Determination of Total Volatile Organic Compounds in Indoor Air Using Agilent 7667A mini TD and 7820A GC

Application Note

Environmental

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Abstract

In China, since 2001, civil building engineering has been regulated by GB50325. The 2010 version emphasizes the analysis for benzene and TVOC. Using the 2010 version, a method for the determination of total volatile organic compounds (TVOCs) was developed on an Agilent 7820A GC System configured with an Agilent 7667A mini Thermal Desorber. The results not only meet the requirements stated in the standard but also demonstrate excellent linearity, low carryover, and superior repeatability.

Introduction

Volatile organic compounds (VOCs) from indoor air pollution present a threat to human health when people spend most of their time indoor and are exposed to emissions from construction materials, house furnishings, and decoration coatings. To determine the total volatile organic compounds in indoor air, since 2001, China has enforced GB50325 to regulate environmental pollution control for civil building engineering requiring TD and GC technologies. The GB50325-2010 version emphasizes the benzene and TVOC's test. Following this standard, the tube-only TD technology has been widely used in recent years, unfortunately facing a high risk of contamination, carryover, poor repeatability, and even safety issues. Agilent has developed a solution based on the reliable 7820A GC and a 7667A mini TD system for indoor air quality tests. This method not only meets the requirements of GB50325-2010, but also demonstrates the Agilent legendary high quality through superior repeatability, low carryover, and excellent linearity.

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Experimental

Chemicals and Standards

All of the independent chemicals including methanol, benzene, toluene, ethylbenzene, *p*-xylene, *m*-xylene, *o*-xylene, styrene, *n*-butylacetate, and *n*-undecane were purchased from J&K Scientific ltd. Purity for each chemical was 99.5%. Methanol was used as solvent.

Sample preparation

Prepare the liquid standard solutions following the standard method GB/T50325. The five concentration levels of target compounds in methanol are 0.05 mg/mL, 0.1 mg/mL, 0.5 mg/mL, 1.0 mg/mL, 2.0 mg/mL. Add 1 µL standard solution into the Tenax-TA tube and purge the tube by a nitrogen flow of 100 mL/min for 5 minutes. The final five-point calibration curves range from 50 ng to 2,000 ng for each compound.

Instrument Conditions

Table 1 shows the optimized instrument conditions.

Results

The chromatogram in Figure 1 shows the 50-ng standards desorption result. All of the peaks are symmetrical without tailing and the responses satisfy the standard. Additionally, performance of carryover and repeatability has also been

Table 1. Optimized Instrument Conditions for TVOCs Analysis

Agilent 7667A mini Thermal Desorber		**Agilent 7820A GC**	
Tube sorbent	Tenax TA	Inlet	250 °C
Tube temperature program	40 °C (0 minutes) > 300 °C (6 minutes) at 500 °C/min	Carrier Split ratio	N_2, 2 mL/min 40:1
Injection start time	1 minute	FID temperature	300 °C
Transfer line	180 °C	Oven program	50 °C (0.5 minutes) > 135 °C (0 minutes) at 5 °C/min > 245 °C (1 minutes) at 25 °C/min
Valve box	175 °C		
Dry purge	50 mL/min for 0.5 minutes		
Cleaning	200 mL/min at 310 °C for 5 minutes	Column	HP-1 30 m × 0.32 mm, 4 µm (19091Z-613)

