APPLICATIONS

A Means of Improving the Resolution Between Acetaldehyde and Methanol in the Limit Test for 96% Ethanol (Ph.Eur.1317)

Zachary Woodward and Heiko Behr
Phenomenex, Inc., 411 Madrid Avenue., Torrance, CA 90501 USA
Data courtesy of WZZ Herbapol S, Katarzyna Piechota, Senior Assistant of Laboratory Quality Control

Introduction

The European Pharmacopoeia has published a gas chromatography method for the purity analysis of 96% ethanol (Ph. Eur. Monograph 1317; Supplement 10), which stipulates that the peaks for residual amounts of acetaldehyde and methanol be resolved from one another with a minimum resolution factor of 1.5. Acetaldehyde and methanol can be challenging to resolve from one another within the confines of this method, however baseline resolution is imperative for the purity analysis of ethanol. The Ph. Eur. method specifies the use of a poly[(cyanopropylphenyl)-(dimethyl)]siloxane capillary GC column, for which the Zebron™ ZB-624 has been demonstrated to suitably resolve acetaldehyde from methanol.

Acetaldehyde is a precursor to ethanol during fermentation and is also classified as an irritant and carcinogen in humans. The ingestion of relatively low amounts of methanol (as little as 3 – 20 mL) can result in acute central nervous system toxicity in humans. This European Pharmacopoeia (Ph. Eur.) monograph was developed as a limit test for the determination of low levels of acetaldehyde and methanol in 96% ethanol solutions.

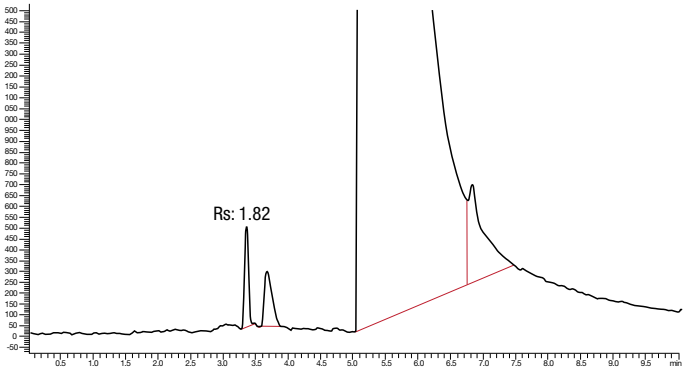
Operating conditions for GC methods that are published by the European Pharmacopoeia may be adjusted within certain allowable limits to further improve the existing method, or to overcome limitations of the instrument used during analysis. These allowances include adjusting the oven temperature to within ±10% and the flow rate to within ±50% of their respective published values. The ZB-624 column was demonstrated to suitably resolve acetaldehyde and methanol upon making adjustments within these allowable limits.

Materials and Methods

Sample Preparation:

"Reference Solution b" was prepared as per Ph. Eur. Monograph 1317; Supplement 10, for which 50 µL of acetaldehyde and 50 µL of anhydrous methanol were diluted to 50 mL with the ethanol sample. A 100 µL aliquot of this spiking solution was transferred to a 10 mL volumetric flask and diluted to volume with ethanol for analysis.

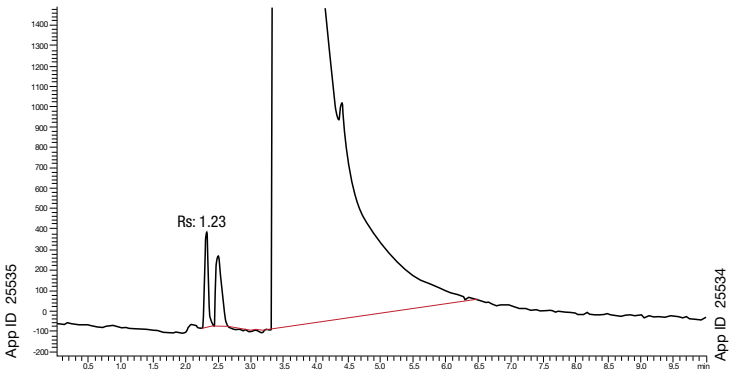
Figure 1.
Chromatogram for Ethanol Analysis on ZB-624 using Modified Method Parameters



GC-FID Method Parameters - Modification of Ph. Eur. Monograph 1317; Supplement 10

Column: Zebron ZB-624
Dimensions: 30 meter x 0.32 mm x 1.80 µm
Part No.: 7HM-G005-31
Injection: Split 20:1 @ 200 °C, 1 µL
Recommended Liner: Zebron PLUS Straight Z-Liner
Liner Part No.: AG2-0A03-05 (for Agilent® & Thermo Scientific® systems)
AG2-4B03-05 (for Shimadzu® systems)
Carrier Gas: Helium @ 25 cm/sec (linear velocity)
Oven Program: 36 °C for 12 min, to 260 °C at 10 °C/min for 15 min
Detector: FID @ 280 °C
Sample: 10 ppm additional spike in 96% ethanol sample
1) Acetaldehyde
2) Methanol

Figure 2.
Original Chromatogram for Ethanoll Analysis on ZB-624



GC-FID Method Parameters – Original Ph. Eur. Monograph 1317; Supplement 10

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Liner Part No.: AG2-0A03-05 (for Agilent® & Thermo Scientific® systems)
AG2-4B03-05 (for Shimadzu® systems)
Carrier Gas: Helium @ 35 cm/sec (linear velocity)
Oven Program: 40 °C for 12 min, to 260 °C at 10 °C/min for 15 min
Detector: FID @ 280 °C
Sample: 10 ppm additional spike in 96% ethanol sample
1) Acetaldehyde
2) Methanol

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Results and Discussion

The ZB-624 afforded a resolution factor of 1.82 between acetaldehyde and methanol upon making suitable adjustments to Ph. Eur. Monograph 1317; Supplement 10 within the range of allowed adjustments, as shown in **Figure 1**. The original method was only able to generate resolution factors up to 1.23 across a selection of equivalent phases that shared the same column dimensions and film thickness, as shown in **Figure 2**.

