

US EPA Method 8260 with the Tekmar Lumin P&T Concentrator, AQUATek LVA and the Agilent 7890B GC/5977A MS

Amy Nutter, Applications Chemist; Teledyne Tekmar

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Abstract

US EPA Method 8260 was used to determine the concentration of volatile organic compounds (VOCs) in water samples. The Teledyne Tekmar Lumin purge and trap (P&T) concentrator, along with an AQUATek LVA liquid autosampler and an Agilent 7890B Gas Chromatograph (GC)/5977A Mass Spectrometer (MS) was used to create a working linear calibration curve and method detection limits (MDLs) for target compounds. This study will demonstrate the ability of the Lumin P&T concentrator's innovative moisture control system (MCS) to remove water vapor transferred to the GC/MS.



Introduction

The AQUATek LVA is Teledyne Tekmar's most advanced water-only P&T autosampler and is based on the proven Atomx XYZ platform. The AQUATek LVA includes whisper-quiet XYZ automation, two standard addition vessels and an optional pH meter. Combined with its 84-position chiller-enabled sample tray, the result is simple and reliable sample preparation and handling. In addition to other refinements, the AQUATek LVA incorporates a precision-machined valve manifold block to reduce potential leak sources and ensure the system is both reliable and robust. By pairing the AQUATek LVA with the Lumin's innovative moisture control system (MCS), water vapor removed is improved by as much as 60%, thereby reducing peak interference and increasing GC column lifespan.

Sample Preparation

A 50 ppm calibration working standard was prepared in methanol from the following Restek® standards: 8260B MegaMix™, 8260B Acetate, California Oxygenates, VOA (Ketones), 502.2 Calibration Mix, 2-Chloroethyl Vinyl Ether, and Hexachloroethane. In total the standard contained 97 compounds.

A calibration curve was prepared from 0.5 ppb to 200 ppb for all compounds. The relative response factor (RF) was calculated for each compound using one of the four internal standards: Pentafluorobenzene, 1,4-Difluorobenzene, Chlorobenzene-d5, and 1,4-Dichlorobenzene-d4. Surrogate standards consisted of: Dibromofluoromethane, 1,2-Dichloroethane-d4, Toluene-d8, and Bromofluorobenzene. Internal and surrogate standards were prepared in methanol from Restek standards at a concentration of 25 ppm, after which 5 µL was then mixed with each 5 mL sample, for a resulting concentration of 25 ppb.

Seven 0.5 ppb standards were prepared for MDL and accuracy and precision calculations. All calibration and MDL standards were analyzed with the Teledyne Tekmar Lumin P&T concentrator and AQUATek LVA conditions in [Table I](#). GC/MS conditions are shown in [Table II](#).

Experimental Instrument Conditions

Table I Teledyne Tekmar Lumin P&T Concentrator/AQUATek LVA Water Method Conditions			
Standby	Variable	Desorb	Variable
Valve Oven Temp	150 °C	Desorb Preheat Temp	245 °C
Transfer Line Temp	150 °C	Desorb Temp	250 °C
Sample Mount Temp	90 °C	Desorb Time	2.00 min
Standby Flow	10 mL/min	Drain Flow	300 mL/min
Purge Ready Temp	35 °C	GC Start Signal	Begin Desorb
MCS Purge Temp	20 °C		
Purge	Variable	Bake	Variable
Purge Temp	20 °C	Bake Time	2.00 min
Purge Time	11.00 min	Bake Temp	280 °C
Purge Flow	40 mL/min	Bake Flow	200 mL/min
Dry Purge Temp	20 °C	MCS Bake Temp	180 °C
Dry Purge Time	1.00 min		
Dry Purge Flow	100 mL/min	AQUATek LVA	Variable
Sample Temp	40 °C	Sample Loop Time	0.35 min
Pre-Purge Time	0.50 min	Sample Transfer Time	0.35 min
Pre-Purge Flow	40 mL/min	Rinse Loop Time	0.30 min
Preheat Time	1.00 min	Sweep Needle Time	0.30 min
Sample Heater Enable	Off	Presweep Time	0.25 min
Trap	K	Water Temp	90 °C
Chiller Tray	Off	Bake Rinse Cycles	1
Purge Gas	Helium	Bake Rinse Drain Time	0.35 min