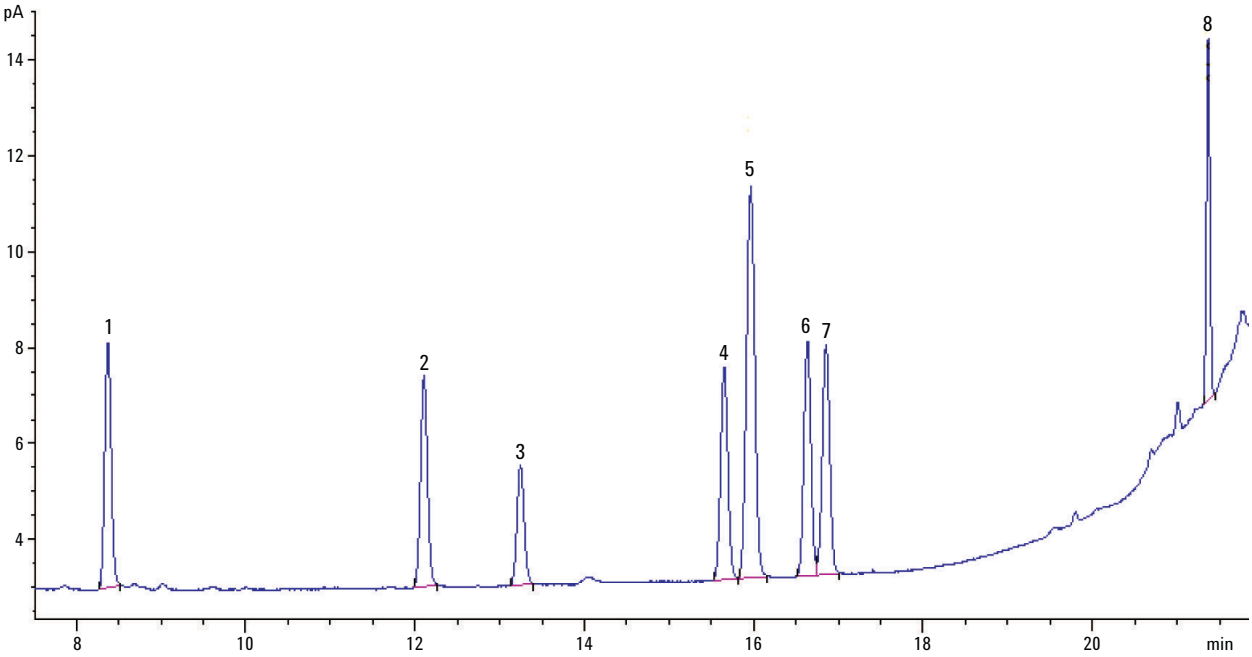

Figure 1. Chromatogram of 50-ng liquid standards on Tenax tube.

evaluated in this application note. After injection of high concentration standards, the chromatogram of secondary blank desorption shows no peaks of target compounds which means no carryover (Figure 2). Overlapped chromatograms in Figure 3 show excellent repeatability over seven runs of liquid standards loading and desorption. Table 2 lists detailed information of the target compounds regarding retention time, calibration linearity, and RSD(%) results.