"Reference Solution b" is spiked to approximate 10 ppm each of acetaldehyde and methanol with respect to ethanol. The original Ph. Eur. method calls for an initial isothermal hold of 40 °C for 12 minutes, while a lower isothermal hold of 36 °C allows for increased retention of the targeted impurities, and therefore increased separation. The original Ph. Eur. method also calls for a linear velocity of 35 cm/sec, whereas a lower flow-rate of 25 cm/sec affords more opportunities for mass transfer of the target impurities into and out of the stationary phase. Furthermore, the lower flow-rate preserves the integrity of the narrow analytical bands for each analyte as they transfer between the carrier gas and stationary phase at a lower temperature.

The lower isothermal hold of 36 °C is within the allowable ±10% adjustment to the original temperature of 40 °C. Likewise, the lower flow-rate is well within the allowable ±50% adjustment to the original 35 cm/sec flow of the published Ph. Eur. method.

Conclusion

The selectivity of the Zebron ZB-624 column is particularly adept at resolving acetaldehyde from methanol when making allowable adjustments to the Ph. Eur. Monograph 1317; Supplement 10 analytical method. The resulting resolution is well above the minimum value that is stipulated within the monograph, affording the analyst leeway for fluctuations in GC instrument performance, and for routine cutting of each column end during repeated installations of the column. The combined levels of acetaldehyde and other acetal impurities within the ethanol sample may not exceed 10 ppm, and the ZB-624 column affords the resolution required to separate acetaldehyde from methanol for quantitative determination.

References

1. European Pharmacopeia 10, Section 2.2.46, (2019)

Ordering Information

Zebron ZB-624 GC Columns

ID(mm)	df(µm)	Temp. Limits °C	Part No.
20-Meter			
0.18	1.00	-20 to 260	7FD-G005-22
30-Meter			
0.25	1.40	-20 to 260	7HG-G005-27
0.32	1.80	-20 to 260	7HM-G005-31
0.53	3.00	-20 to 260	7HK-G005-36
60-Meter			
0.25	1.40	-20 to 260	7KG-G005-27
0.32	1.80	-20 to 260	7KM-G005-31
0.53	3.00	-20 to 260	7KK-G005-36
75-Meter			
0.53	3.00	-20 to 260	7LK-G005-36
105-Meter			
0.53	3.00	-20 to 260	7NK-G005-36

Note: If you need a 5 in. cage, simply add a (-B) after the part number, e.g., 7HG-G005-27-B. Some exceptions may apply. Agilent 6850 and some SRI and process GC systems use only 5 in. cages.

Australia
t: +61 (0)2-9428-6444
auinfo@phenomenex.com

Austria
t: +43 (0)1-319-1301
anfrage@phenomenex.com

Belgium
t: +32 (0)2 503 4015 (French)
t: +32 (0)2 511 8666 (Dutch)
beinfo@phenomenex.com

Canada
t: +1 (800) 543-3681
info@phenomenex.com

China
t: +86 400-606-8099
cninfo@phenomenex.com

Denmark
t: +45 4824 8048
nordicinfo@phenomenex.com

Finland
t: +358 (0)9 4789 0063
nordicinfo@phenomenex.com

France
t: +33 (0)1 30 09 21 10
franceinfo@phenomenex.com

Germany
t: +49 (0)6021-58830-0
anfrage@phenomenex.com

India
t: +91 (0)40-3012 2400
indiainfo@phenomenex.com

Ireland
t: +353 (0)1 247 5405
eireinfo@phenomenex.com

Italy
t: +39 051 6327511
italiainfo@phenomenex.com

Luxembourg
t: +31 (0)30-2418700
nlinfo@phenomenex.com

Mexico
t: 01-800-844-5226
tecnicomx@phenomenex.com

The Netherlands
t: +31 (0)30-2418700
nlinfo@phenomenex.com

New Zealand
t: +64 (0)9-4780951
nzinfo@phenomenex.com

Norway
t: +47 810 02 005
nordicinfo@phenomenex.com

Portugal
t: +351 221 450 488
ptinfo@phenomenex.com

Singapore
t: +65 800-852-3944
sginfo@phenomenex.com

Spain
t: +34 91-413-8613
espinfo@phenomenex.com

Sweden
t: +46 (0)8 611 6950
nordicinfo@phenomenex.com

Switzerland
t: +41 61 692 20 20
swissinfo@phenomenex.com

United Kingdom
t: +44 (0)1625-501367
ukinfo@phenomenex.com

USA
t: +1 (310) 212-0555
info@phenomenex.com

All other countries
Corporate Office USA
t: +1 (310) 212-0555
info@phenomenex.com

www.phenomenex.com

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