

Need Maximum Column Lifetime and Resilience for 1701 GC Columns?

See How RMX-1701Sil MS Columns Outperform Competitor Columns in Thermal and Matrix-Induced Stress Tests

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Key Highlights

- Increase thermal stability and GC column lifetime with state-of-the-art RMX-1701Sil MS polymer technology powered by TriMax deactivation.
- Improve performance resilience of both acidic and basic compounds exposed to thermal and matrix-induced stress.
- Minimize pesticide breakdown while analyzing challenging matrices.

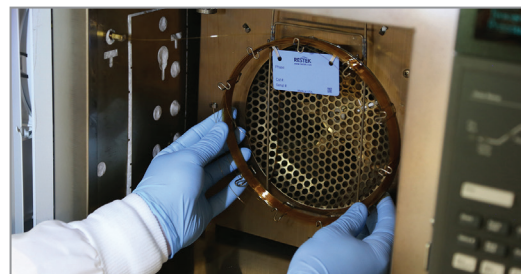
Background

Pesticide analysis for the food industry comes with many challenges related to sample matrices, which can heavily impact analytical performance and GC column lifetime. Foods contain a wide range of sugars, fats, and other complex nutrients that can contaminate a GC system. Mitigating matrix contamination with sample cleanup can be difficult in commercial settings due to the multitude of sample matrices and the wide variety of target pesticides. Rather than investing in complex sample preparation procedures, labs can reduce matrix impact by using consumables that will withstand the harsh conditions brought about by both complex matrices and the high-temperature holds (“bake outs”) that are used to remove matrix contaminants.

There are a wide variety of GC columns available for pesticide analysis, with many tailored to specific analytes or methods. In general, a 5-type column can efficiently separate most pesticides, though many labs will run complimentary analyses on a more polar phase, such as a 1701, especially if there are isobaric interferences from either the matrix or other pesticides. However, one of the main challenges with using a 1701-type column is reduced lifetime under harsh conditions, such as those encountered in routine pesticide analysis. Since 1701-type columns have a lower maximum temperature than 5-type columns, high molecular weight matrix components cannot always be completely baked out, which leaves the column more vulnerable to deteriorating analytical performance.

Longer column lifetime can be achieved with RMX-1701Sil MS columns, which feature state-of-the-art TriMax deactivation technology. TriMax deactivation creates a robust, inert coating interface that helps prevent deterioration under heat and matrix-induced stress, allowing for extended column lifetime compared to traditional 1701-type columns. In addition, the arylene polymer backbone in RMX-1701Sil MS columns allows for higher operating temperatures that support analysis of a wider range of pesticide polarities while still providing alternative selectivity.

To demonstrate the benefit of TriMax technology on a 1701-selectivity column, this study compares the RMX-1701Sil MS column to a traditional 1701 GC column that is commonly used for pesticides analysis. The columns were exposed to two types of stressors that affect column lifetime: thermal stress and matrix contamination.



Related Products

- *RMX-1701Sil MS, 30 m, 0.25 mm ID, 0.25 μ m (cat.# 17423)*
- *Topaz 4.0 mm ID Precision inlet liner w/wool (cat.# 23305)*
- *Methoxychlor (cat.# 32233)*
- *Endrin aldehyde (cat.# 32468)*
- *2,4'-DDT (cat.# 32200)*
- *Leak detector (cat.# 28500)*
- *Flowmeter (cat.# 22656)*