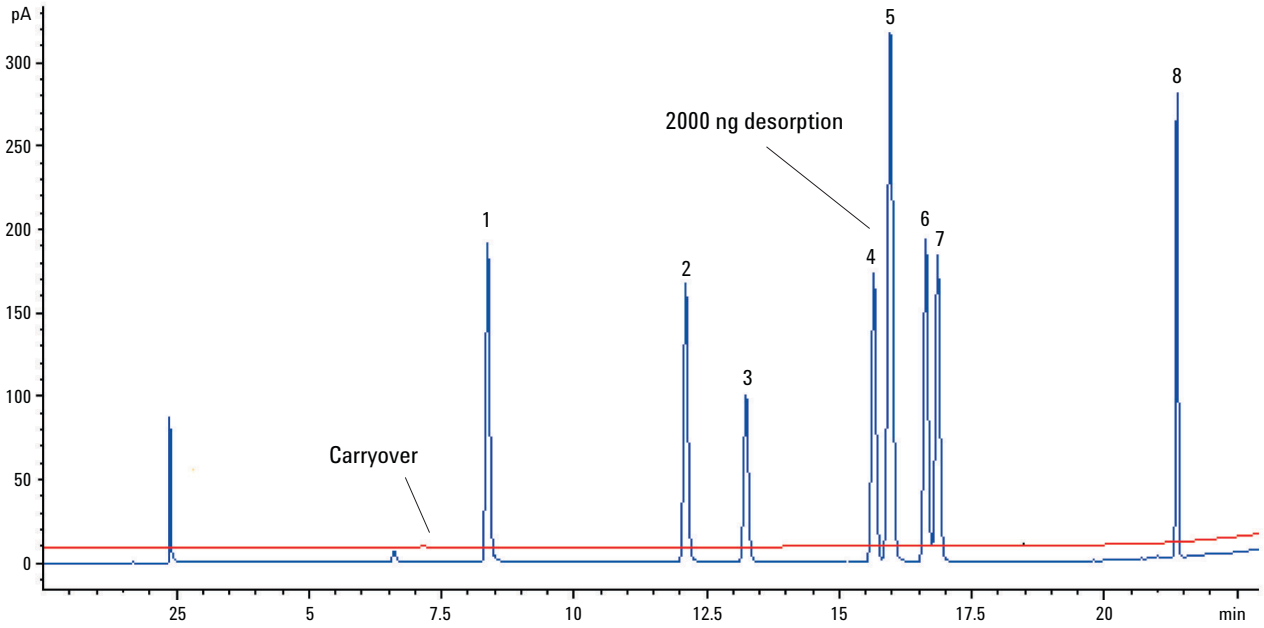

Figure 2. Overlapped chromatograms of 2000-ng standards desorption and carryover.

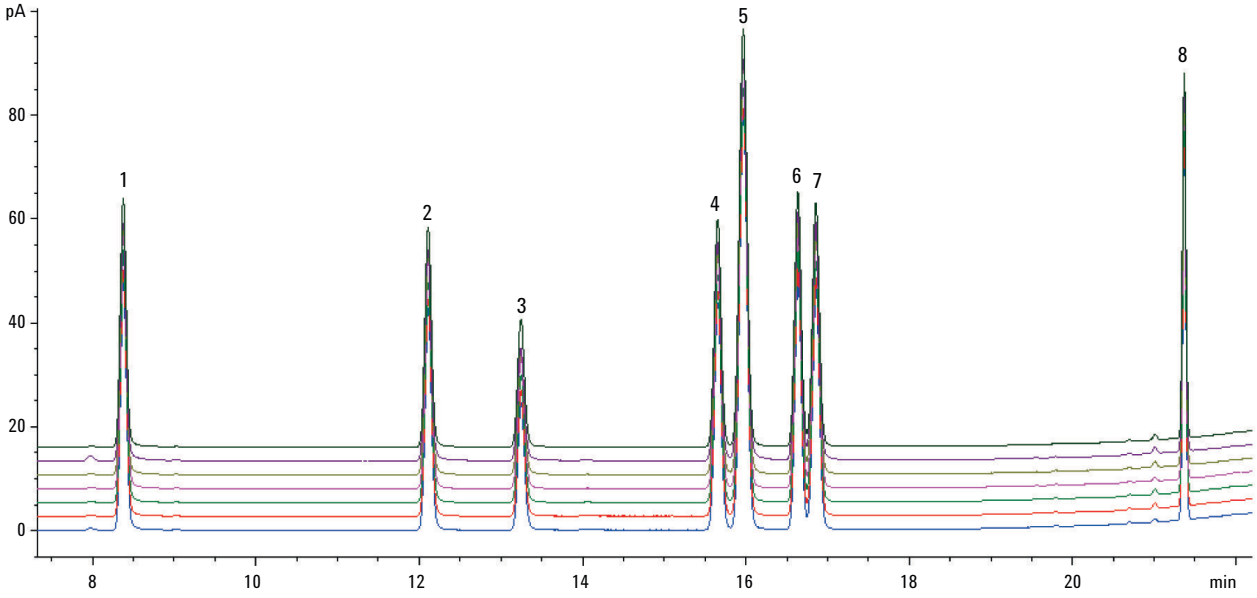

Figure3. Overlapped chromatograms of seven runs with 500-ng standards desorption.

Table 2. Retention Time, Linearity, and Repeatability of Target Compounds

No.	Compounds	R.T. (min)	Linearity (R^2)	Area RSD (%)	R.T. RSD (%)
1	Benzene	8.37	0.9999	1.96	0.023
2	Toluene	12.11	0.9999	1.51	0.021
3	Butyl acetate	13.25	0.9998	2.61	0.010
4	Ethylbenzene	15.65	0.9999	1.45	0.014
5	m/p-xylene	15.96	0.9999	1.24	0.012
6	Styrene	16.63	0.9999	1.62	0.010
7	o-xylene	16.85	0.9999	1.51	0.009
8	C11	21.37	0.9997	1.14	0.003

Ten liters of indoor air was sampled into a Tenax tube by personal pump at the flow rate of 500 mL/min for 20 minutes. Then the Tenax tube was placed on the 7667A min TD for desorption. Figure 4 shows the resulting chromatogram.

