MTI's new Trapper 2000™ portable sample concentrator (Figure A) was developed for concentration of the 41 toxic volatile organic compounds (VOCs) in the US Environmental Protection Agency's Compendium Method TO-14. This instrument, combined with the MTI high-speed micro gas chromatograph, allows field concentration and analysis for on-site environmental assessment and remediation (2). The system yields results comparable to laboratory purge-and-trap and GC/MS systems (3).

Air samples are drawn through and concentrated on the trap at ambient temperatures, using an internal pump. Immediately following adsorption, and prior to desorption of the sample, the trap undergoes a purge with dry helium to remove air and water, thus preventing oxidization of the sample or adsorbents. The trap is then rapidly heated to the user-defined desorption temperature, and the desorbed concentrated sample is backflushed with helium into a gas-tight syringe for chromatographic analysis. Finally, the entire system is flushed with helium, while at the desorption temperature, to ensure minimal sample carryover. The system is microprocessor controlled and provides onboard diagnostics, alerting the user of any potential problems. The user can modify up to 6 parameters per trap to optimize system operation.

The Trapper 2000 concentrator uses a custom-developed four-adsorbent bed thermal desorption tube containing Carbopack™ C, Carbopack B, Carboxen™ 1000, and Carboxen 1001 adsorbents to achieve a 100- to 1000-fold concentration of toxic VOCs in air.

Figure A. MTI Trapper 2000 Concentrator and P200 Micro Gas Chromatograph

995-0010

Photo provided by MTI Analytical Instruments, 41762 Christy Street, Fremont, CA 94538 USA.

Table 1. Analyte Recovery and Analytical Reproducibility

Compound	Boiling Point (°C)	Original Concentration (ng/L)	Desorption Efficiency (%)	Percent RSD (n = 5)
Freon 12	-29.8	50	101	4.9
Vinyl chloride	-13.4	20	100	4.5
Ethyl chloride	12.3	120	92	5.7
Freon 11	23.7	20	92	6.6
Dichloromethane	39.8	60	90	8.1
Carbon tetrachloride	76.5	40	94	6.3
Benzene	80.1	40	90	4.2
Trichloroethylene	87.0	40	94	4.3
Toluene	110.6	40	96	4.6
Tetrachloroethylene	121.1	40	87	8.5
Chlorobenzene	132.0	40	90	2.7
Ethylbenzene	136.2	40	84	4.6
o-Xylene	144.4	80	83	4.8
o-Dichlorobenzene	180.5	30	87	5.0

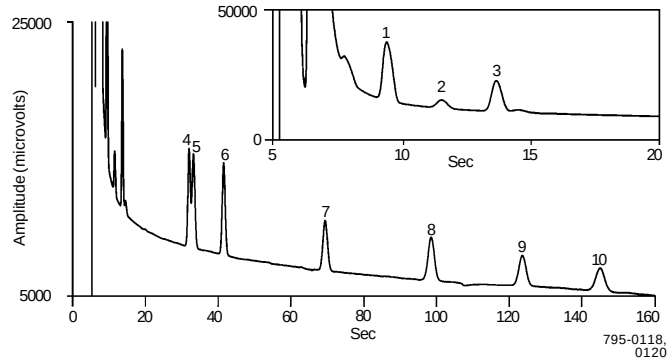
Adsorption: 1000mL at 85mL/min at 30°C (sample saturated with moisture)
Desorption: 2mL at 0.8mL/min at 350°C
Adsorbents: Carbopack C, Carbopack B, Carboxen 1000, Carboxen 1001

