Determination of volatile organic compounds in cabin of car by an Agilent 7667A mini Thermal Desorber and an Agilent 7820A 5975E GC/MSD

ENVIRONMENTAL

Concern over interior air quality in cars has been rising significantly in recent years, since car interiors emit hazardous volatile organic compounds (VOCs). In 2011, the Chinese government published the first national standard for air quality assessment of passenger cars (GB/T 27630-2011 [1]). This standard specifies the concentration limit of benzene, toluene, xylene, ethylbenzene, and styrene and states that VOCs testing should follow the standard method HJ/T 400-2007 [2]. This application brief presents an economical solution to measure the target compounds specified in the standard, using an Agilent 7667A mini Thermal Desorber and an Agilent 7820A 5975E GC/MSD system.

Experimental

All of the independent chemicals including methanol, benzene, toluene, ethylbenzene, *p*-xylene, *m*-xylene, *o*-xylene, styrene, 1,3-dichlorobenzene,1,4-dichlorobenzene, 1,2-dichlorobenzene, *n*-butylacetate, and *n*-undecane were purchased from J&K Scientific Ltd. Purity for each chemical was 99.5%. Methanol was used as solvent.

Prepare the liquid standard solutions following the standard method GB/HJT400. For each compound, the final calibration range will be from 5 ng to 1,000 ng.

The optimized instrument conditions are listed in Table 1.

Table 1. Optimized Instrument Conditions for TVOCs Analysis

Agilent 7667A mini TD		**Agilent 7820A 5975E GC/MSD**	
Tube sorbent	Tenax TA	Inlet temperature	250 °C
Tube temperature program	40 °C (0 minutes), 310 °C (0.5 minutes) at 500 °C/ min	Oven program	50 °C (2 minutes), 180 °C (0 minutes) at 10 °C/min, 240 °C (8 minutes) at 5 °C/min
Leak detection	Yes	Column flow	1 mL/min
Purge	50 mL/min for 0.5 minutes	Split ratio	30:1
Injection start time	1 minute	Solvent delay	3 minutes
Transfer line	180 °C	Scan range	35–200
Valve box	175 °C	Source temperature	230 °C
Cleaning flow	200 mL/min	Quad. temperature	150 °C
Cleaning temperature	320 °C	GC column	Agilent DB-624 30 m × 250 µm, 1.4 µm (p/n 122-1w334)
Cleaning time	5 minutes		

Results and Discussion

Figure 1 shows the chromatogram of 10-ng standards desorption result. All of the peaks are symmetrical without tailing, and responses are good enough to satisfy the standard HJ/T 400-2007. Excellent repeatability was proved by 10 runs of manual liquid standards loading and desorption, as the overlapped chromatograms show in Figure 2.

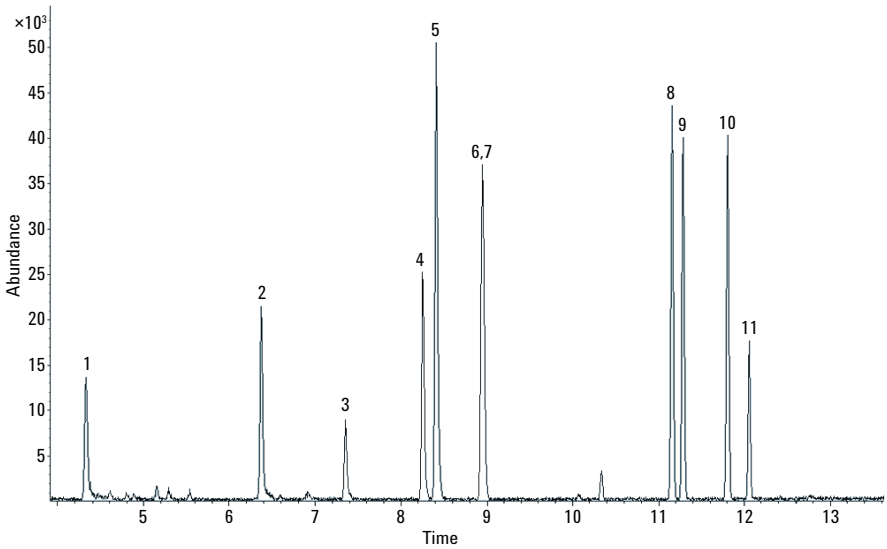

Figure 1. Chromatogram of 10-ng liquid standards on Tenax tube.

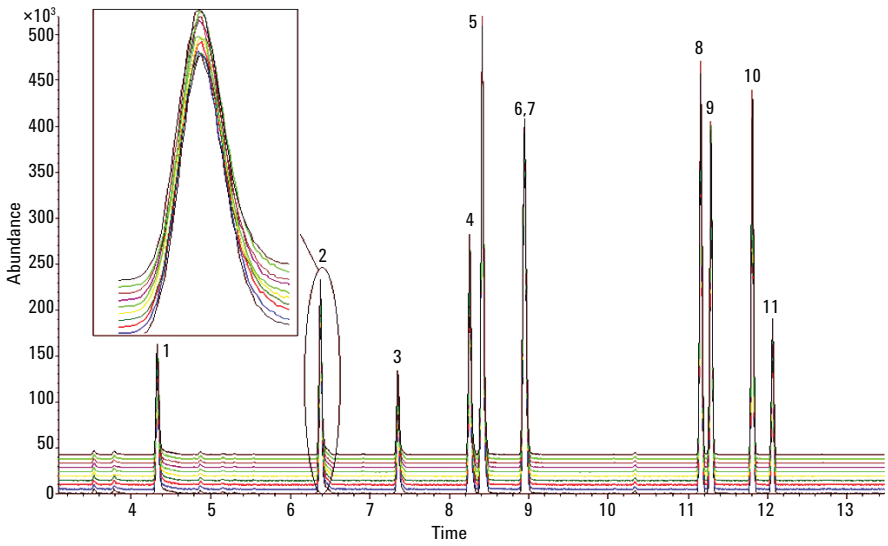

Figure 2. Overlapped chromatograms of 10 runs with 100-ng standards desorption.

