

Analysis of Trace Oxygenates in Petroleum-Contaminated Wastewater, Using Purge-and-Trap/GC/MS (US EPA Methods 5030B & 8260)

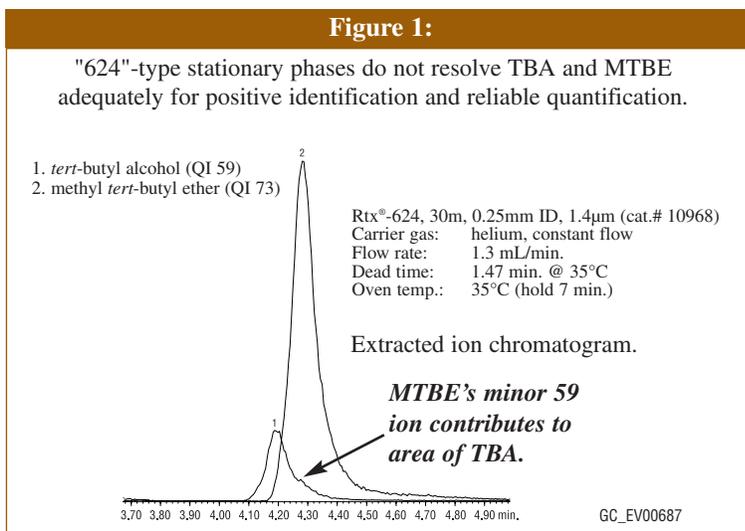
Gasoline and other petroleum-derived fossil fuels consist mainly of compounds that contain only carbon and hydrogen atoms. Oxygenates - ethers and alcohols - contain oxygen atoms in addition to carbon and hydrogen. Oxygenates are added to gasoline to enhance various aspects of its performance as a fuel. Methyl tertiary-butyl ether (MTBE) is the most common fuel oxygenate. MTBE was first introduced into gasoline in 1979, to reduce overall emissions, replace lead, and increase octane rating. In 1992, gasoline with up to 15% MTBE content by volume was used nationally to meet the first federally mandated wintertime reduction of carbon monoxide emission.

With over one million underground fuel tanks in the United States, contamination of ground and surface water with gasoline components, including oxygenates, is a major environmental concern. Storage tanks worldwide potentially will require monitoring and cleanup in the future. The US EPA has not sanctioned any wastewater method specifically for analysis of oxygenates from gasoline. Consequently, environmental laboratories in the US have used a variety of methods to report these analytes, including EPA Methods 8015, 8021, and 8260. Regulatory agencies recommend adding *tert*-butyl alcohol (TBA) to the target list for contaminated sites known to contain MTBE because it is both a breakdown product of MTBE and a gasoline additive in its own right. Identification and quantification of these fuel-derived pollutants in a gasoline-water matrix is a challenging task, because compounds such as MTBE and TBA coelute on many of the stationary phases in capillary gas chromatography columns, and share ions used for identification in gas chromatography/mass spectrometry (GC/MS).

Method 8015 calls for using a flame ionization detector (FID) to match a known chromatographic pattern for gasoline to an unknown sample containing peaks that fall within the gasoline pattern range. This method can be used to identify oxygenates by retention time, but a high probability of misidentifications dictates the need for confirmation on a second column. A second analysis entails additional costs and additional time.

Method 8021 was written specifically for analysis of aromatic and halogenated volatiles, and employs a photoionization detector (PID). This is the least reliable of the three methods: a PID is very sensitive to double bonds, but is much less sensitive to ether and hydroxy groups. In a test analysis of a gasoline composite standard conducted in our laboratories, use of Method 8021 resulted in false positive identification of a sample component as diisopropyl ether. Confirmation analysis by GC/MS correctly identified the compound as 2-methyl-1-pentene.¹

Purge-and-trap/GC/MS methods, such as Method 8260, are favored for monitoring oxygenates in gasoline because they ensure a higher level of confidence in the data obtained, compared to GC methods, as illustrated by the 2-methyl-1-pentene example cited above. Under appropriate conditions, GC/MS circumvents the problem of false identification of unresolved constituents and provides positive identifications. Studies conducted by analysts at Lawrence Livermore National Laboratory indicate that GC/MS is the most reliable method of detecting oxygenates in complex gasoline-containing samples, regardless of the concentration of the gasoline (from neat to greatly diluted with groundwater).² Although confidence in the GC/MS approach is well founded, the stationary phase must be carefully chosen and tested to assure that there are no critical coelutions between target oxygenated analytes and other gasoline components, which could result in false positives for the former. Further, careful attention to operating conditions is necessary, to maximize analyte response and optimize resolution between oxygenates and other compounds of interest. TBA and MTBE, for example, must be separated, because they share ions used for identification. Figure 1 is an example of inadequate resolution of these analytes; "624"-type stationary phases are not recommended for oxygenates analysis due to this limitation. Similarly, incomplete resolution of *tert*-amyl-methyl ether (TAME) and benzene makes an Rtx®-Volatiles column inappropriate for this application.