Table II Agilent 7890B GC and 5977A MSD System Conditions	
Agilent 7890B GC Conditions	
Column	Rtx® VMS, 20m x 0.18 mm, 1µm Film, Helium – 1 mL/min
Oven Profile	35 °C, 4 min, 15 °C/min to 85 °C, 30 °C/min to 225 °C, 2 min hold, Run Time 14.00 min
Inlet	180 °C, 120:1 Split, 19.752 psi
Agilent 5977A MSD Conditions	
Temp	Transfer Line °C; Source 230 °C; Quad 150 °C
Scan	Range 35 <i>m/z</i> to 260 <i>m/z</i> , Solvent Delay 0.50 min, Normal Scanning
Gain	Gain Factor 10.00, Autotune

Results

The relative standard deviation (%RSD) of the response factors (RF) for the calibration curve, MDL, and accuracy and precision data are shown in Table III. Figure 1 displays a 50 ppb standard, indicating excellent peak resolution for all VOCs.

Table III US EPA Method 8260 Calibration, Accuracy and Precision Data						
Compound	Calibration			Accuracy and Precision (n=7, 0.5 ppb) ¹		
	Linearity RF (≤20%RSD)	MDL (ppb)	Average RF	Average Concentration (ppb)	Accuracy (70-130%)	Precision (≤20%RSD)
Pentafluorobenzene (IS)						
Dichlorodifluoromethane	14.2	0.15	0.273	0.54	107	8.71
Chloromethane	10.8	0.13	0.226	0.54	107	7.91
Vinyl Chloride	13.7	0.16	0.363	0.52	103	9.96
Bromomethane ²	0.995	0.06	0.468	0.63	127	2.77
Chloroethane	9.34	0.17	0.239	0.56	112	9.78
Trichlorofluoromethane	13.6	0.12	0.747	0.49	99	7.73
Diethyl Ether	3.64	0.09	0.252	0.48	96	6.21
1,1,2-Trichlorotrifluoroethane	13.8	0.11	0.445	0.50	100	7.27
Methyl Acetate	15.2	0.26	0.209	0.64	128	13.2
1,1-Dichloroethene	10.4	0.11	0.410	0.55	110	6.53
Carbon Disulfide	12.4	0.12	1.10	0.56	111	7.08
Iodomethane ²	0.998	0.09	0.837	0.39	78	7.66
Acetone ²	0.998	0.15	0.103	0.61	122	7.86
Allyl Chloride	8.17	0.14	0.290	0.50	101	8.82
Acetonitrile	12.8	0.07	0.305	0.47	95	4.77
Methylene Chloride	9.54	0.06	0.502	0.58	115	3.07
tert-Butyl Alcohol (TBA)	8.98	0.11	0.163	0.56	111	6.15
Methyl-tert-butyl Ether (MTBE)	3.83	0.07	1.05	0.51	101	4.22
Vinyl Acetate	8.24	0.10	0.242	0.54	107	5.91
Diisopropyl Ether	9.81	0.09	0.451	0.47	94	6.13
trans-1,2-Dichloroethene	8.95	0.12	0.309	0.51	103	7.65
Acrylonitrile	10.9	0.19	0.125	0.53	105	11.6

