

# APPLICATIONS

## Determination of Residual Solvents and Terpenes in Cannabis by GC-FID using Zebron™ ZB-624PLUS™ GC Column

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*He has a PhD in Analytical Chemistry and a total of 14 years experience in chromatographic method development and troubleshooting. Ramkumar loves to write poems, read Shakespeare, and attend Shakespeare plays.*

### Introduction

While legalization of medical and recreational marijuana is proliferating more and more throughout North America, the use of cannabis remains illegal on a federal level in the United States. As such, the range of volatile contaminants, such as residual solvents, have diverse ranges of regulatory guidance on a state by state basis. In addition, terpenes account for the flavor and aroma of cannabis and its profiling via GC-FID is a very important tool in identifying and quantifying terpenes in cannabis products for both quality and branding purposes.

624-type phases are common for pharmaceutical residual solvents due to their excellent selectivity for USP General Chapter <467> residual solvents, which are generally consistent with typical residual solvents to examine in cannabis and cannabis products. Some unique challenges with cannabis residual solvents arrive from some additional light solvents, like butane and isobutane that are difficult to retain with the typical 624 selectivity, as well as some heavier terpenes that one might want to quantify together, or, even if analyzing separately, would still have to elute from the column at a higher temperature than a traditional 624-type phase is stable to.

Provided in this technical note is a method for both residual solvents and terpenes in one column. The sample has both light and heavy boiling analytes. While common practice is to use a traditional 624 selectivity for residual solvents and go for a low polar 5% phenyl phase with a thin film for terpene analysis, here we utilized the versatile 624 selectivity and high temperature limit of the Zebron ZB-624PLUS to provide a one column solution to cannabis residual solvent and terpenes testing via GC-FID.



### Experimental Conditions

#### Residual Solvents

**Column:** Zebron ZB-624PLUS  
**Dimensions:** 30 meter x 0.25 mm x 1.40 μm  
**Part No.:** 7HG-G040-27  
**Recommended Z-Guard™:** 7CG-G000-00-GHK  
**Injection:** Split 10:1 @ 250 °C, 1 μL  
**Recommended Liner:** Zebron PLUS Straight Z-Liner™  
**Liner Part No.:** AG2-OA03-05 (for Agilent® and Thermo Scientific® systems)  
**Carrier Gas:** Helium @ 1.0 mL/min (constant flow)  
**Oven Program:** 35 °C for 4 min, 50 °C @ 20 °C/min for 1 min, 160 °C @ 10 °C/min for 4 min, 300 °C @ 15 °C/min for 5 min  
**Detector:** FID @ 240 °C  
**Sample:** See Table 1.

#### Terpenes

**Column:** Zebron ZB-624PLUS  
**Dimensions:** 30 meter x 0.25 mm x 1.40 μm  
**Part No.:** 7HG-G040-27  
**Recommended Z-Guard™:** 7CG-G000-00-GHK  
**Injection:** Split 10:1 @ 250 °C, 1 μL  
**Recommended Liner:** Zebron PLUS Straight Z-Liner™  
**Liner Part No.:** AG2-OA03-05 (for Agilent® and Thermo Scientific® systems)  
**Carrier Gas:** Helium @ 1.0 mL/min (constant flow)  
**Oven Program:** 50 °C for 1 min, 160 °C @ 10 °C/min, hold for 4 min, 280 °C @ 12 °C/min  
**Detector:** FID @ 300 °C  
**Sample:** See Table 1.