We evaluated the Rtx[®]-VMS stationary phase for recovery of oxygenates, verifying passing criteria by following EPA Method 5030B (with modification) and Method 8260. Samples of non-oxygenated gasoline, spiked with low levels of oxygenates, enabled us to determine if operating conditions were appropriate for separating and detecting these target compounds in the presence of high concentrations of other gasoline components. Purge and trap conditions in Method 5030B were modified to address the oxygenates in the samples: to increase responses for the oxygenates, we used a 40°C purge temperature, rather than the ambient temperature suggested. GC oven conditions were optimized to eliminate coelutions of ion-sharing analytes.

The GC/MS system was tuned using a 25ng standard of 4-bromofluorobenzene (BFB). Commonly analyzed compounds on the Method 8260 target list were added to the calibration mix, along with internal standards, ethers, and TBA. Methanol and ethanol were not added to these samples; alcohols are more amenable to headspace or direct injection techniques.

Method 8260B does not specifically assign internal standards to target compounds. Therefore, we used the internal standards and corresponding analytes listed in Table 6 of Method 8260.³ This allowed us to measure relative response factors (RF) against established internal standards. We also incorporated the Method 8260 surrogates, and the characteristic primary ions for quantification, into our experimental design. The curve was calibrated using mean response factors, as outlined in Method 8260, section 7.6.2.1. Minimum mean response factors for the volatile system performance check compounds (SPCC), as described in the method, are listed in Table 1. These values confirm acceptable performance by the purge and trap concentrator. Note that the 40°C purge temperature used to increase responses for the oxygenates also will increase responses for the SPCC compounds.

After the system passed the SPCC evaluation, the calibration check compounds (CCC) were used to verify the validity of the calibration. Relative standard deviations (%RSD) for these compounds must be less than 15% (Table 2). The internal standards in Table 3 were used for calculating RFs, %RSDs, and % recoveries (%Recov.) of target analytes, as shown. Oxygenates were calculated relative to internal standard methyl-d3-*tert*-butyl ether, to account for differences in purging efficiency specific to the ethers.

Table 1:

System performance check compound (SPCC) response factor criteria for all columns under specific conditions.

	EPA Criterion (Minimum Mean RF)	Rtx[®]-VMS Column (RF)
pentafluorobenzene (IS)		
chloromethane (SPCC)	>0.10	0.59
1,1-dichloroethane (SPCC)	>0.10	0.64
chlorobenzene-d5 (IS)		
chlorobenzene (SPCC)	>0.30	1.06
bromoform (SPCC)	>0.10	0.32
1,4-dichlorobenzene-d4 (IS)		
1,1,2,2-tetrachloroethane (SPCC)	>0.30	0.71

Table 2:

Calibration check compound (CCC) relative standard deviation criteria for all columns under specific conditions.

	EPA Criterion (%RSD)	Rtx[®]-VMS Column (%RSD)
pentafluorobenzene (IS)		
1,1-dichloroethene (CCC)	<15	11.4
chloroform (CCC)	<15	5.5
1,4-difluorobenzene (IS)		
1,2-dichloropropane (CCC)	<15	4.9
toluene (CCC)	<15	3.0
chlorobenzene-d5 (IS)		
ethylbenzene (CCC)	<15	5.5
1,4-dichlorobenzene-d4 (IS)		
1,1,2,2-tetrachloroethane (SPCC)	<15	8.6

Table 3:

Internal standards with corresponding analytes assigned for quantification.

methyl-d3-<i>tert</i>-butyl ether (IS)	pentafluorobenzene (IS)	1,4-difluorobenzene (IS)	chlorobenzene-d5 (IS)
methyl- <i>tert</i> -butyl ether	chloromethane (SPCC)	1,2-dichloroethane-d4 (SS)	chlorobenzene (SPCC)
<i>tert</i> -butyl alcohol (x5)*	1,1-dichloroethene (CCC)	1,2-dichloropropane (CCC)	ethylbenzene (CCC)
diisopropyl ether	acetone (x2.5)*	toluene-d8 (SS)	bromoform (SPCC)
ethyl- <i>tert</i> -butyl ether	1,1-dichloroethane (SPCC)	toluene (CCC)	1,4-dichlorobenzene-d4 (IS)
<i>tert</i> -amyl-methyl ether	chloroform (CCC)	bromofluorobenzene (SS)	1,1,2,2-tetrachloroethane (SPCC)
	dibromofluoromethane (SS)		naphthalene

*Compound added at 5 times or 2.5 times the concentration of other target analytes.