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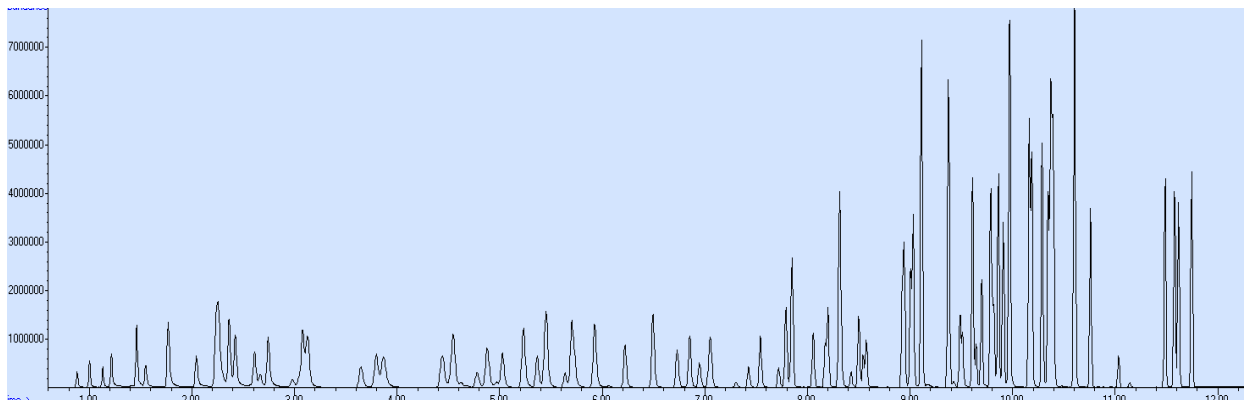
Compound	Calibration			Accuracy and Precision (n=7, 0.5 ppb) ¹		
	Linearity RF (≤20%RSD)	MDL (ppb)	Average RF	Average Concentration (ppb)	Accuracy (70-130%)	Precision (≤20%RSD)
1,1-Dichloroethane	7.51	0.06	0.373	0.52	103	3.87
Chloroprene	16.6	0.14	0.247	0.49	98	8.93
Ethyl-tert-butyl- Ether (ETBE)	8.28	0.06	0.531	0.46	92	4.25
2,2-Dichloropropane	11.6	0.09	0.342	0.49	97	5.94
cis-1,2-Dichloroethene	12.7	0.10	0.410	0.52	104	6.00
Isobutanol	13.3	0.15	0.154	0.49	99	9.69
2-Butanone (MEK)	5.87	0.17	0.068	0.50	99	11.0
Ethyl Acetate	6.94	0.12	0.243	0.52	103	7.12
Methyl Acrylate	9.94	0.10	0.169	0.50	99	6.27
Propionitrile	20.4	0.10	0.003	0.48	95	6.44
Bromochloromethane	4.92	0.12	0.286	0.51	101	7.26
Chloroform	6.86	0.08	0.484	0.53	106	4.57
Methacrylonitrile	5.91	0.18	0.088	0.51	102	11.6
Tetrahydrofuran	20.4	0.16	0.045	0.51	103	9.76
1,1,1-Trichloroethane	13.2	0.11	0.448	0.50	101	7.03
Dibromofluoromethane (SURR)	1.81		0.442	25.1	100	1.52
Carbon Tetrachloride	14.1	0.11	0.470	0.56	112	6.04
1,1-Dichloropropene	13.0	0.11	0.309	0.55	110	6.23
1,2-Dichloroethane-d4 (SURR)	3.81		0.310	26.0	104	1.91
Benzene	8.75	0.07	1.03	0.50	100	4.48
1,2-Dichloroethane	9.11	0.09	0.318	0.57	114	4.92
Isopropyl Acetate	7.17	0.11	0.393	0.47	94	7.19
tert-Amyl Methyl Ether (TAME)	9.39	0.09	0.625	0.46	93	6.09
1,4-Difluorobenzene (IS)						
Trichloroethylene	11.8	0.13	0.340	0.54	108	7.74
1,2-Dichloropropane	11.1	0.13	0.169	0.56	112	7.21
Dibromomethane	6.78	0.16	0.280	0.48	96	10.7
Methyl Methacrylate	8.41	0.13	0.121	0.47	95	8.96
Propyl Acetate	8.10	0.15	0.148	0.49	98	9.76
Bromodichloromethane	6.10	0.05	0.289	0.47	95	3.15
2-Nitropropane	6.45	0.19	0.035	0.54	109	11.2
2-Chloroethyl Vinyl Ether	9.71	0.10	0.094	0.45	91	7.35
cis-1,3-Dichloropropene	8.30	0.10	0.298	0.46	93	6.61
Toluene-d8 (SURR)	0.880		1.17	24.7	99	0.456
4-Methyl-2-Pentanone	5.86	0.12	0.102	0.52	104	7.60
Toluene	11.9	0.09	0.954	0.51	103	5.39
trans-1,3-Dichloropropene	8.33	0.11	0.272	0.48	95	7.27
Ethyl Methacrylate	11.1	0.12	0.216	0.45	89	8.80
Tetrachloroethene	14.1	0.09	0.621	0.56	112	4.92
1,1,2-Trichloroethane	2.87	0.11	0.240	0.47	94	7.56
1,3-Dichloropropane	4.16	0.12	0.319	0.47	94	7.98
Chlorobenzene-d5 (IS)						