**Table 1.**  
Residual Solvents  
**Figure 1**

Compound	RT(min)
1. Propane	2.476
2. Isobutane	2.793
3. n-Butane	3.071
4. Neopentane	3.204
5. Methanol	3.477
6. Ethylene Oxide	3.645
7. n-Pentane	4.57
8. Ethanol	4.723
9. 2-Propanol	5.372
10. Acetone	5.666
11. Acetonitrile	5.877
12. n-Hexane	7.136
13. THF	8.656
14. Chloroform	8.806
15. Carbon Tetrachloride	9.254
16. n-Heptane	9.54
17. Benzene	9.951
18. Toluene	12.265
19. n,n-Dimethyl Formamide	13.877
20. m,p-Xylene	14.572
21. o-Xylene	15.126
22. n,n-Dimethyl Acetamide	16.295

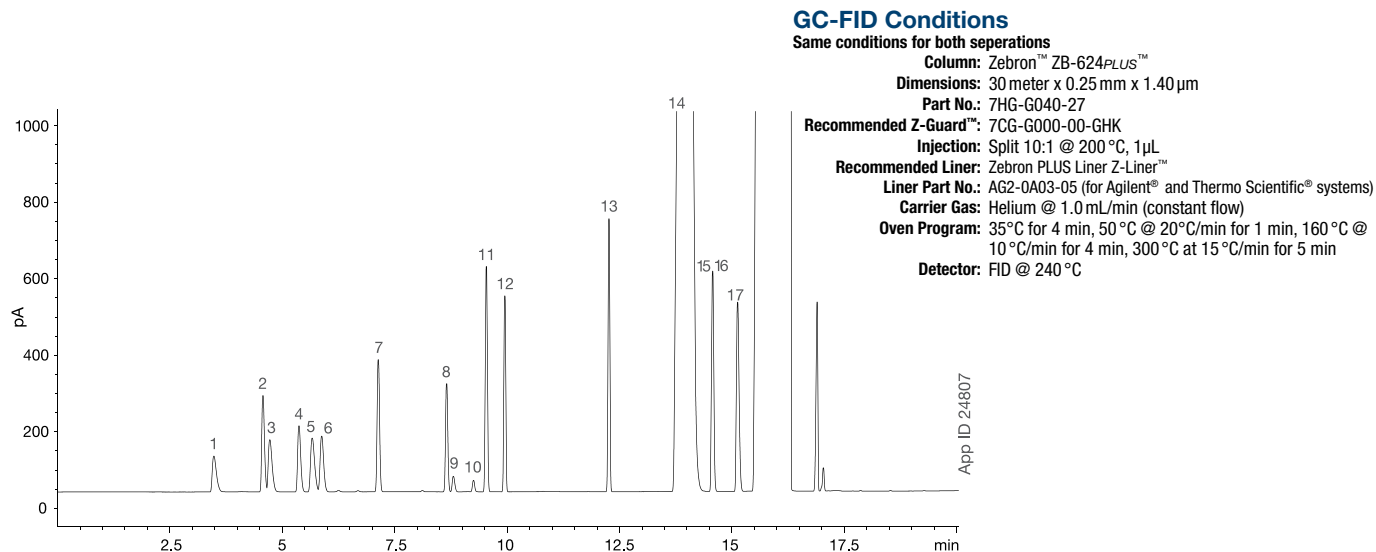
Terpenes  
**Figure 2**

Compound	RT(min)
1. α Pinene	10.987
2. Camphene	11.399
3. β-Myrcene	11.83
4. (-)-β-3-Pinene	11.917
5. Δ-3-Carene	12.369
6. α Terpinene	12.543
7. d-Limonene	12.621
8. p-Cymene	12.756
9. Ocimene	12.818
10. γ-Terpinene	12.916
11. Terpinolene	13.291
12. Linalool	13.941
13. Isopulegol	14.708
14. Geraniol	16.515
15. β-Caryophyllene	18.74
16. α Humulene	21.738
17. Nerolidol 1	22.274
18. Nerolidol 2	23.097
19. Guaiol	23.485
20. α Bisabolol	23.485