Thermal Stress Test for 1701 GC Column Lifetime

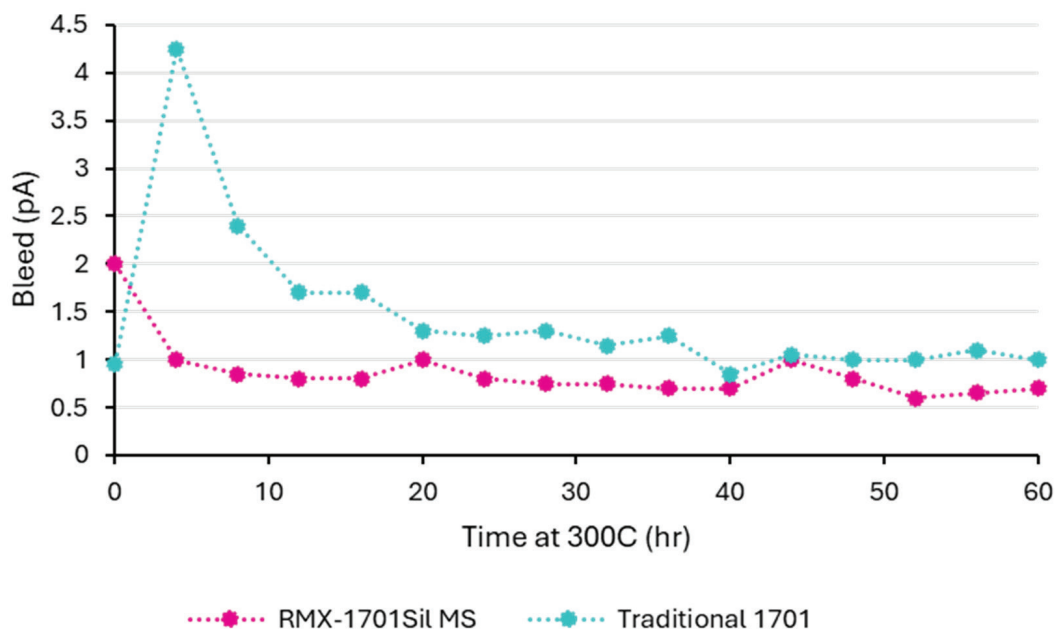
The thermal stress test used to assess differences in 1701 GC column lifetime was designed to challenge column integrity with extended high-temperature holds. The maximum operating temperature of the RMX-1701Sil MS column is 320 °C, but testing was conducted at 300 °C because the traditional column's maximum temperature is only 300 °C. Columns were first quality tested, and then performance was monitored regularly while the columns spent a cumulative 60 hours at 300 °C (Figure 1).

Figure 1: Thermal Stress Test Design



As shown in Figure 2, column bleed on the RMX-1701Sil MS column was very low and stable throughout the stress test. In contrast, bleed on the traditional 1701-type column was initially high but then stabilized after approximately 20 hours at 300 °C. Although it eventually stabilized, the bleed profile on the traditional column was still higher than on the RMX-1701Sil MS column over the course of the experiment. The RMX-1701Sil MS column is capable of maintaining exceptionally low column bleed because the TriMax deactivation technology produces superior bonding between the inner surface of the fused silica capillary and stationary phase polymer.

Figure 2: Compared to the traditional 1701-type column, RMX-1701Sil MS columns started low bleed and stayed low bleed throughout thermal stress testing.