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Compound	Calibration			Accuracy and Precision (n=7, 0.5 ppb) ¹		
	Linearity RF (≤20%RSD)	MDL (ppb)	Average RF	Average Concentration (ppb)	Accuracy (70-130%)	Precision (≤20%RSD)
2-Hexanone	9.52	0.17	0.061	0.50	101	10.8
Dibromochloromethane	8.58	0.09	0.280	0.47	95	6.28
Butyl Acetate	8.60	0.18	0.138	0.47	94	12.3
1,2-Dibromoethane	5.36	0.14	0.219	0.52	103	8.41
Chlorobenzene	9.61	0.13	0.638	0.53	105	7.95
1,1,1,2-Tetrachloroethane	6.36	0.14	0.263	0.48	96	8.98
Ethylbenzene	14.7	0.14	0.847	0.48	95	9.25
m-,p-Xylene	14.3	0.17	0.647	1.00	100	5.42
o-Xylene	14.5	0.10	0.675	0.46	92	7.18
Styrene	15.3	0.07	0.634	0.45	89	5.24
Bromoform	9.67	0.16	0.253	0.44	89	11.6
Amyl Acetate	12.7	0.06	0.149	0.44	89	3.96
Isopropylbenzene	17.5	0.07	0.929	0.45	90	5.03
cis-1,4-Dichloro-2-Butene	7.01	0.13	0.258	0.49	99	8.25
Bromofluorobenzene (SURR)	4.04		0.387	23.3	93	0.840
Bromobenzene	5.39	0.15	0.365	0.50	100	9.86
n-Propylbenzene	15.6	0.06	1.03	0.48	97	4.27
1,4-Dichlorobenzene-d4 (IS)						
1,1,2,2-Tetrachloroethane	4.94	0.11	0.288	0.46	93	7.64
1,2,3-Trichloropropane	2.42	0.20	0.341	0.51	102	12.3
trans-1,4-dichloro-2-butene	8.60	0.18	0.083	0.51	102	11.1
2-Chlorotoluene	8.35	0.10	0.797	0.52	103	6.05
1,3,5-Trimethylbenzene	11.5	0.06	1.07	0.49	97	3.66
4-Chlorotoluene	10.6	0.16	0.927	0.52	104	9.58
tert-Butylbenzene	16.8	0.10	1.22	0.48	96	6.65
1,2,4-Trimethylbenzene	14.1	0.12	1.07	0.49	99	7.81
Pentachloroethane ²	0.998	0.16	0.127	0.49	99	10.5
sec-Butylbenzene	15.8	0.11	1.39	0.49	97	7.29
1,3-Dichlorobenzene	11.8	0.11	0.909	0.51	102	6.81
p-Isopropyltoluene	15.9	0.11	1.30	0.47	94	7.65
1,4-Dichlorobenzene	9.02	0.15	0.937	0.54	107	8.88
n-Butylbenzene	17.6	0.13	1.03	0.49	99	8.25
1,2-Dichlorobenzene	8.77	0.12	0.913	0.53	105	7.03
Hexachloroethane	12.5	0.10	0.264	0.51	101	6.15
1,2-Dibromo-3-Chloropropane	9.98	0.17	0.111	0.54	107	10.2
Nitrobenzene	10.4	0.29	0.023	0.57	114	16.1
1,2,4-Trichlorobenzene	19.7	0.19	0.717	0.54	107	11.1
Hexachlorobutadiene	18.4	0.21	0.424	0.50	101	13.2
Naphthalene	16.2	0.12	1.36	0.52	103	7.41
1,2,3-Trichlorobenzene	17.5	0.12	0.728	0.51	102	7.43

1. Data from seven 0.5 ppb samples.
2. Compounds were linear regressed.

Figure 1 Total Ion Chromatogram of a Water Method 50 ppb VOC Standard Indicating Consistent Peak Shapes for all Compounds with No Water Interference.



Conclusion

This study demonstrates the capability of the Teledyne Tekmar Lumin P&T concentrator and AQUATek LVA to process water samples for VOCs following US EPA Method 8260 with detection by an Agilent 7890B GC/5977A MS. The %RSD of the calibration curve passed all method requirements. Furthermore, MDL, and accuracy and precision for seven 0.5 ppb standards showed no interference from excessive water.

By making additional, appropriate changes to the GC oven temperature program, the GC/MS cycle time may also be reduced, increasing laboratory throughput in a 12-hour period.

References

1. *Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)*; US EPA, Office of Solid Waste, SW-846 Method 8260B, Revision 2, December 1996.
2. *Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)*; US EPA, Office of Solid Waste, SW-846 Method 8260C, Revision 3, August 2006.
3. *Purge and Trap for Aqueous Samples*; US EPA, Office of Solid Waste, SW-846 Method 5030B, Revision 2, December 1996.
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