

Application News

Gas Chromatography Mass Spectrometry

A Guide to the Novel Shimadzu GC-MS BFB Tuning for the Analysis of Volatile Organic Compounds in Environmental Samples

■ Abstract

The Environmental Protection Agency (EPA) establishes strict BFB tuning criteria to ensure the quality of the results when analyzing volatile compounds. Due to many challenges inherent to GC-MS Purge and Trap instruments required for this analysis, several GC-MS instruments have difficulties in passing the required US EPA BFB tuning criteria or remaining stable over prolonged operations period. In this study, the performance of a novel BFB tuning algorithm was demonstrated on the latest Shimadzu GCMS-QP2020 NX. The demonstration study consisted of two phases that comprised 1) evaluating the BFB tune and 2) testing the stability of internal standards and surrogates for EPA methods 524.2 and 624/8260. The results illustrate that the BFB spectra was able to pass all EPA requirements of methods 524.2 and 624/8260 criteria for the analysis of at least 1407 samples for over 4 months.

Moreover, these results confirm that the novel tuning algorithm used with the GCMS-QP2020 NX is a robust tool for performing EPA methods 524.2 and 624/8260.

■ Introduction

In the analysis of environmental samples, the United States Environmental Protection Agency (EPA) has a stringent quality assurance/quality control requirement to determine if the performance of a gas chromatography mass spectrometry (GC-MS) is optimal for Volatile Organic Analysis (VOA) according to its guidelines^{i,ii,iii}. In addition to a standard instrument autotune, EPA requires that 4-Bromofluorobenzene (BFB), a VOA tuning compound, passes a set of defined criteria. BFB tuning is a spectrum check of BFB and is used for the standardization of EI spectra to ensure data reproducibility between operators and across different instrument platforms^{iv}. Because GC-MS systems may produce different mass spectra depending on optimized parameters and tuning

protocols (based on manufacturer), BFB tuning is used to optimize the GC-MS ion source optics to achieve comparable mass spectra across different platforms. BFB tuning does not replace a standard autotune. Instead, BFB is used in conjunction with a standard autotune, which is first performed to determine if a GC-MS is in good condition. The BFB tuning is then applied to have mass pattern adjustment across a broad range of masses. The BFB tune is required as part of the Quality Assurance/Quality Control protocols from EPA VOC methods^{i,ii,iii}.

As underscored in the EPA daily GC-MS performance test for analysis of Volatile Organic Compounds (VOCs) by methods 524.2 or 624/8260, it is required that an acceptable performance (specific criteria discussed later in the document) be achieved for BFB before proceeding to analyze the target compounds^{i,ii,iii}. The procedure for BFB tuning can be tedious because of the mass pattern adjustment that is needed to achieve the desired mass spectra.

Moreover, many novel instruments across all vendor platforms may use BFB tuning algorithms that are outdated and not fully compatible with the latest technological advances in modern design of the ion optics. Thus, passing the BFB tuning criteria and maintaining a stable response over time may be challenging for some modern GC-MS instruments.



Figure 1: Shimadzu GCMS-QP2020 NX.

This application demonstrates the performance of a modern BFB tuning algorithm for the Shimadzu GCMS-QP2020 NX (Figure 1) for the analysis of VOCs. The project consisted of two phases that comprised:

- 1) evaluating the BFB tune
- 2) testing the stability of internal standards and surrogates for EPA method 524.2 and 624/8260.

Results are presented from an evaluation of BFB tune against method 524 and 624/8260 criteria and the demonstration of the instrument stability using the new tuning algorithm.

■ Tuning Criteria

The BFB tuning criteria for analysis of VOCs in drinking water (EPA methods 524.2 and 524.3) ^{i, vi}, municipal waste and industrial water (EPA method 624) and solid waste (EPA method 8260) ^{iii, vii} are listed in Table 1.

Overall, most criteria are the same for all methods. The tuning criteria for methods 624 and 8260C are identical; as a result, they are evaluated together in this work. Traditionally, the criteria for m/z 176 is the most challenging to achieve during VOA. The new tuning algorithm presented here demonstrates its ability to pass the criteria for m/z 176, simultaneously to those for other masses.

Table 1: Comparison of BFB Relative Abundance Criteria for US EPA VOC Methods.

Mass (m/z)	Method 524.2	Method 524.3	EPA 624 & EPA 8260C	EPA 8260D
50	15 to 40% of 95	N/A	15 to 40% of 95	N/A
75	30 to 80% of 95	N/A	30 to 60% of 95	N/A
95	Base peak, 100% Relative Abundance	Base peak, 100% Relative Abundance	Base peak, 100% Relative Abundance	50 to 200% of 174
96	5 to 9% of 95	5 to 9% of 95	5 to 9% of 95	5 to 9% of 95
173	<2% of 174	<2% of 174	<2% of 174	<2% of 174
174	>50% of 95	>50% of 95	>50% of 95	50 to 200% of 95
175	5 to 9% of 174	5 to 9% of 174	5 to 9% of 174	5 to 9% of 174
176	>95 to <101% of 174	>95 to <105% of 174	>95 to <101% of 174	95 to 105% of 174
177	5 to 9% of 176	5 to 10% of 176	5 to 9% of 176	5 to 10% of 176

■ Materials and Methods

GC-MS conditions

Instrument and method conditions can affect an instrument standard autotune as well as the stability of BFB tuning. While conducting BFB autotune, the MS optics optimization process is affected by GC conditions such as column flow and MS conditions such ion source temperature. Ion source temperature may affect the cleanliness of the source with a higher temperature leading to more dirtiness and the likelihood of failure of BFB tuning. Table 2 summarizes the instrument conditions used in the two phases of this study.