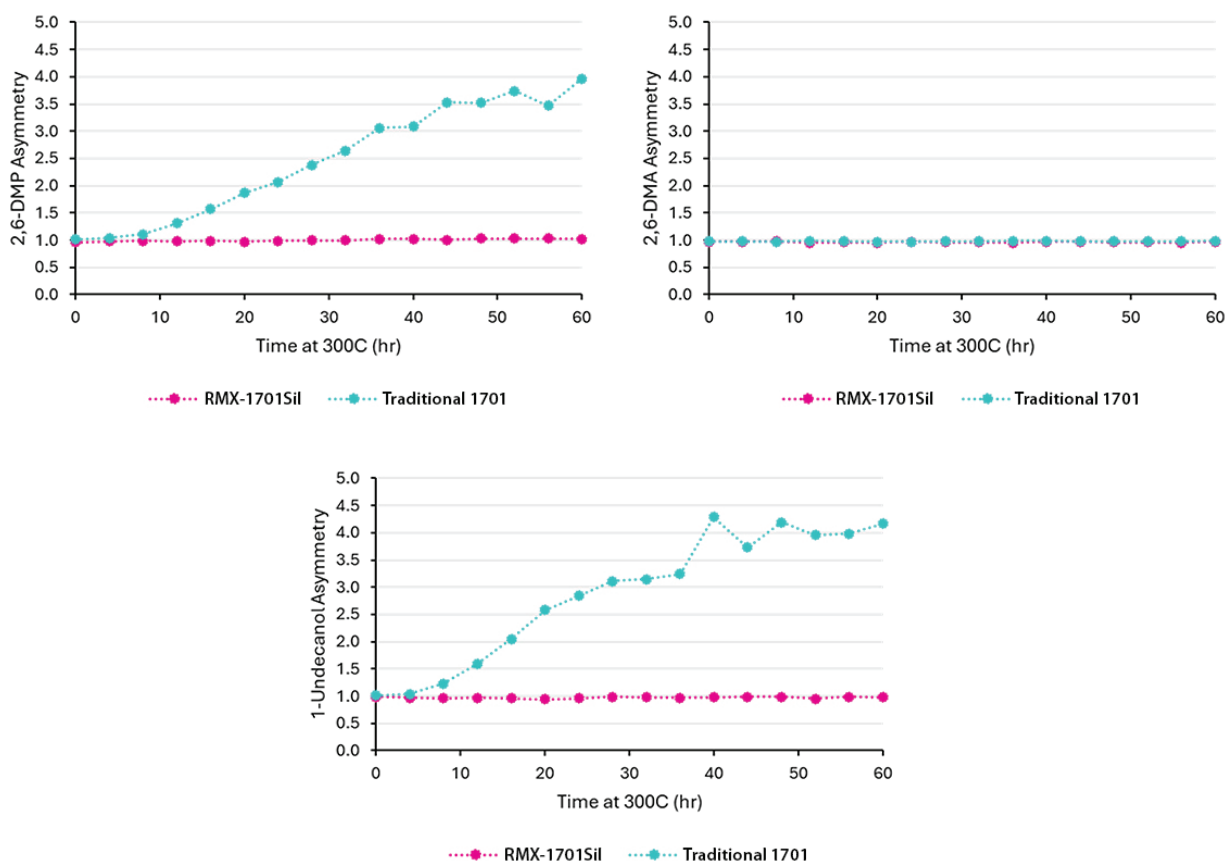


In addition to monitoring column bleed, peak asymmetry and area were also assessed for 2,6-dimethylphenol (DMP, a weak acid); 2,6-dimethylaniline (DMA, a weak base); and 1-undecanol (an alcohol). These analytes were chosen because they were found to best represent deterioration across three key analyte functionalities typically analyzed with 1701-type columns: phenols, bases, and alcohols.

Figure 3 demonstrates that peak asymmetries for 2,6-DMP, 2,6-DMA, and 1-undecanol were stable on the RMX-1701Sil MS column throughout thermal stress testing while asymmetries of 2,6-DMP and 1-undecanol rapidly deteriorated on the traditional 1701-type column. Increasing asymmetry occurs as the result of reversible adsorption to active sites, which rapidly form on traditional 1701-type column technology under continuous thermal stress. Peak asymmetries of 2,6-DMA were stable on both columns, suggesting traditional 1701 GC columns demonstrate a bias towards basic analyte performance.

In contrast, the RMX-1701Sil MS column provides balanced performance across all three analyte probes. The TriMax deactivation technology powering the RMX-1701Sil MS column reduces the formation of active sites in the polymer through a robust adhesion of the polymer to the capillary surface, allowing it to withstand elevated temperatures for a longer period of time.

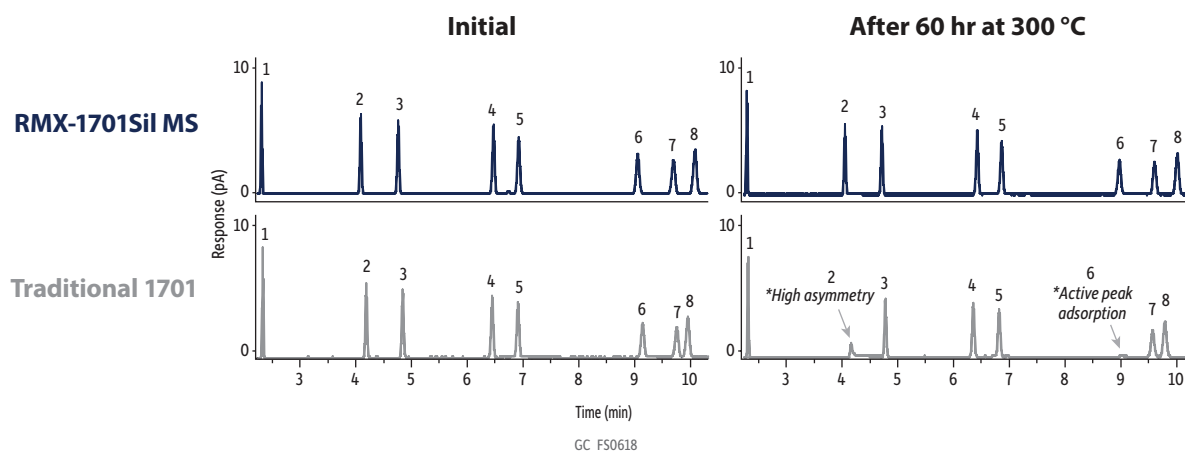
Figure 3: Only the RMX-1701Sil MS column produced symmetric peaks for all three analyte probes throughout thermal stress testing.