Figure B. Toxic VOCs in Air

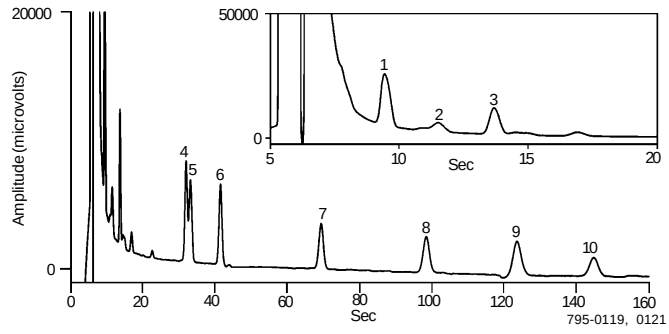
Sample Conc.: adsorption — 1000mL at 85mL/min at 30°C
desorption — 2mL at 0.8mL/min at 350°C
adsorbents — Carbopack C, Carbopack B, Carboxen 1000, Carboxen 1001
Column: **OV®-1, 0.15mm ID, 1.2µm film**
Oven: 53°C
Carrier: helium, column head pressure 21.7psi
Inj. Time: 100msec
Sample Time: 5 sec
Det.: micro thermal conductivity, medium gain

1. Ethyl chloride (120ppm)
2. Freon 11 (20ppm)
3. Dichloromethane (60ppm)
4. Benzene (40ppm)
5. Carbon tetrachloride (40ppm)
6. Trichloroethylene (40ppm)
7. Toluene (40ppm)
8. Tetrachloroethylene (40ppm)
9. Chlorobenzene (40ppm)
10. Ethylbenzene (40ppm)

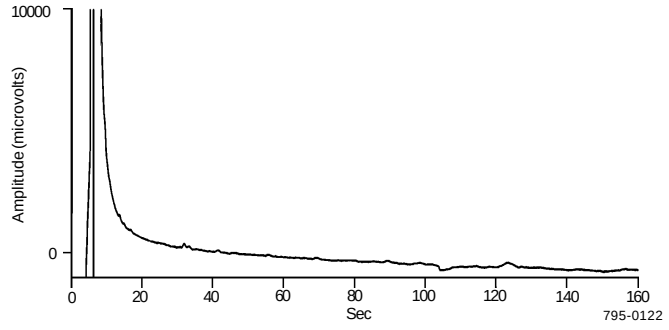
B1 — Concentrated Standard Mixture of VOCs at ppm Level Prior to Dilution



B2 — First 2mL Desorption



B3 — Second 2mL Desorption



Figures provided by MTI Analytical Instruments, 41762 Christy Street, Fremont, CA 94538 USA.

Analyte adsorption is achieved without the use of cryogenics, which would hinder portability and use in the field. This particular adsorbent trap has been demonstrated to have a breakthrough volume of 5 liters of Freon® 12 (at 50ppm) in moisture-saturated helium at 40°C. It provides excellent analyte recovery and precision, yielding results comparable to full-scale laboratory techniques and instrumentation (Table 1).

Figure B1 illustrates a 500-fold dilution of a VOC sample, and Figure B2 a 500-fold concentration. The four-adsorbent bed trap effectively adsorbs and desorbs the trapped VOCs (Figure B2) to achieve the original concentration of the standard mixture (Figure B1). The absence of a detectable signal from the desorption volume in Figure B3 demonstrates the efficient desorption (with negligible carryover) of the adsorbent material with the first 2mL volume. (Note that the amplitude axis in Figure B3 is expanded.) No sample breakthrough (Figures B1 and B2) or carryover (Figures B2 and B3) from the initial desorption volume is detected.

If your work involves the analysis of airborne toxics, and field analysis would be helpful, consider the convenience of the MTI Trapper 2000 portable concentrator and the dependability of Supelco adsorbents. Supelco can customize adsorbent tubes according to your unique requirements.

Ordering Information:

For more information about the Trapper 2000 Concentrator, the P200H Micro Gas Chromatograph, or other MTI products, contact MTI Analytical Instruments, 41762 Christy Street, Fremont, CA 94538 USA (phone 510-490-0900, FAX 510-651-2498).

For more information about custom packed adsorbent traps for VOCs analysis or any other application, phone Supelco at 800-247-6628 or 814-359-3441, FAX 800-447-3044 or 814-359-3044, or contact your nearest Supelco representative.

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3. Carney, K.R., and E.B. Overton, article submitted to *American Laboratory* for publication in early 1995.

Reference 3 is available from MTI Analytical Instruments, 41762 Christy Street, Fremont, CA 94538 USA.

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