Table 2: GC-MS Operating Conditions during standard Tune and BFB Tune Evaluation

Gas Chromatography	GC-2030
Injection Port	200 °C, split mode, 40:1 split ratio
Column	SH-I-624Sil MS, 30 m x 0.25 mmID x 1.4 um He carrier gas Linear Velocity, 32 cm/sec
Oven Temperature	35 °C (isothermal)
Mass Spectrometer	GCMS-QP2020 NX
Interface Temperature	250 °C
Ion Source Temperature	200 °C
Detector Voltage	Relative to Tune +0.1 kV
Threshold	100
Scan Range	m/z 35 to 330 Event time 0.18 seconds

Tuning Conditions

As required by EPA, the standard tune of the GCMS-QP2020 NX was conducted using an electron emission current of 60 μ A as well as standard ionization voltage of 70 eV^{i,ii,iii}. Previous Shimadzu tune algorithms optimized m/z 69, 131, 219, 414, 502 and 614 to meet BFB method criteria (Figure 2A). In this novel tune algorithm m/z 614 is removed from the adjustable parameters (Figure 2B).

The m/z 50 was added to the new BFB tune mass pattern adjustment. As a result of the above changes, this has led to increased stability of the tune.

In the new BFB tuning algorithm, target mass m/z 264 is still used for adjusting sensitivity. The new BFB tuning algorithm incorporates two additional features to ease the tuning process. One is the automatic adjustment of the mass pattern for the selected ions shown in Figure 2 and their respective ion ratios; this feature needs to be selected in the software prior to performing the tune (Figure 3). Thesecond one is the automatic selection of the tuning mode (normal or high concentration) built into the BFB tuning file.

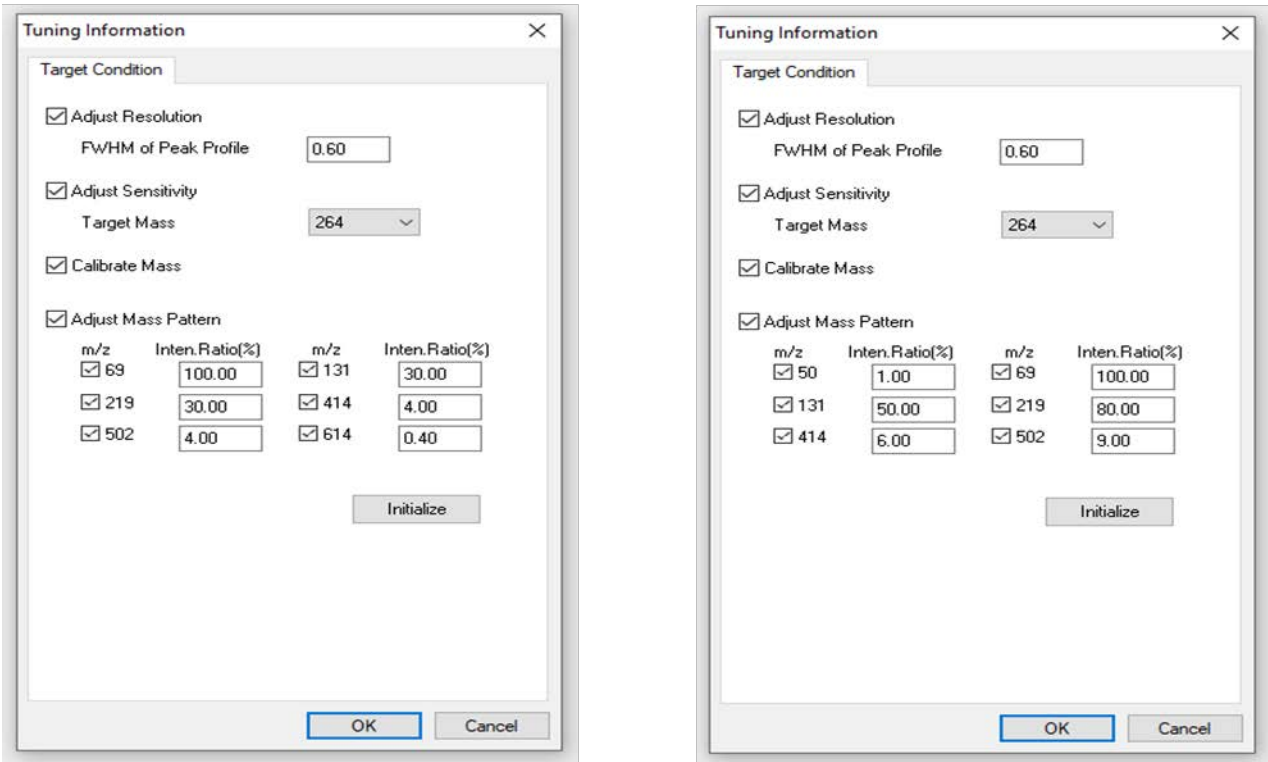


Figure 2: Conventional BFM autotune mass pattern adjustment (Figure 2A, left) and novel BFB autotune mass pattern adjustment (Figure 2B, right)