Peak areas also deteriorated in the same way as asymmetry on the traditional 1701-type column, which was a consequence of the distorted peak shapes. Notably, on the traditional 1701-type column, DMP and 1-undecanol were nearly completely adsorbed by active sites after 60 hours at 300 °C while there was no change in peak shape or response on the RMX-1701Sil MS column (Figure 4). The TriMax deactivation technology used to build the RMX-1701Sil MS column prevented the formation of adsorptive active sites, preserving chromatographic performance.

Stable performance under thermal stress has real-world benefits because, at the end of the run, the temperature program can be set to “bake” the column, which drives less-volatile matrix components off the column, keeping it clean and usable longer. Ultimately, greater thermal stability means longer column lifetime and less downtime to replace consumables.

Figure 4: Peak response is stable on RMX-1701Sil MS columns even after 60 hr at 300 °C but degrades on traditional 1701 GC columns.



Peaks	t_r (min)
1. 3-Octanone	2.18
2. 2,6-Dimethylphenol	3.91
3. 2,6-Dimethylaniline	4.56
4. Tetradecane	6.23
5. 2-Methylnaphthalene	6.64
6. 1-Undecanol	8.77
7. Methyl undecanoate	9.38
8. Pentadecane	9.75

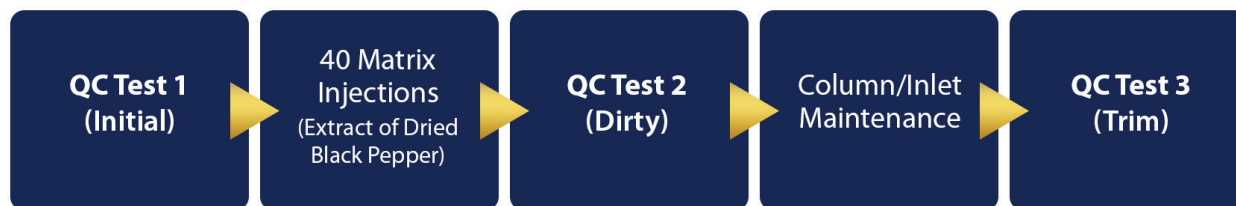
Column RMX-1701Sil MS, 30 m, 0.25 mm ID, 0.25 μ m (cat.# 17423)
Standard/Sample RMX-1701Sil MS QC mix
Diluent: 1,2-Dichloroethane
Injection
Inj. Vol.: 1 μ L split (split ratio 250:1)
Liner: Topaz 4.0 mm ID Precision inlet liner w/wool (cat.# 23305)
Inj. Temp.: 250 °C
Oven
Oven Temp.: 130 °C (hold 12 min)
Carrier Gas H₂, constant flow
Flow Rate: 1.1 mL/min @ 130 °C
Detector FID @ 300 °C
Make-up Gas Flow Rate: 30 mL/min
Make-up Gas Type: N₂
Hydrogen flow: 40 mL/min
Air flow: 400 mL/min
Data Rate: 50 Hz
Instrument Agilent 7890B GC

Matrix Stress Test for 1701 GC Column Lifetime

The matrix-induced stress test was designed to challenge column integrity with heavy contamination and then evaluate “bounceback” or how well analytical performance was restored following maintenance. To test this, the columns were first quality tested, then exposed to sample extract and tested again, and then finally retested after maintenance was performed. Maintenance consisted of replacing the inlet consumables and trimming the column, and the matrix exposure/maintenance cycle was repeated five times overall (Figure 5).

For this challenge, dried black pepper was selected as the sample because it is a notoriously difficult matrix in the area of food chemistry. In preliminary testing, it was found to affect 2,6-DMA and 1-undecanol peak asymmetries, which were monitored here to represent base and alcohol probes. Methoxychlor and DDT were evaluated as well because they are also known to be susceptible to degradation.