Purge and Trap Procedures

Table 4 summarizes the purge and trap conditions used for recovering oxygenates from gasoline. Samples were heated using the Infra-Sparge™ sample heater on an O.I. 4560 concentrator. The minimum purge temperature effective for detecting TBA at a concentration of 25ppb in 10mL of water was 40°C. Purge flow rate was carefully adjusted to 38mL/min.; lower flows dramatically affect recovery of the brominated compounds, higher flows contribute to analyte breakthrough and excessive water retention on the trap.

Analytical Procedures

An Agilent 5890 Series II GC coupled with an Agilent 5971A GC/MS detector fitted with a K&M electron multiplier was used for the analysis. Helium carrier gas was adjusted to 1.3mL/min. constant flow. The oven temperature program was optimized as follows: 35°C (hold 7 min.) to 90°C @ 4°C/min. (hold 0 min.), to 220°C @ 45°C/min. (hold 1 min.). Analysis time was 25 minutes; cycle time was 30 minutes. The MS was set for full scan from 35amu to 260amu and was initially tuned with FC-43 or PFTBA calibration gas, followed by BFB. A 30m x 0.25mm x 1.4µm Rtx®-VMS column (cat.# 19915) was used for the separations.

Standards

The five points of the calibration were 5, 10, 20, 40, and 80 ppb, with internal standards (IS) and surrogate standards (SS) added to each calibration standard at 20ppb. Intermediate standards were made separately for each calibration point, to maintain equal amounts of methanol added to the 10mL volume of water. Samples were spiked and were transferred to the concentrator by hand. Calibration was performed using the analyte list in Table 3, but all compounds shown in Figure 2 were added in order to check for critical coelutions between oxygenates and Method 8260B target compounds. Calibration verification standards (CVS) were added at 10ppb; recoveries were within 20% of expected values. Two blanks were analyzed, followed by a 5ppb QC standard to verify recoveries at the low point of the curve.⁴ Reference materials used are listed in Table 5.

Gasoline-Spiked Samples

Analysis of the 5ppb QC standard was followed by analysis of a 1ppm non-oxygenated gasoline standard, then by analysis of the non-oxygenated standard with 5ppb of each target compound added. % recoveries for the 5ppb oxygenate standards were calculated from this high concentration gasoline matrix. The final standard analyzed was 1ppm (unweathered) unleaded gasoline. All samples were spiked with the appropriate IS and SS. The calibration curve passed EPA 8260 criteria for response factors and relative standard deviations. Only two compounds in the test set showed poor response: acetone and TBA.

Table 4:

Purge and trap conditions for recovering oxygenates from gasoline (O.I. 4560 concentrator).

Trap:	#10 (Tenax®/silica gel/carbon molecular sieve)
Purge Time:	11 min.
Purge Flow Rate:	38mL/min.
Desorb Flow Rate:	32mL/min.
Desorb Time:	1.0 min.
Bake Time:	10 min.
Sample Size:	10mL
Water Management:	110°C purge, 0°C desorb, 240°C bake
Split Ratio:	1:25
Temperatures:	
Sample:	40°C
Trap:	20°C purge, 190°C desorb, 210°C bake
6-Port Valve:	110°C
Transfer Line:	110°C
Sparge Mount:	45°C
Desorb Preheat:	150°C
Valve Manifold:	50°C
Other Conditions:	pre-purge, pre-heat, dry purge OFF

Conditions suggested by O.I. Analytical.

Optimizing the Analysis of Volatile Organic Compounds

Our technical guide is a concise, thorough overview to analyzing volatile organics in environmental samples:

- ✓ Purge and trap theory - adsorbents and traps - troubleshooting
- ✓ GC system configurations for narrow-bore or wide-bore capillary columns
- ✓ Optimizing detection systems