Table 2 presents all information of the target compounds regarding retention time, calibration linearity and RSD(%) results.

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

No.	Compounds	R.T. (min)	Calibration range	Linearity (R^2)	Area RSD (%)	R.T. RSD (%)
1	Benzene	4.33	5–1,000 ng	0.9980	2.06	0.029
2	Toluene	6.37	5–1,000 ng	0.9994	1.89	0.025
3	Butyl acetate	7.35	5–1,000 ng	0.9992	2.57	0.019
4	Ethylbenzene	8.26	5–1,000 ng	0.9995	1.61	0.015
5	*m/p*-xylene	8.41	5–1,000 ng	0.9993	1.71	0.021
6	*o*-xylene	8.93	5–1,000 ng	0.9996	1.92	0.017
7	Styrene	8.96	5–1,000 ng	0.9989	1.61	0.018
8	1,3-Dichlorobenzene	11.16	5–1,000 ng	0.9995	1.75	0.008
9	1,4-Dichlorobenzene	11.28	5–1,000 ng	0.9995	2.00	0.017
10	1,2-Dichlorobenzene	11.81	5–1,000 ng	0.9994	2.36	0.011
11	C11	12.06	5–1,000 ng	0.9997	3.02	0.011

Figure 3 shows the overlapped chromatograms of a 5-L air sample, which was sampled inside a car using a personal pump and a Tenax tube, and the secondary desorption as carryover. No peak was found in the carryover chromatogram.

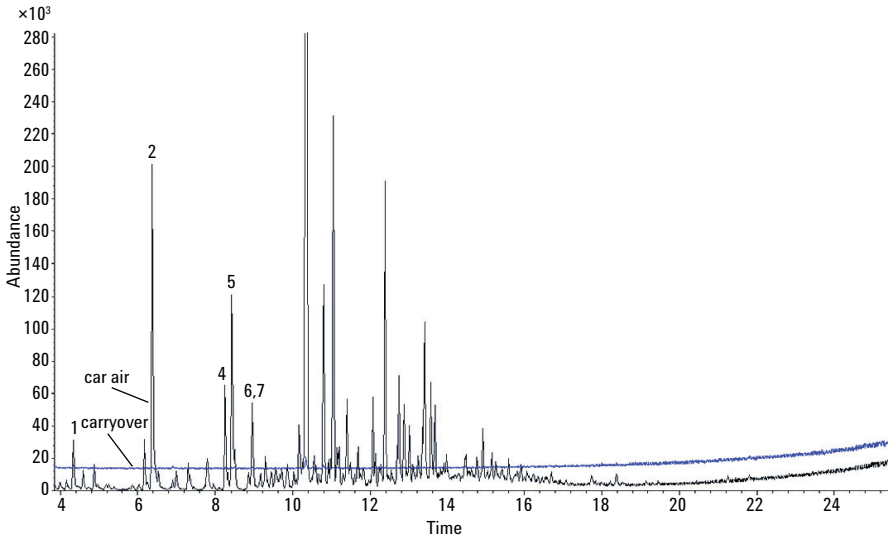

Figure 3. Chromatogram of 5 L interior car air sample.

Table 3 lists the measurement results of the 5-L interior car air sample.

Table 3. Test Results for 5-L Interior Car Air Sample

No.	Compounds	*C_c(mg/m³)	Criteria in guideline
1	Benzene	0.006	≤ 0.11
2	Toluene	0.018	≤ 1.10
3	Butyl acetate	N.D	–
4	Ethylbenzene	0.006	–
5	*p,m*-Xylene	0.003	≤ 1.50
6	*o*-Xylene	0.003	
7	Styrene	0.003	≤ 0.26
8	1,3-Dichlorobenzene	N.D	–
9	1,4-Dichlorobenzene	N.D	–
10	1,2-Dichlorobenzene	N.D	–
11	C11	N.D.	–

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

C_c = (Mi/V)*(101.3/P)*((T+273)/273)

C_c = Concentration for Component i sampled in Tenax tube, mg/m³

Mi = weight of Component i sampled in Tenax tube calculated by calibration curve, ng

V = Volume of sampled air, L

P = Atmospheric pressure, Pa

T = Ambient temperature, °C

Conclusion

Using an Agilent 7667A mini TD and an Agilent 5975E GC/MSD to determinate total volatile organic compounds for car interior air, meets requirements of HJT-400-2007. Test results in this paper demonstrate good performance of sensitivity, repeatability, linearity, and low carryover for whole system.

References

1. GB/T 27630-2011 Guideline for air quality assessment of passenger car
2. HJ/T 400-2007 Determination of Volatile Organic Compounds and Carbonyl Compounds in Cabin of Vehicles

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