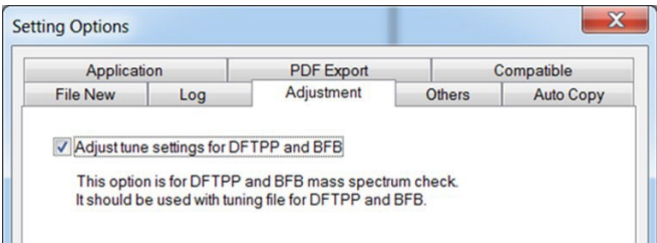


Figure 3: Automatic adjustment of BFB autotune mass pattern adjustment

Operational considerations

A standard autotune must be done prior to loading the new BFB tuning algorithm in to check the instrument conditions. With satisfactory standard autotuning results, the BFB tune algorithm is loaded followed by a BFB autotune.

Long-term analysis

While conducting sample analysis, in instances when the method criteria for BFB is outside the acceptable ranges after long term analysis, which can occur because of changes in analytical conditions, the next steps must be taken: 1) reload the initial default BFB tune file, 2) perform a BFB autotune with those existing default tune conditions (including mass pattern adjustments) and 3) inject BFB and check the method criteria again.

Experimental conditions

BFB tuning can be conducted by directly injecting BFB into the injection port of the GC or using the P&T system to infuse this standard into an injection loop containing the water sample. In this work, to check the long-term stability of BFB results, injections were carried out using the P&T unit. A 5-ppm standard solution containing surrogates BFB and 1,2-Dichlorobenzene-d4 and internal standard Fluorobenzene were injected into a sample loop containing either laboratory milli-Q water or tap water. The tap water samples were collected from multiple households. The final concentration of BFB, 1,2-Dichlorobenzene-d4 and fluorobenzene was 5 ppb.

Prior to testing of the stability of internal and surrogate standards, the GC oven, injection port, MS interface, and ion source were set to 220 °C for at least 1 hour. In addition, the P&T VOCARB 3000 trap was baked out for two cycles at 260 °C. These conditions were used to ensure the system was clean and free of contamination or carry over from previous analysis.

■ Results and Discussion

Method 524 - Phase I: Evaluation of BFB Tune

The first part of the study focused on EPA method 524.2. At the start of the work, a BFB autotune was conducted with the new tune algorithm, BFB was injected into the GCMS-purge and trap system. The mass spectrum for BFB passed the EPA BFB criteria (see detailed criteria in Table 1). A single BFB tune file was used for all the analysis included in this study, for methods 524.2 and 624/8260. This single BFB file was adequate for meeting criteria outline by EPA for the analysis of VOCs by both methods 524 and 624/8260.

According to EPA method 524.2, a BFB daily check was conducted prior to start of each sequence. A total of 850 samples (including standards and tap water) divided into 25 sequences over a 7-week period was analyzed (approximately one sequence per working day during the study period). Figure 4 summarizes the BFB relative abundance for all m/z and their acceptable interval required for the daily BFB check.

Table 3 shows the numeric results for BFB daily spectra check with respect to EPA tuning acceptance criteria from three representative sequences in the study: #1 (first), #13 (middle) and #25 (last). It was determined that all criteria from the BFB daily check were met and greatly exceeded, as all results were within the corresponding acceptable intervals and minimal variability in relative responses were observed. For example, BFB's m/z 177 were relatively constant in the first, middle and last sequence (Table 3).

Noteworthy are the results from m/z 176 that were able to pass method 524.2 criteria on all injections. The percentage of this ion compared to m/z 174, ranged from 95.04 to 100.42 %, which was within the method criteria. Summarizing, results shown here demonstrate that the new BFB tune algorithm was suitable and stable (confirmed by means of the BFB daily check) for the analysis of more than 850 samples (approximately equivalent to 427 hours of continuous operation) according to EPA method 524.2. This also confirms the robustness of the instrument used to conduct this work, that resulted in minimal down-time as no maintenance or sample reanalysis were required due to failure of BFB tune daily checks.