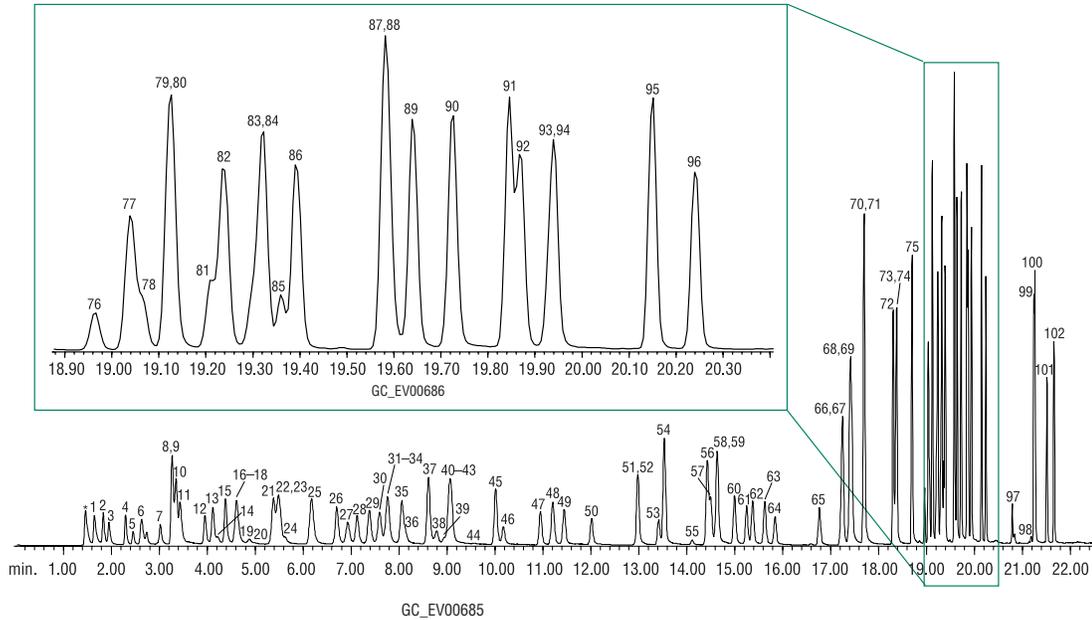
Many chromatograms show how changes in chromatographic parameters achieve specific goals. Invaluable information for new chromatographers; experienced analysts can find ideas and justification for updating methodology. 72 pages.

Free on request - ask for lit. cat.# 59887A, or visit our website.



Figure 2:

Detecting oxygenates in gasoline-water samples: 80ppb each analyte.



Rtx®-VMS, 30m, 0.25mm ID, 1.4µm (cat.# 19915)
 Sample: Calibration, internal standard, surrogate standard mixes (cat.# 30475B, 30465, 30006, 30240, 30074)

Purge and trap conditions

Trap: #10 (Tenax®/silica gel/carbon molecular sieve)
 Purge Time: 11 min.
 Purge Flow Rate: 38mL/min.
 Desorb Flow Rate: 32mL/min.
 Desorb Time: 1.0 min.
 Bake Time: 10 min.
 Sample Size: 10mL
 Water Management: 110°C purge, 0°C desorb, 240°C bake
 Split Ratio: 1:25

Temperatures:

Sample: 40°C
 Trap: 20°C purge, 190°C desorb, 210°C bake
 6-Port Valve: 110°C
 Transfer Line: 110°C
 Sparge Mount: 45°C
 Desorb Preheat: 150°C
 Valve Manifold: 50°C

Other Conditions:

pre-purge, pre-heat, dry purge OFF

Chromatography

Inj. temp.: 250°C
 Carrier gas: helium, constant flow
 Flow rate: 1.3 mL/min.
 Dead time: 1.47 min. @ 35°C
 Oven temp.: 35°C (hold 7 min.) to 90°C @ 4°C/min.(no hold) to 220°C @ 45°C/min. (hold 1 min.).
 Det.: Agilent 5971A GC/MS
 Transfer line temp.: 280°C
 Scan range: 35-260 amu
 Tune: PFTBA/BFB