Figure 5: Matrix Stress Test Design (Repeated 5x)



Throughout matrix-induced stress testing, it was expected that asymmetries would stray further from 1.0 under “dirty” conditions and then return closer to 1.0 after maintenance, but it is important to note that different compounds respond in different ways. 1-Undecanol responds to matrix activity by tailing, gradually increasing asymmetry values, whereas methoxychlor and DDT display peak fronting, which decreases peak asymmetry.

As shown in Figures 6-8, 1-undecanol and 2,6-DMA remained consistently close to 1.0 on the RMX-1701Sil MS column while 1-undecanol asymmetry gradually increased with continued matrix exposure on the traditional 1701 GC column, regardless of maintenance. In addition, peak asymmetry for methoxychlor and DDT was initially poor on the traditional 1701-type column but gradually increased to a stable value close to 1.0, suggesting the matrix “primes” the column surface, reducing residual silanol activity. The increasing asymmetry of 1-undecanol but not 2,6-DMA is further evidence of the bias toward basic compound performance on the traditional 1701-type column while the RMX-1701Sil MS provides greater inertness for both acidic and basic functionalities. Results demonstrate that TriMax technology provides a robust bond that masks active sites and protects analytes from adsorption and degradation in the face of harsh sample matrices like black pepper.

Figure 6: Peak shape was more resilient on RMX-1701Sil MS columns than on traditional 1701-type columns following repeated exposure to harsh matrix.