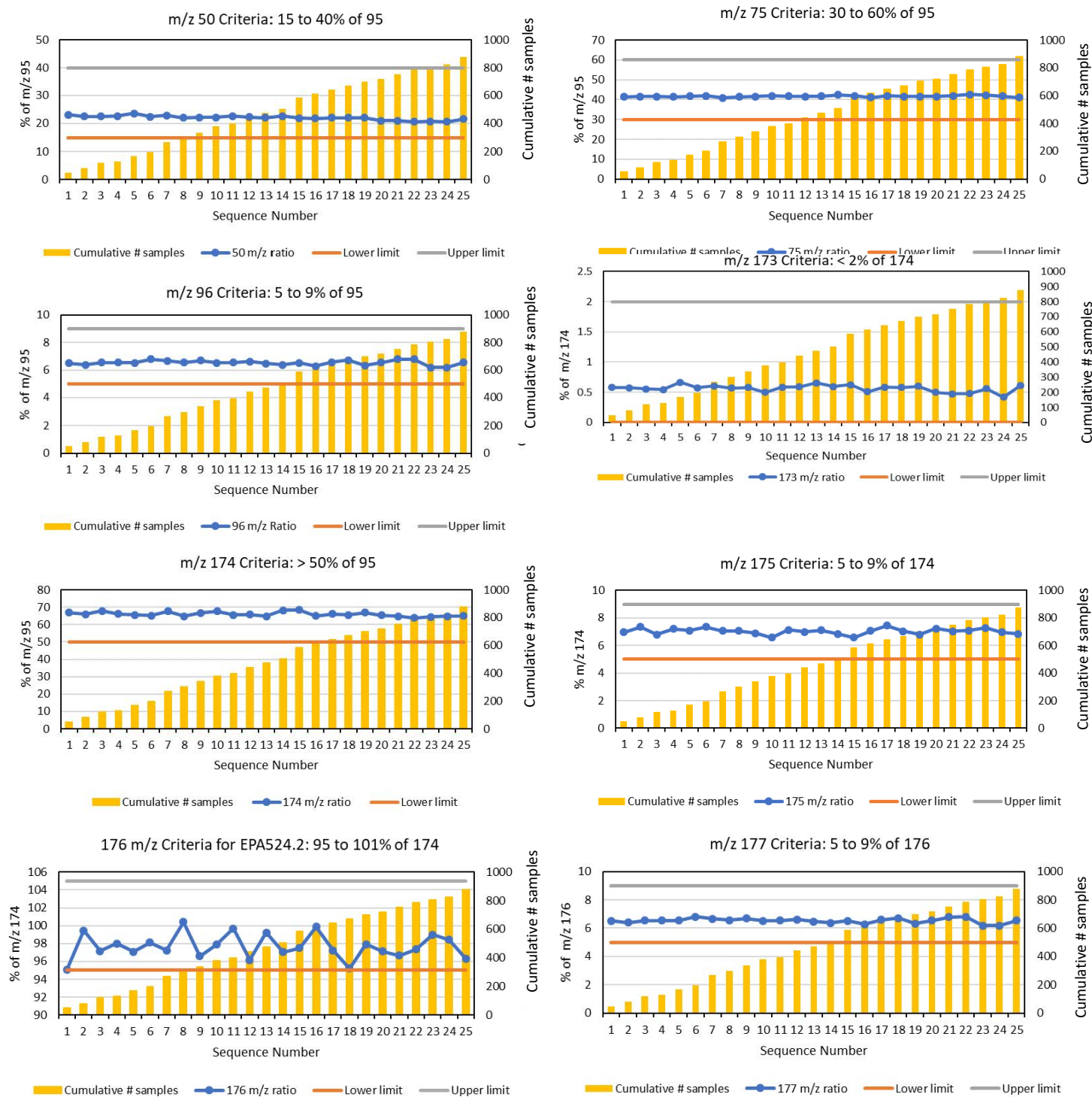


Figure 4: Evaluation of method 524 BFB Tune Criteria for 25 sequences over 7 weeks.

Table 3: Comparison of BFB spectra across stability test against criteria in EPA 524.

m/z	Spectrum Check Criteria	Results		Results		Results	
		Sequence #1	Status	Sequence #13	Status	Sequence #25	Status
50	15 to 40% of mass 95	23.06	Pass	21.98	Pass	21.58	Pass
75	30 to 60% of mass 95	41.43	Pass	41.72	Pass	41.10	Pass
95	Base Peak, 100% Relative Abundance	100.0	Pass	100.0	Pass	100.0	Pass
96	5 to 9% of mass 95	6.75	Pass	6.45	Pass	6.41	Pass
173	< 2% of mass 174	0.58	Pass	0.65	Pass	0.61	Pass
174	> 50% of mass 95	66.88	Pass	64.91	Pass	65.12	Pass
175	5 to 9% of mass 174	6.96	Pass	7.10	Pass	6.83	Pass
176	95% to 101% of mass 174	95.04	Pass	99.22	Pass	96.32	Pass
177	5 to 9% of mass 176	6.51	Pass	6.48	Pass	6.54	Pass

Method 524 - Phase 2: Internal Standard Stability

In addition to monitoring the stability of BFB responses during the BFB daily check, the internal and surrogate standards were analyzed to determine the stability of the overall BFB tune. The number of injections per sequence ranged from 16 to 71, for a total number of 850 samples. Using %RSD of the analyte peak area as an indication of the stability of the BFB tune, the results indicate that the tune remained stable for at least the length of this study (850 samples, equivalent to approximately 427 hours of operation). The data was evaluated on a sequence and injection bases. Table 4 summarizes the results of the BFB tuning algorithm stability evaluation for all sequences. Figure 5 illustrates stability of the internal standards based on injections. From the sequence evaluation, %RSD peak area of Fluorobenzene ranged from 1.88 to 5.59, Toluene -d8 ranged from 2.25 to 5.41 and BFB ranged from 2.29 to 5.59. Average %RSD for all 850 injections was 8.08 for Fluorobenzene, 6.44 for Toluene d-8 and 7.71 for BFB. These results corroborate the conclusions drawn from the BFB daily check: the new BFB tune algorithm is stable and the system overall is robust for long-term operation.