*carbon dioxide	26. <i>cis</i> -1,2-dichloroethene	52. 2-chloroethyl vinyl ether	78. <i>cis</i> -1,4-dichloro-2-butene
1. dichlorodifluoromethane	27. 2,2-dichloropropane	53. toluene-d8	79. 1,4-dichlorobutane
2. chloromethane	28. bromochloromethane	54. toluene	80. <i>n</i> -propylbenzene
3. vinyl chloride	29. chloroform	55. 2-nitropropane	81. 1,1,2,2-tetrachloroethane
4. bromomethane	30. carbon tetrachloride	56. tetrachloroethene	82. 2-chlorotoluene
5. chloroethane	31. tetrahydrofuran	57. 2-bromo-1-chloropropane	83. 1,2,3-trichloropropane
6. trichlorofluoromethane	32. methyl acrylate	58. 4-methyl-2-pentanone	84. 1,3,5-trimethylbenzene
7. diethylether	33. 1,1,1-trichloroethane	59. <i>trans</i> -1,3-dichloropropene	85. <i>trans</i> -1,4-dichloro-2-butene
8. 1,1-dichloroethene	34. dibromofluoromethane	60. 1,1,2-trichloroethane	86. 4-chlorotoluene
9. carbon disulfide	35. 1,1-dichloropropene	61. ethyl methacrylate	87. <i>tert</i> -butylbenzene
10. Freon® 113	36. 2-butanone	62. dibromochloromethane	88. pentachloroethane
11. iodomethane	37. benzene	63. 1,3-dichloropropane	89. 1,2,4-trimethylbenzene
12. allyl chloride	38. propionitrile	64. 1,2-dibromoethane	90. <i>sec</i> -butylbenzene
13. methylene chloride	39. methacrylonitrile	65. 2-hexanone	91. <i>p</i> -isopropyltoluene
14. acetone	40. 1,2-dichloroethane-d4	66. chlorobenzene-d5	92. 1,3-dichlorobenzene
15. <i>trans</i> -1,2-dichloroethene	41. pentafluorobenzene	67. chlorobenzene	93. 1,4-dichlorobenzene-d4
16. methyl-d3- <i>tert</i> -butyl-ether	42. <i>tert</i> -amyl-methyl ether	68. ethylbenzene	94. 1,4-dichlorobenzene
17. methyl acetate	43. 1,2-dichloroethane	69. 1,1,1,2-tetrachloroethane	95. <i>n</i> -butylbenzene
18. methyl- <i>tert</i> -butyl-ether	44. isobutyl alcohol	70. <i>m</i> -xylene	96. 1,2-dichlorobenzene
19. <i>tert</i> -butyl alcohol	45. trichloroethene	71. <i>p</i> -xylene	97. 1,2-dibromo-3-chloropropane
20. acetonitrile	46. 1,4-difluorobenzene	72. <i>o</i> -xylene	98. nitrobenzene
21. diisopropyl ether	47. dibromomethane	73. bromoform	99. hexachlorobutadiene
22. chloroprene	48. 1,2-dichloropropane	74. styrene	100. 1,2,4-trichlorobenzene
23. 1,1-dichloroethane	49. bromodichloromethane	75. isopropylbenzene	101. naphthalene
24. acrylonitrile	50. methyl methacrylate	76. 4-bromo-1-fluorobenzene (SS)	102. 1,2,3-trichlorobenzene
25. ethyl- <i>tert</i> -butyl ether	51. <i>cis</i> -1,3-dichloropropene	77. bromobenzene	

Acknowledgment: purge & trap courtesy of O.I. Analytical.

Not detected: 2-chloroethanol

Results

Table 6 summarizes results. All oxygenates were resolved from other target compounds and potentially interfering gasoline components. TBA and MTBE were well resolved using the 35°C starting temperature. Figure 3 represents a TIC of 1ppm non-oxygenated unleaded gasoline spiked with 5ppb of oxygenates. The inset is an extracted ion chromatogram showing oxygenates are recovered without interference from the gasoline matrix.

The internal standard methyl-d3 *tert*-butyl ether was added to compensate for variations in purging efficiency specific to the ethers. After the data were acquired we observed a small ion 73 component as part of the IS spectra (Figure 4). MTBE and the IS share retention time and MTBE produces ion 73. Our initial thought was to discard the data, but we determined the distribution of the relative abundance of ion 73 to ion 76 for the IS was between 0.3% and 0.5%. This would affect calculated concentrations of MTBE by no more than 2%. Analysts in environmental laboratories can decide if this is an acceptable degree of error. We are currently evaluating other potential internal standards that behave in a manner similar to the ethers. One such substitution used in some laboratories is TBA-d9, which accounts for variations common to alcohols, but not to ethers.

Figure 3:

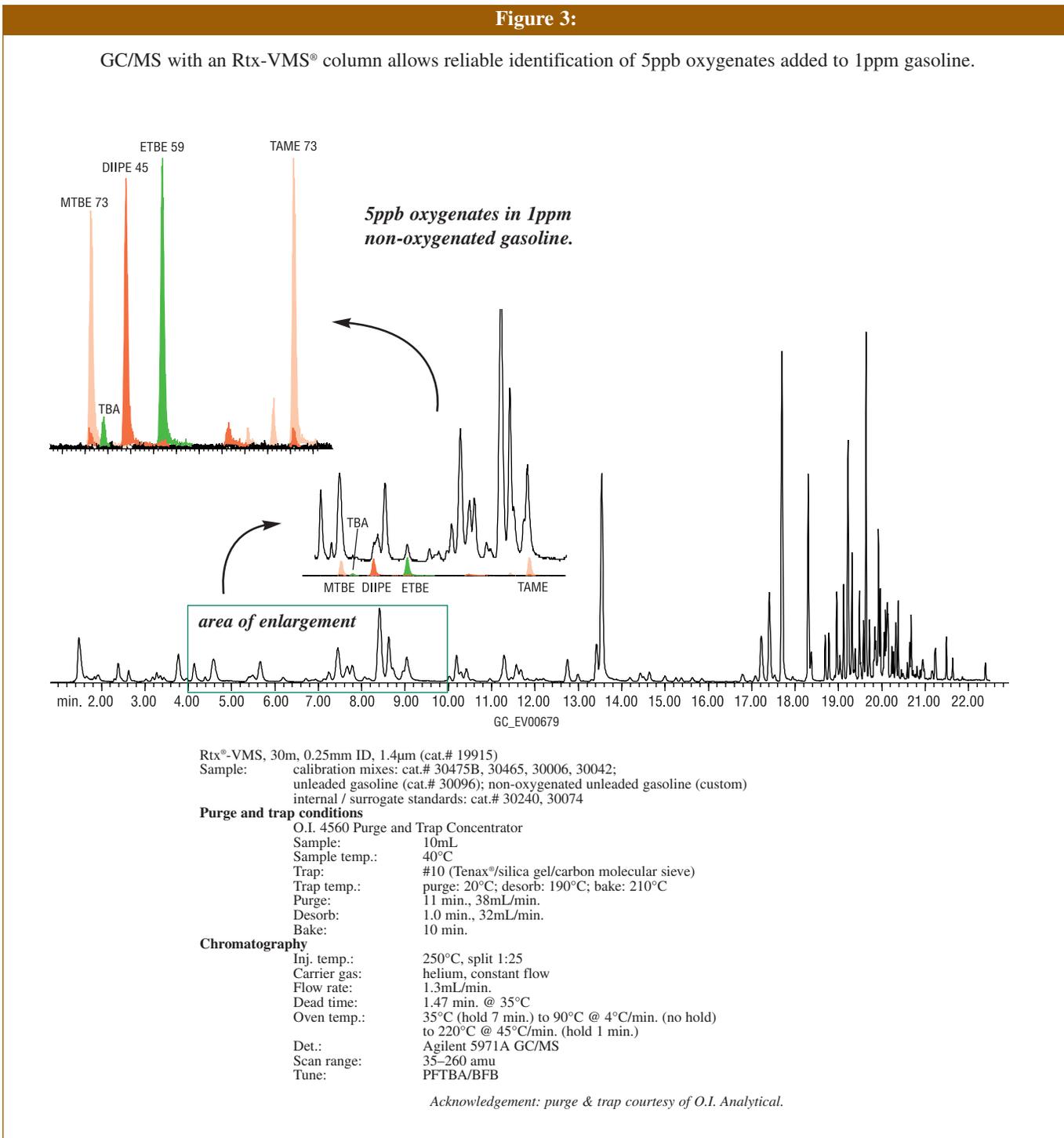


Table 5:

Calibration mixes and other reference materials for oxygenates analysis.

Reference Material	Restek cat.# / lot#	
Internal Standard & Surrogate Standard Mix	cat.# 30240	lot# A025538
	custom	lot# 03010401s
Calibration Mix	cat.# 30074	lot# A022472
	cat.# 30475A	lot# A020908
	cat.# 30465	lot# A024826
	cat.# 30006	lot# A024175
	cat.# 30042	lot# A024616
QC Second Source Calibration Mix	cat.# 553595	lot# A025888
Unleaded Gasoline (Unweathered)	cat.# 30096	lot# A022384
Non-Oxygenated Unleaded Gasoline (Unweathered)	custom	lot# OFR-TK253

Table 6:

Efficient recovery of ppb oxygenates, using an Rtx[®]-VMS column.

Compound	5-Point Curve (RF)	5-Point Curve (%RSD)	Method Blank (%Recov.)	5ppb Standard (%Recov.)	1ppm Non-oxygenated Standard (%Recov.)	1ppm Non-oxygenated Standard, 5ppb Spike (%Recov.)	1ppm Gasoline Composite Standard (%Recov.)
methyl-d3- <i>tert</i> -butyl ether (IS)							
<i>tert</i> -butyl alcohol (x5)*	0.13	17		93		90	
methyl- <i>tert</i> -butyl ether	0.91	7		99		92	6.2ppb
diisopropyl ether	1.08	7		100		94	
ethyl- <i>tert</i> -butyl ether	1.21	8		98		90	
<i>tert</i> -amyl-methyl ether	1.15	5		105		98	< D.L.
pentafluorobenzene (IS)							
acetone (x2.5)*	0.05	12		62	< D.L.	N.D.	
dibromofluoromethane (SS)	0.43	3	102	89	106	97	98
1,4-difluorobenzene (IS)							
1,2-dichloroethane-d4 (SS)	0.22	6	103	111	102	100	102
toluene-d8 (SS)	1.02	4	101	108	98	97	98
toluene (CCC)	0.78	3		106	94.4ppb	89.6ppb	81.9ppb
bromofluorobenzene (SS)	0.45	2	91	103	90	90	95
chlorobenzene-d5 (IS)							
chlorobenzene (SPCC)	1.06	6		108			
ethylbenzene (CCC)	1.71	5		110	21.4ppb	24.9ppb	23.9ppb
1,4-dichlorobenzene-d4 (IS)							
naphthalene	2.08	3		93	4.7ppb	8.8ppb	5.0ppb