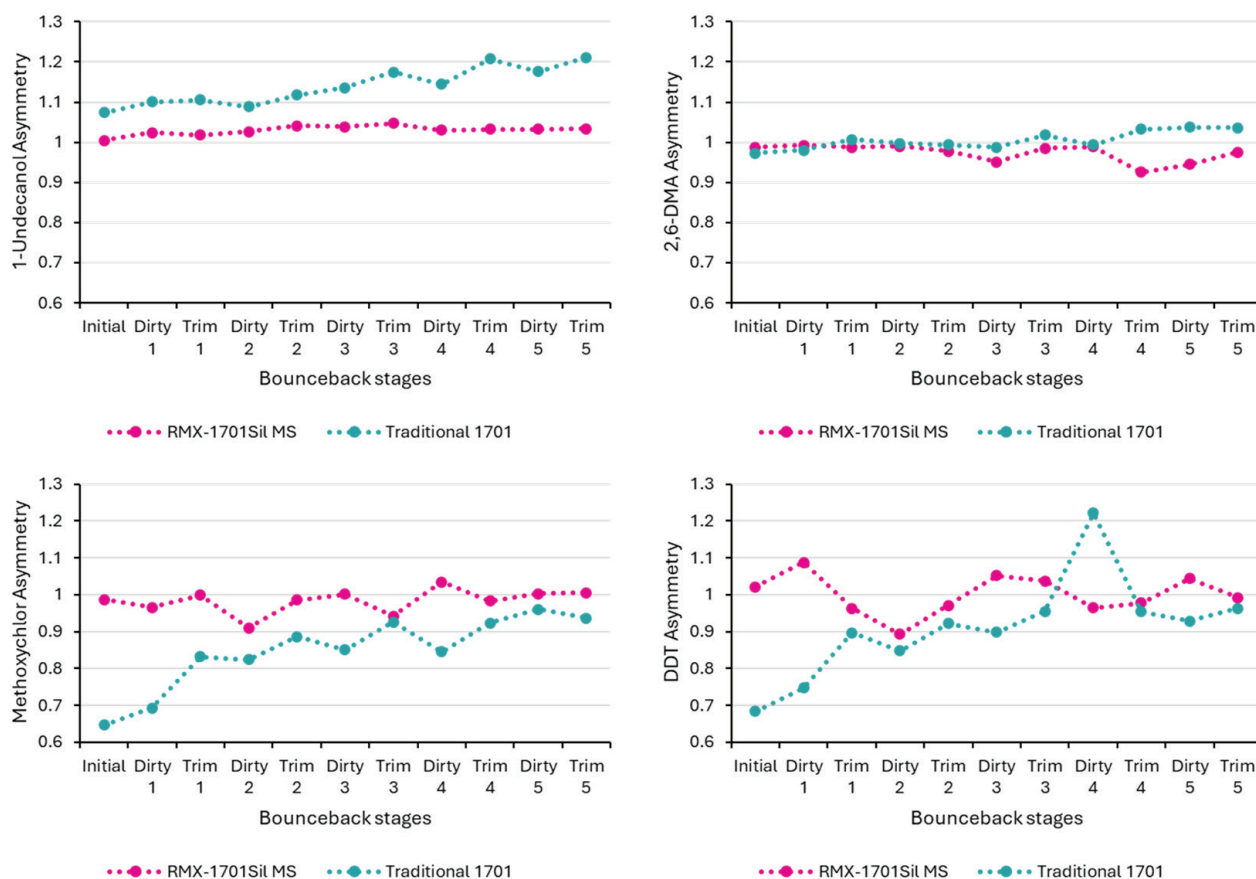
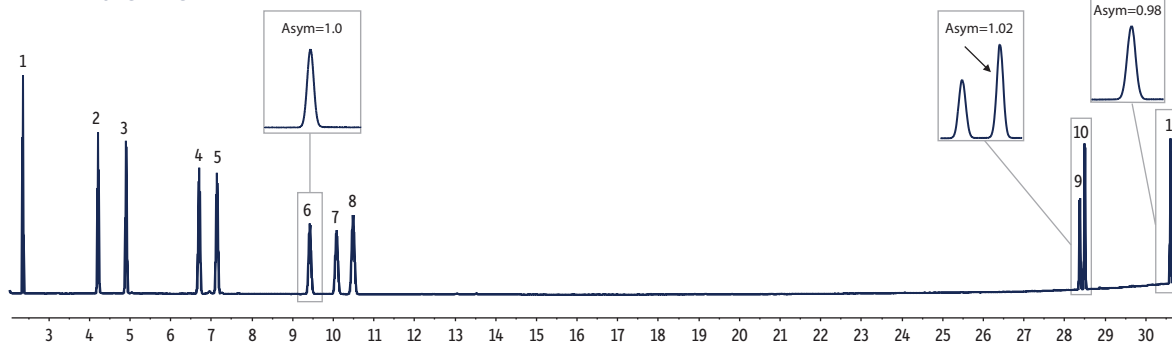
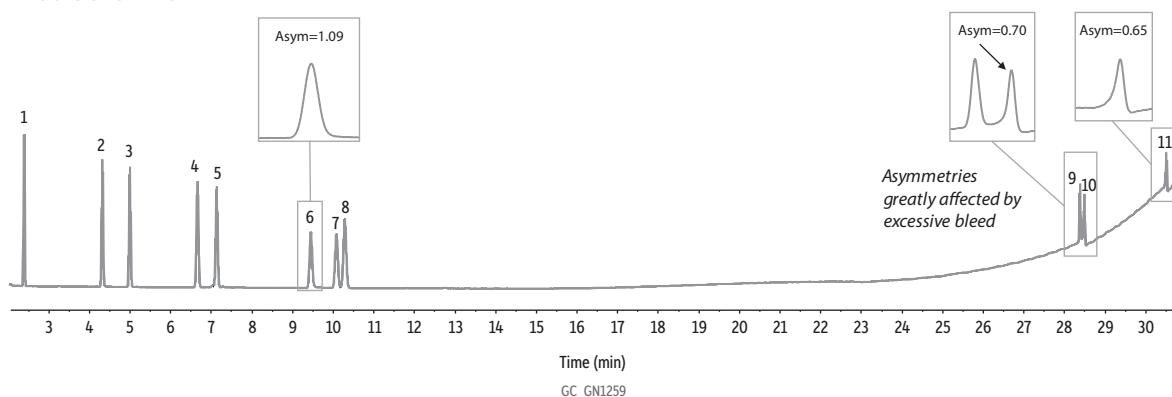


Figure 7: Initial QC Test (1 ppm on-column)