Table 4: %Relative standard deviation of IS (Fluorobenzene) and SS Peak Area (SS#1: Toluene-d8; SS#2: 4- Bromofluorobenzene).

Summary of Method 524.2 Stability Results				
Sequence Number	Number of samples in sequence	IS Area Count %RSD	SS#1 Area Count %RSD	SS#2 Area Count %RSD
1	49	1.88	2.46	4.83
2	31	2.24	2.25	2.56
3	39	2.56	2.31	2.29
4	11	2.98	2.91	4.41
5	39	2.52	3.25	5.34
6	28	2.29	2.46	3.49
7	71	2.39	2.45	3.12
8	32	2.85	2.92	3.67
9	38	2.72	2.82	3.41
10	41	2.54	2.78	3.61
11	18	3.53	3.97	4.28
12	44	2.97	3.04	3.66
13	32	3.00	2.72	2.96
14	31	2.42	2.48	3.14
15	82	3.69	3.56	3.81
16	30	2.94	2.79	3.07
17	27	2.49	2.57	3.24
18	28	2.71	2.72	3.28
19	30	3.33	3.38	3.58
20	16	4.12	3.41	5.32
21	34	2.73	2.65	2.88
22	34	5.59	5.41	5.59
23	19	3.75	3.49	3.52
24	20	3.49	3.29	3.25
25	54	4.01	4.12	4.00

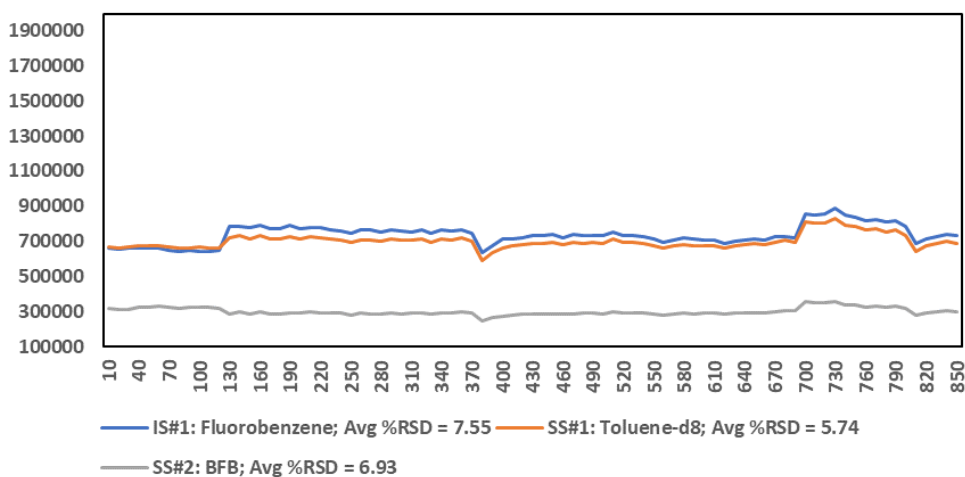


Figure 5. Stability of IS (Fluorobenzene) and SS Peak Area (SS#1: Toluene-d8; SS#2: 4-Bromofluorobenzene) for all injection

Method 624/8260 - Phase 1: Evaluation of BFB Tune

Stability of the BFB daily check with the new tune algorithm according to criteria outlined in EPA methods 624/8260 was also studied in this work. A total of 500 samples (combination of standards and water samples collected in local ponds) were analyzed for this purpose. These samples were divided into 13 sequences over a 258 hours period. Methods 624 and 8260 have the same BFB tuning criteria and share similar list of analytes. To that end, the evaluation of BFB tuning criteria and stability for both methods was conducted simultaneously. The initial tune used in this phase of the study (phase 1) was later applied for the experiments focused on internal standard stability (phase 2). This tune passed the method criteria until the end of the study.

In the same way as the study of method 524.2 (described in sections 1 and 2 from the results and discussion), at the beginning of this set of experiments, a BFB tune was conducted to ensure that EPA BFB criteria could be achieved. In addition, at the beginning of each sequence an aliquot of BFB was injected to determine the instrument suitability for conducting the necessary study.

Figure 6 summarizes the BFB relative abundance from all m/z and their acceptable interval required for the daily BFB check.

Table 5 shows the numeric results for BFB daily spectra check with respect to EPA tuning acceptance criteria from three representative sequences in the study: #1(first), #7 (middle) and #13 (last). It was determined that all criteria from the BFB daily check were met and greatly exceeded, as all results were within the corresponding acceptable intervals and minimal variability in relative responses were observed. For example, BFB's m/z 96 were relatively constant in the first, middle and last sequence (Table 3).

Noteworthy are the results from m/z 176 that were able to pass method 524.2 criteria on all injections. The percentage of this ion compared to m/z 174, ranged from 95.13 to 98.68 %, which was within the method criteria. Summarizing, results shown here demonstrate that the new BFB tune algorithm was suitable and stable (confirmed by means of the BFB daily check) for the analysis of more than 500 samples (approximately equivalent to 258 hours of continuous operation) according to EPA method 624/8260.