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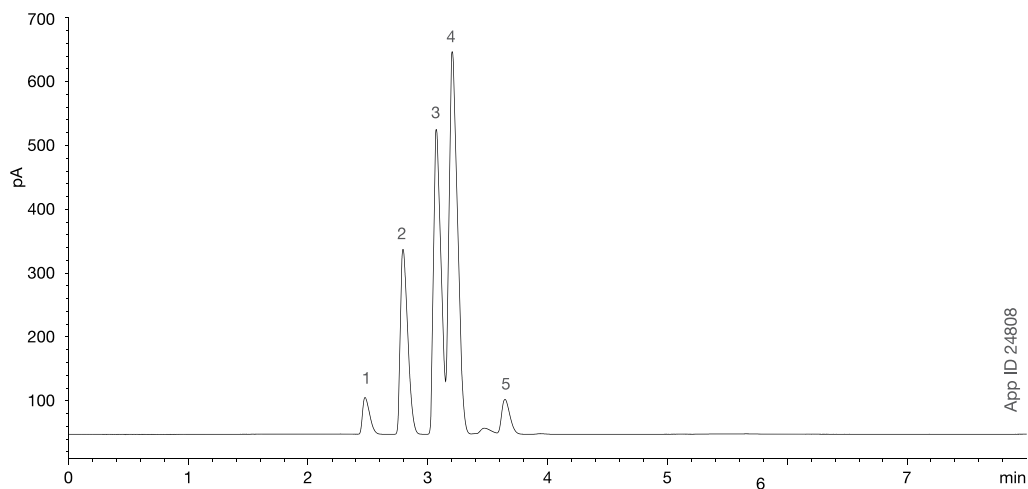
**Figure 1a.**  
Cannabis Residual Solvents (17 mix).



Emerald Scientific Residual Solvent standards STRS01024 at 1000 μg/mL

1. Methanol	10. Carbon Tetrachloride
2. n-Pentane	11. n-Heptane
3. Ethanol	12. Benzene
4. 2-Propanol	13. Toluene
5. Acetone	14. Dimethylformamide
6. Acetonitrile	15. m-Xylene
7. n-Hexane	16. p-Xylene
8. THF	17. o-Xylene
9. Chloroform	

**Figure 1b.**  
Low Boiling Cannabis Residual Solvents



Emerald Scientific Residual Solvent standards STRS01075 at 500-5000 μg/mL

1. Propane
2. 2-Methylpropane
3. n-Butane
4. Neopentane
5. Ethylene Oxide

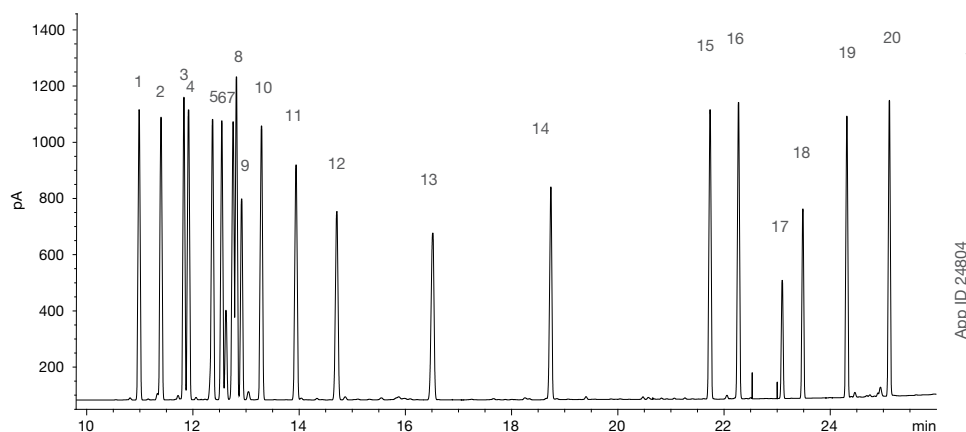
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## GC-FID Conditions