RMX-1701Sil MS



Traditional 1701

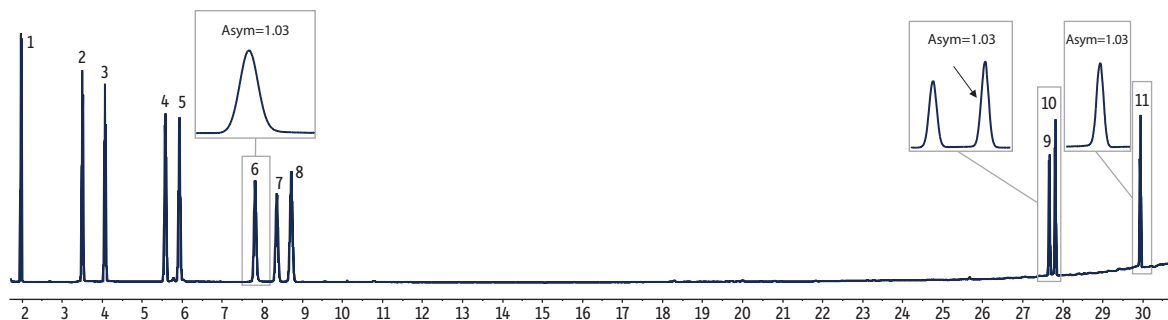


Peaks	t_r (min)	Conc. ($\mu\text{g/mL}$)
1. 3-Octanone	2.35	100
2. 2,6-Dimethylphenol	4.2	100
3. 2,6-Dimethylaniline	4.89	100
4. Tetradecane	6.68	100
5. 2-Methylnaphthalene	7.12	100
6. 1-Undecanol	9.41	100
7. Methyl undecanoate	10.07	100
8. Pentadecane	10.47	100
9. Endrin	28.36	100
10. 4,4-DDT	28.48	100
11. Methoxychlor	30.6	100

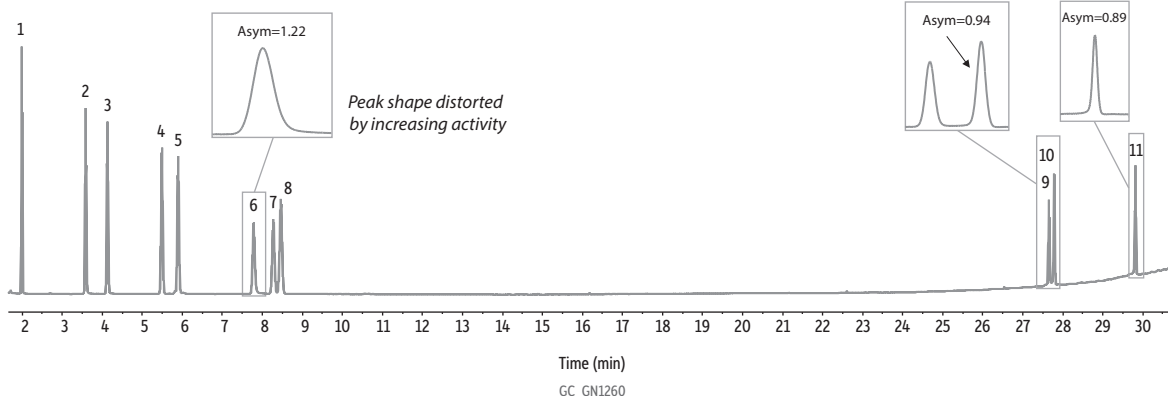
Column	RMX-1701Sil MS, 30 m, 0.25 mm ID, 0.25 μm (cat.# 17423)
Standard/Sample	Methoxychlor (cat.# 32233) Endrin aldehyde (cat.# 32468) 2,4'-DDT (cat.# 32200) Custom mix
Diluent:	1,2-Dichloroethane
Conc.:	100 $\mu\text{g/mL}$ Prepared by mixing 100 μL of cat.#s 32233, 32468, and 32200 with 200 μL of the custom mix and 500 μL of 1,2-dichloroethane for 100 $\mu\text{g/mL}$ of each analyte.
Injection	
Inj. Vol.:	1 μL split (split ratio 100:1)
Liner:	Topaz 4.0 mm ID Precision inlet liner w/wool (cat.# 23305)
Inj. Temp.:	250 $^{\circ}\text{C}$
Split Vent Flow Rate:	150 mL/min
Oven	
Oven Temp.:	130 $^{\circ}\text{C}$ (hold 15 min) to 300 $^{\circ}\text{C}$ at 10 $^{\circ}\text{C/min}$ (hold 10 min)
Carrier Gas	He, constant flow
Flow Rate:	1.5 mL/min
Linear Velocity:	37.78 cm/sec @ 130 $^{\circ}\text{C}$
Detector	FID @ 300 $^{\circ}\text{C}$
Make-up Gas Flow Rate:	35 mL/min
Make-up Gas Type:	N_2
Hydrogen flow:	40 mL/min
Air flow:	400 mL/min
Data Rate:	50 Hz
Instrument	Agilent 7890B GC