Table 5: Comparison of BFB spectra across stability test against criteria in EPA 624/8260.

Spectrum Check Criteria	Results		Results		Results	
	Sequence #1	Status	Sequence #7	Status	Sequence #13	Status
15 to 40% of mass 95	21.13	Pass	23.29	Pass	24.09	Pass
30 to 60% of mass 95	40.70	Pass	45.53	Pass	42.06	Pass
Base Peak, 100% Relative Abundance	100.0	Pass	100.0	Pass	100.0	Pass
5 to 9% of mass 95	6.56	Pass	6.47	Pass	6.58	Pass
< 2% of mass 174	0.51	Pass	0.48	Pass	0.41	Pass
> 50% of mass 95	63.36	Pass	57.14	Pass	66.19	Pass
5 to 9% of mass 174	6.90	Pass	7.22	Pass	7.01	Pass
95% to 101% of mass 174	96.00	Pass	95.13	Pass	96.10	Pass
5 to 9% of mass 176	6.44	Pass	6.51	Pass	6.56	Pass

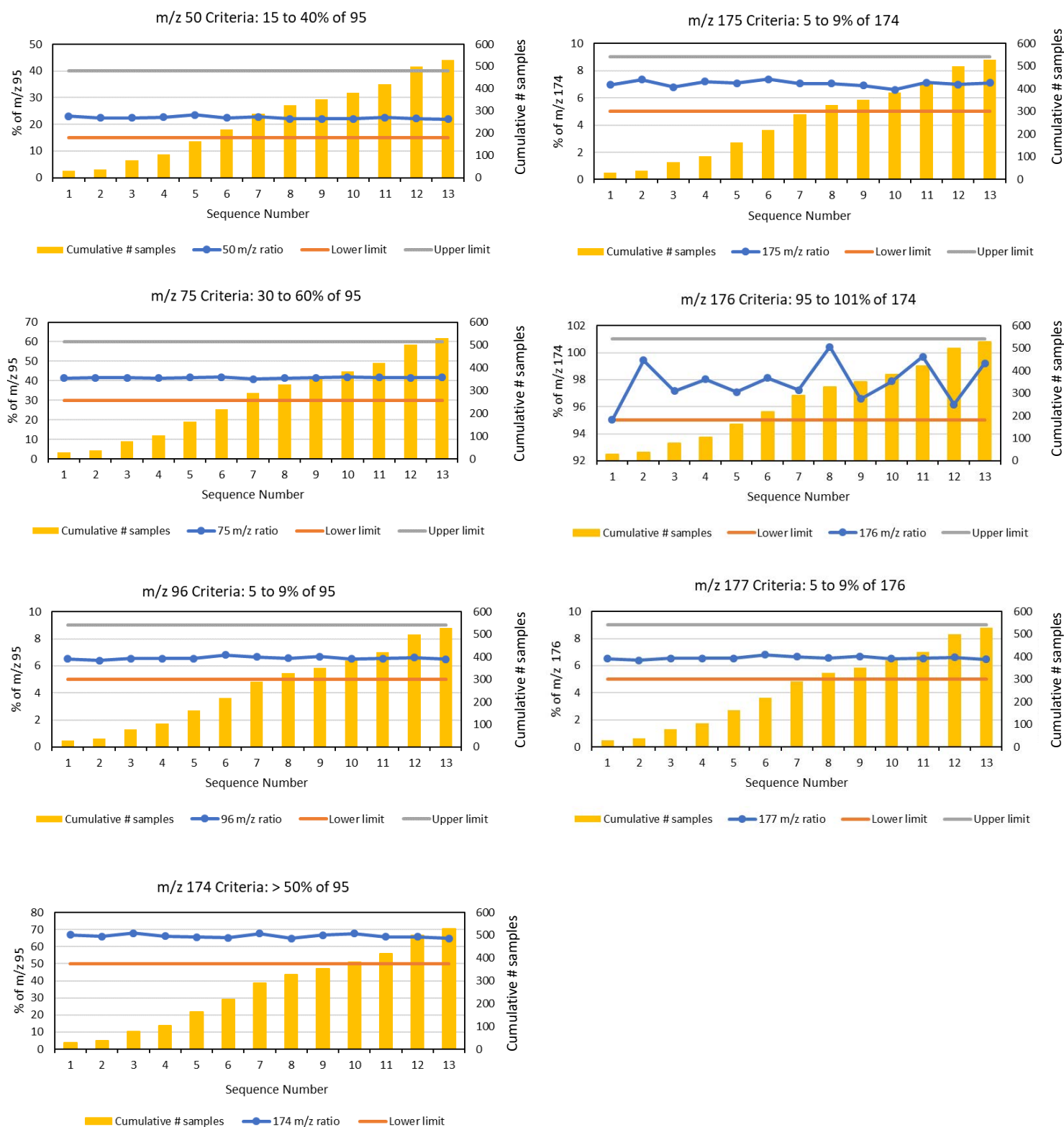


Figure 6: Evaluation of method 624/8260 BFB Tune Criteria for 13 sequences over 258 hours.