**Column:** Zebron™ ZB-624<sup>PLUS</sup>™  
**Dimensions:** 30 meter x 0.25 mm x 1.40 μm  
**Part No.:** 7HG-G040-27  
**Recommended Z-Guard™:** 7CG-G000-00-GHK  
**Injection:** Split 20:1 @ 250°C, 1μL  
**Recommended Liner:** Zebron PLUS Straight Z-Liner™  
**Liner Part No.:** AG2-0A03-05 (for Agilent® and Thermo Scientific® systems)  
**Carrier Gas:** Helium @ 1 mL/min (constant flow)  
**Oven Program:** 50 °C for 1 min, 160 °C @ 10 °C/min, hold for 4 min, to 280 °C @ 12 °C/min  
**Detector:** FID @ 300 °C  
**Sample:**

1. α-Pinene	11. Terpinolene
2. Camphene	12. Linalool
3. β-Myrcene	13. Isopulegol
4. (-)-β-Pinene	14. Geraniol
5. Δ-3-Carene	15. β-Caryophyllene
6. α-Terpinene	16. α-Humulene
7. d-Limonene	17. Nerolidol 1
8. Δ-Cymene	18. Nerolidol 1
9. Ocimene	19. Guaiol
10. γ-Terpinene	20. α-Bisabolol

**Figure 2.**  
20 Terpene Standards Chromatogram at 2500 μg/mL



## Results and Discussion

Described in **Figure 1 a and b** is an excellent scenario for 624-type selectivity that benefits from low bleed and higher temperature stability. The new Zebron ZB-624<sup>PLUS</sup> provides retention and selectivity for low and high boiling residual solvents, with low bleed. The small ID of 0.25 mm provides high efficiency which helps to resolve critical pairs. **Figure 2** demonstrates the separation of 20 terpenes from cannabis using the same column without the need to change to a nonpolar column. This is possible because of the high temperature limit of 300/320 °C of the Zebron ZB-624<sup>PLUS</sup>. The ZB-624<sup>PLUS</sup> not only has a thick film to retain low boiling permanent gases like butane and isobutane, but also has an upper temperature limit of 300/320 °C which gives the flexibility to elute out high boiling solvents and separate terpenes, all on one column. This prevents the hassle of changing multiple column for cannabis analysis.

## Conclusions

While common practice is to use multiple selectivity columns for testing residual solvents and terpenes from cannabis via GC-FID. The Zebron ZB-624<sup>PLUS</sup> with retention and selectivity for low and high boiling residual solvents, high efficiency, low bleed, an upper temperature limit of 300/320 °C, and is GC-MS certified, serves as a one column solution to analyze terpenes and residual solvents from cannabis for both safety and quality purposes.



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## Ordering Information

### Zebtron™ PLUS Liners

Description	Application	Inlet Style	Dimensions ID x L (mm)	Deactivation	Part No.	Unit
<b>For 5890, 6890 and 7890 Models</b>						
Straight Z-Liner™ 	Dirty samples, Volatiles, High initial oven temperatures	S/SL	4 x 78.5	PLUS Inert	AG2-0A03-01 AG2-0A03-05 AG2-0A03-25	ea 5/pk 25/pk

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anfrage@phenomenex.com

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### Zebtron ZB-624<sup>PLUS</sup>™ GC Columns

ID (mm)	df (µm)	Temp. Limits °C	Part No.
<b>20-Meter</b>			
0.18	1.00	-20 to 300/320	7FD-G040-22
<b>30-Meter</b>			
0.25	1.40	-20 to 300/320	7HG-G040-27
0.32	1.80	-20 to 300/320	7HM-G040-31
0.53	3.00	-20 to 300/320	7HK-G040-36
<b>60-Meter</b>			
0.25	1.40	-20 to 300/320	7KG-G040-27
0.32	1.80	-20 to 300/320	7KM-G040-31
0.53	3.00	-20 to 300/320	7KG-G040-36

Note: If you need a 5 in. cage, simply add a (-B) after the part number, e.g. 7HG-G040-27-B. Some exceptions may apply. Agilent 6850 and some SRI and process GC systems use only 5 in. cages.



If Phenomenex products in this technical note do not provide at least an equivalent separation as compared to other products of the same phase and dimensions, return the product with comparative data within 45 days for a FULL REFUND.

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