Figure 8: Final Post-Matrix Exposure and Maintenance QC Test (1 ppm on-column)

RMX-1701Sil MS



Traditional 1701



Peaks	t_r (min)	Conc. (µg/mL)
1. 3-Octanone	1.96	100
2. 2,6-Dimethylphenol	3.49	100
3. 2,6-Dimethylaniline	4.05	100
4. Tetradecane	5.56	100
5. 2-Methylnaphthalene	5.91	100
6. 1-Undecanol	7.81	100
7. Methyl undecanoate	8.35	100
8. Pentadecane	8.71	100
9. Endrin	27.65	100
10. 4,4-DDT	27.8	100
11. Methoxychlor	29.93	100

Column Standard/Sample

RMX-1701Sil MS, 30 m, 0.25 mm ID, 0.25 µm (cat.# 17423)

Methoxychlor (cat.# 32233)
Endrin aldehyde (cat.# 32468)
2,4'-DDT (cat.# 32200)

Diluent:

Custom mix

Conc.:

100 µg/mL 100 µg/mL Prepared by mixing 100 µL of cat.#s 32233, 32468, and 32200 with 200 µL of the custom mix and 500 µL of 1,2-dichloroethane for 100 µg/mL of each analyte.

Injection

Inj. Vol.: 1 µL split (split ratio 100:1)
Liner: Topaz 4.0 mm ID Precision inlet liner w/wool (cat.# 23305)
Inj. Temp.: 250 °C
Split Vent Flow Rate: 150 mL/min

Oven

Oven Temp.: 130 °C (hold 15 min) to 300 °C at 10 °C/min (hold 10 min)

Carrier Gas

He, constant flow
Flow Rate: 1.5 mL/min
Linear Velocity: 37.78 cm/sec @ 130 °C

Detector

FID @ 300 °C

Make-up Gas Flow Rate:

35 mL/min

Make-up Gas Type:

N₂

Hydrogen flow: 40 mL/min

Air flow: 400 mL/min

Data Rate: 50 Hz

Instrument: Agilent 7890B GC

Which Column Fared Best?

In summary, the RMX-1701Sil MS column produces rugged, low-bleed performance under extreme thermal challenge, indicating longer column lifetime compared to a traditional 1701 GC column. In addition, it provides greater, long-lasting, protection from matrix-based reactive sites for a wider range of analytes compared to traditional columns, which favored basic species at the expense of other compound types. For labs analyzing a diverse array of compounds, RMX-1701Sil MS columns are recommended based on their proven resilience under thermal and matrix challenges.

RMX-1701Sil MS GC Capillary Column

Catalog No.	Product Name	Units
17423	RMX-1701Sil MS GC Capillary Column, 30 m, 0.25 mm ID, 0.25 µm	ea.



Topaz Precision Inlet Liner

Catalog No.	Product Name	Units
23305	Topaz, Precision Inlet Liner, 4.0 mm x 6.3 x 78.5, for Agilent GCs, w/Quartz Wool, Premium Deactivation	5-pk.



Restek Electronic Leak Detector

Catalog No.	Product Name	Units
28500	Restek Electronic Leak Detector (includes carrying case; universal AC power adaptor [U.S., UK, Europe, Australia, Japan]; 6-ft USB charging cable)	ea.



Restek ProFLOW 6000 Electronic Flowmeter

Catalog No.	Product Name	Units
22656	Restek ProFLOW 6000 Electronic Flowmeter	ea.



Methoxychlor

Catalog No.	Product Name	Units
32233	Methoxychlor Standard, 1000 µg/mL, Methanol, 1 mL/ampul	ea.

Endrin Aldehyde

Catalog No.	Product Name	Units
32468	Endrin Aldehyde Standard, 1000 µg/mL in acetone, 1 mL/ampul	ea.



2,4'-DDT

Catalog No.	Product Name	Units
32200	2,4'-DDT Standard, 1000 µg/mL, Methanol, 1 mL/ampul	ea.



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