Method 624/8260 - Phase 2: Internal Standard Stability Test

The response of internal standards and surrogates in the 500 samples were monitored to determine the stability of the BFB tune for method 624/8260.

Internal and surrogate standards were injected, using the P&T system, into laboratory milli-Q water and water samples from local ponds. As an alternative to wastewater samples, pond water was used in the study. The number of analysis for each sequence ranged from 8 to 80. Table 6 summarizes the results of the BFB tuning algorithm stability evaluation for 13 sequences. Using % RSD of the Internal and surrogate standards peak area as an indication of the stability of the BFB autotune, the results indicate that the autotune is stable for at least 258 hours. % RSD peak area of internal standards Fluorobenzene ranged from 2.12 to 5.15, Chlorobenzene-d5 from 2.19 to 4.77 and 1,4-Dichlorobenzene-d4 from 2.06 to 5.27, while surrogates 1,2-Dichloroethane-d4 ranged from 2.35 to 4.65, Toluene-d8 from 2.22 to 4.94 and BFB ranged from 2.41 to 4.64.

Figure 7 illustrates stability of the tune based on injections. Average %RSD for all 500 injections was 11.16 for Fluorobenzene, 6.40 for Chlorobenzene-d5, 5.88 for 1,4-Dichlorobenzene-d4, 9.86 for 1,2-Dichloroethane-d4, 8.74 for Toluene d-8 and 4.95 for BFB. These results support the conclusions drawn from the BFB daily check: the new BFB tune algorithm is stable and the system overall is robust for long-term operation of method 624/8260.

Table 6: %Relative standard deviation of IS Peak Area (IS#1: Fluorobenzene, IS#2: Chlorobenzene-d5, IS#3: 1,4-Dichlorobenzene-d4) and SS Peak Area (SS#1: 1,2-Dichloroethane-d4; SS#2: Toluene-d8; SS#3: 4-Bromofluorobenzene).

Summary of Method 624/8260 Stability Results							
Sequence Number	Number of samples in the sequence	IS #1 Area %RSD	IS #2 Area %RSD	IS #3 Area %RSD	SS #1 Area %RSD	SS #2 Area %RSD	SS #3 Area %RSD
1	30	4.15	4.05	5.27	4.65	4.03	4.28
2	8	4.57	4.43	4.18	4.53	4.49	4.09
3	39	4.26	4.26	4.86	4.58	4.16	4.32
4	27	4.48	4.44	4.95	4.57	4.54	4.4
5	59	5.15	4.77	4.32	5.2	4.94	4.64
6	54	3.4	3.05	3.13	3.81	3.29	3.11
7	72	3.79	3.62	3.58	3.86	3.7	3.61
8	38	2.92	2.25	2.37	3.12	2.26	2.44
9	25	2.12	2.23	2.48	2.35	2.18	2.48
10	31	3.34	2.95	3.1	3.8	3.04	3.05
11	37	2.41	2.19	2.06	2.73	2.22	2.41
12	80	2.89	2.8	2.76	3.16	2.71	2.72
13	29	3.36	2.9	3.04	3.34	3.57	3.53
IS #1: Fluorobenzene					SS #1: 1,2-Dichloroethane-d4		
IS #2: Chlorobenzene-d5					SS #2: Toluene-d8		
IS #3: 1,4-Dichlorobenzene-d4					SS #3: 4-Bromofluorobenzene		