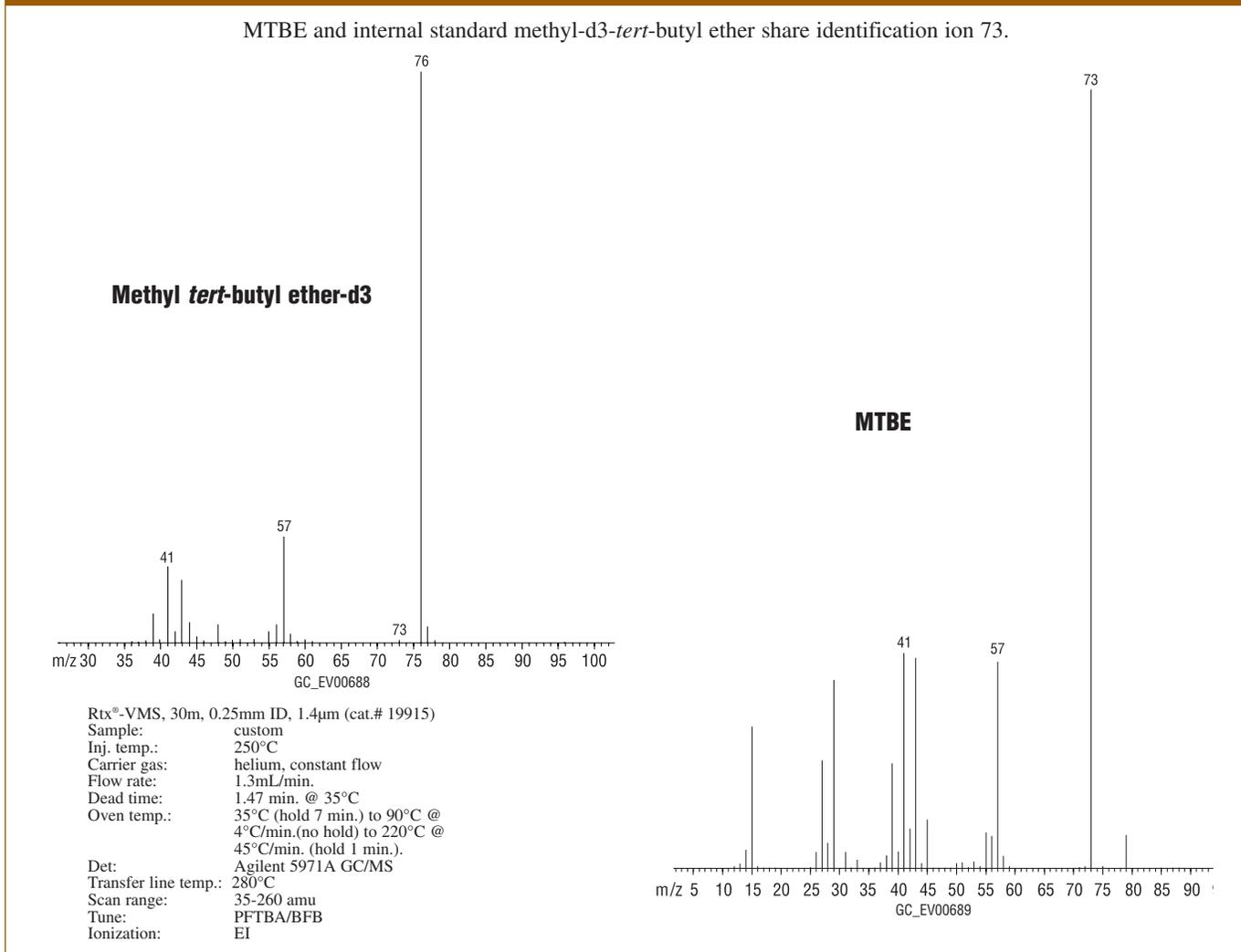
*Compound added at 5 times or 2.5 times the concentration of other target analytes.

<D.L. - below detection limit. N.D. - not detected.

Column: Rtx[®]-VMS, 30m x 0.25mm x 1.4µm (cat.# 19915)

Conditions: given in text

Figure 4:



Conclusion

With an expanding target list and difficult sample matrixes, such as petroleum distillates, extreme care must be taken, even with GC/MS, to assure correct identification of oxygenates in the presence of interfering analytes. Under the conditions used here, an Rtx®-VMS column is suitable for analyzing low levels of oxygenates in the presence of other gasoline components. For additional information, see reference 5.