The concentration for each component in the Tenax tube was calculated by this formula:

$$Cc = (Mi/V)^*(101.3/P)^*((T+273)/273)$$

Cc: Concentration for Component i sampled in the Tenax tube, mg/m^3;

Mi: Weight of Component i sampled in the Tenax tube calculated by calibration curve, ng;

V: Volume of sampled air, L;

P: Atmospheric pressure at sampling point, Pa;

T: Ambient temperature at sampling point, °C.

The concentration of total volatile organic compounds (TVOCs) was calculated by this formula:

$$C_{TVOC} = \sum_{i=1}^{i=n} C_c$$

C_{TVOC}: concentration result for TVOCs

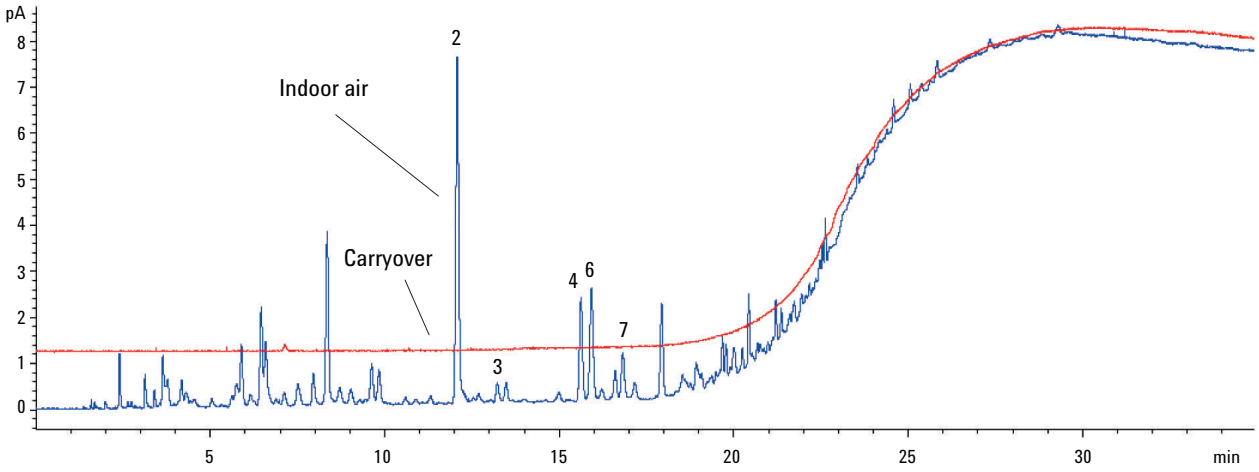

Figure 4. Chromatogram of 10-L indoor air sample and secondary desorption as carryover.

Table 3 shows the test results the for 10-L indoor air sample.

Table 3. Test Results for 10-L Indoor Air Sample

No.	Compounds	Concentration (mg/m^3)	Criteria I	Criteria II
1	Benzene	N.D.	0.09	0.09
2	Toluene	0.005	–	–
3	Butyl acetate	0.003	–	–
4	Ethylbenzene	0.003	–	–
5	m/p-xylene	0.002	–	–
6	Styrene	N.D.	–	–
7	o-xylene	0.002	–	–
8	C11	N.D.	–	–
	TVOC	0.015	0.5	0.6

Conclusion

Using an Agilent 7667A mini Thermal Desorber and an Agilent 7820A GC System to determinate total volatile organic compounds for indoor air pollution can completely meet requirements of GB 50325-2010. Test results in this application note also demonstrated good performance of sensitivity, repeatability, linearity, and low carryover for whole system.

Reference

1 GB 50325-2010 Code for indoor environmental pollution control of civil building engineering

For More Information

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