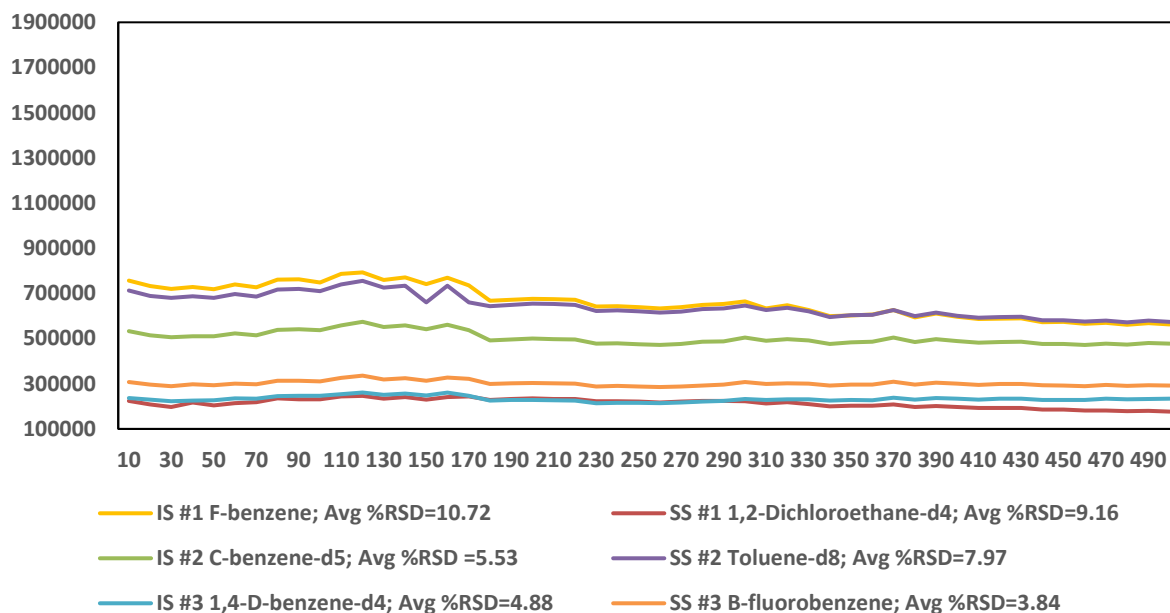


Figure 7: Stability of IS Peak Area (IS #1: Fluorobenzene, IS #2: Chlorobenzene, IS #3: 1,4-Dichlorobenzene-d4) and SS Peak Area (SS #1: Dibromofluoromethane; SS #2: Toluene-d8; SS#3: 4-Bromofluorobenzene) for all injection

■ Conclusion

The novel BFB tuning algorithm demonstrated in this applications study shows not only that the new algorithm easily and consistently meets all BFB criteria described in EPA methods 524, 624 and 8260 for Volatile Organic Compounds, but results in great stability of the GCMS-QP2020 NX. A single tune file produced consistent passing results for BFB over the course of the 4-month study, including the analysis of 1,350 samples (587 Milli-Q blanks, 480 tap water and 283 pond samples) in an equivalent of 685 hours of operation. The GCMS-QP2020 NX did not require retuning or maintenance that might impact the responses for meeting EPA criteria for the entirety of this project.

The study shows that using the GCMS-QP2020 NX system and the new tuning algorithm, reliable instrument performance and passing BFB criteria evaluations over an extended period can be obtained for the analysis of VOCs. This is pivotal, as EPA regulations continue to evolve, lower detection limits are required, and laboratories aim at more efficient operations.

■ References

- I. United States Environmental Protection Agency Method 524.2, Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, Revision 4.1 June 2009.
- II. United States Environmental Protection Agency Method 624: Purgeables, Promulgated 1984.
- III. United States Environmental Protection Agency Method 8260C, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Revision 3, August 2006.
- IV. Shimadzu Guide to BFB Tuning for Analysis of Volatile Organic Compounds, GCMS Application News No. GCMS-1405.
- V. United States Environmental Protection Agency Method 624.1: Purgeables by GC/MS, EPA Document #EPA 821-R-16-008.
- VI. United States Environmental Protection Agency Method 524.3, Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, Version 1.0, June 2009, EPA Document #EPA 815-B-009-009.
- VII. United States Environmental Protection Agency Method 8260D, Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Revision 4, June 2018.

■ Consumables

Part Number	Item Name	Item Description
221-75926-30	Capillary Column	SH-I-624Si MS, 30m x 0.25 mmID x 1.40 µm
220-90784	Inlet Liner	Low-volume liner, 1.0 mmID, Straight, 5/pkg (Restek)
84890	Gas tight syringes	Hamilton 1800 series gas tight syringes (Hamilton)
21051	Micro vials	3.0 ml Micro vial with screw thread (Restek)
24903	Sampling valves	Mininert precision sampling valves for micro vials (Restek)
89091-302	Volumetric flask	Pyrex 2 ml class A volumetric flask with stopper (VWR)
80070-360	Volumetric flask	Chemglass 500 ml class A volumetric flask with stopper (VWR)
10124-072	Volumetric flask	Vwr 100ml class A Heavy Duty volumetric flask with stopper (VWR)
21797	Sampling vials	40 ml Volatile Organic Analyte sampling vials (Restek)
MX0482-6	Methanol	Omnisolv methanol for purge and trap (VWR)
30074	Internal Standards Mix	8260 Internal Standard Mix (4 components) (Restek)
30073	Surrogate Mix	8260 Surrogate Standard Mix (3 components) (Restek)
121950-02	Custom 8260 Gas Mix	Custom 8260 Gas Mix, 8-142, 2,000 mg/L, 1ml (o2si)
120730-02	Method 524.2 Drinkwater VOA Mix	Method 524.2 Drinking Water VOA Mix, 2,000 mg/L, 1ml (o2si)
120486-02	Method 524 Oxygenates Standard	Method 524 Oxygenates Standard, 5-486, 2,000 mg/L, 1ml (o2si)
020439-02	Methyl Acetate Solution	Methyl Acetate Solution, 2,000 mg/L, 1ml (o2si)
0202203-02	Iodomethane Solution	Iodomethane Solution, 2,000 mg/L, 1ml (o2si)
120016-03	Method 8260 Gases	Method 8260 Gases, 2,000 mg/L, 2 x 0.6ml (o2si)
120023-03-02	Method 8260 VOC liquid	8260 VOC Liquids, 54 Compounds, 2,000 mg/L, 2 x 0.6ml (o2si)
123485-02	Methods 8260 VOC solution	Method 8260 VOC Reactive Solution 8-1, 2,000 mg/L, 1ml (o2si)

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Related Products

Some products may be updated to newer models.



➤ GCMS-QP2020 NX
Gas Chromatograph Mass
Spectrometer

Related Solutions

➤ Water

➤ Price Inquiry

➤ Product Inquiry

➤ Technical Service /
Support Inquiry

➤ Other Inquiry