References

1. C. English, C. Cox, F. Dorman, D. Patwardhan, *The Analysis of Gasoline Oxygenates Using a New Capillary Column Stationary Phase*, Pittsburgh Conference 2001, Session 199 (poster).
<http://www.restekcorp.com/2001/1868P.pdf>
2. Happel, A.M., E.H. Beckenbach, R.U. Halden, *An Evaluation of MTBE Impacts to California Groundwater Resources* Lawrence Livermore National Laboratory, UCRL-AR-130897 (1988).
<http://www-erd.llnl.gov/mtbe/pdf/mtbe.pdf>
3. U.S. Environmental Protection Agency, *Volatile Organic Compounds by Gas Chromatography/Mass Spectroscopy (GC/MS): Capillary Column Technique Method 8260*. Revision 0, July 1992, US EPA Office of Solid Waste. Washington, D.C.
4. U.S. Environmental Protection Agency, *Volatile Organic Compounds by Gas Chromatography/Mass Spectroscopy (GC/MS): Capillary Column Technique Method 8260B*. Revision 2, December 1996, US EPA Office of Solid Waste. Washington, D.C.
5. C.M. English, F.L. Dorman, G.B. Stidsen, *The Analysis of Gasoline Oxygenates by EPA Method 8260B* Pittsburgh Conference 2003, Session 590-6P (poster).
<http://www.restekcorp/pittcon2003.htm#slides>

Acknowledgement

We are grateful to O.I. Analytical for supplying the purge and trap unit used in this study, and for their help with establishing analytical conditions.

Product Listing

Rtx®-VMS Columns (fused silica)

ID	df (µm)	temp. limits	30-Meter	60-Meter	75-Meter
0.25mm	1.40	-40 to 240/260°C	19915	19916	
0.32mm	1.80	-40 to 240/260°C	19919	19920	
0.45mm	2.55	-40 to 240/260°C	19908	19909	
0.53mm	3.00	-40 to 240/260°C	19985	19988	19974
ID	df (µm)	temp. limits	20-Meter	40-Meter	
0.18mm	1.00	-40 to 240/260°C	49914	49915	

8260A/B Surrogate Mix

4-bromofluorobenzene 1,2-dichloroethane-d4
dibromofluoromethane toluene-d8
2,500µg/mL each in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30240	30240-510	—
	w/data pack	
30240-500	30240-520	30340

8260 Internal Standard Mix

chlorobenzene-d5 1,4-difluorobenzene
1,4-dichlorobenzene-d4 pentafluorobenzene
2,500µg/mL each in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30074	30074-510	—
	w/data pack	
30074-500	30074-520	30174

8260B MegaMix™ Calibration Mix (76 + 1 components)

Note: This product is provided as a two ampul set:

2,000µg/mL each component in P&T methanol, 1mL/ampul
2,000µg/mL 2-chloroethyl vinyl ether in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30475	30475-510	—
	w/data pack	
30475-500	30475-520	30575

California Oxygenates Mix

diisopropyl ether 2,000µg/mL
ethyl-tert-butyl ether 2,000
tert-amyl methyl ether 2,000
tert-butyl alcohol 10,000
methyl tert-butyl ether 2,000
In P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30465	30465-510	—
	w/data pack	
30465-500	30465-520	30565

VOA Calibration Mix #1 (ketones)

acetone 2-hexanone
2-butanone 4-methyl-2-pentanone
5,000µg/mL each in P&T methanol:water (90:10), 1mL/ampul

Each	5-pk.	10-pk.
30006	30006-510	—
	w/data pack	
30006-500	30006-520	30106

502.2 Calibration Mix #1 (gases)

bromomethane dichlorodifluoromethane
chloroethane trichlorofluoromethane
chloromethane vinyl chloride
2,000µg/mL each in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30042	30042-510	—
	w/data pack	
30042-500	30042-520	30142

Unleaded Gasoline Standard: Unweathered

Prepared from a single source (one refinery) product. Samples of regular and premium grade unleaded gasoline were collected, then blended in equal volumes.

5,000µg/mL in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30096	30096-510	—
	w/data pack	
30096-500	30096-520	30196

8240/8260 Calibration Check Mix

chloroform ethylbenzene
1,1-dichloroethene toluene
1,2-dichloropropane vinyl chloride
2,000µg/mL each in P&T methanol, 1mL/ampul

Each	5-pk.	10-pk.
30427	30427-510	—
	w/data pack	
30427-500	30427-520	30527

Other reference materials prepared on request. Please inquire.

For permission to reproduce any portion of this application note, please contact Restek's publications/graphics department by phone (ext. 2128) or FAX.

Restek Trademarks: Rtx, Restek logo.

Other Trademarks: Freon (E.I. du Pont de Nemours & Co., Inc.), Infra-Sparge (O.I. Analytical Corp.), Tenax (Enka Research Institute, Arnhem).



© Copyright 2003, Restek Corporation



Australian Distributors
Importers & Manufacturers
www.chromtech.net.au

Website NEW : www.chromalytic.com.au E-mail : info@chromtech.net.au Tel: 03 9762 2034 . . . in AUSTRALIA