

Single Column GC/MS Analysis of the 12 Polychlorinated Biphenyls (PCBs) Designated as Toxic by the World Health Organization (WHO)

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Introduction

Polychlorinated Biphenyls (PCBs) are a class of priority environmental pollutants that have been identified for international regulation. Until 1977, PCBs were commonly used as an insulator in transformers and capacitors, as well as for other industrial applications. Their high chemical stability has made them a persistent environmental pollutant subject to long-range transport and bioaccumulation.

The World Health Organization (WHO) has identified 12 of the 209 congeners to have toxicity characteristics similar to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). These "dioxin-like" PCBs have been assigned Toxic Equivalency Factors (TEF) relative to the 2,3,7,8-TCDD isomer. The identification of these compounds is specified by EPA Method 1668, Revision A. This method requires confirmation using two different GC columns in order to completely resolve all 12 isomers.

The current work greatly simplifies this analysis by providing resolution of all 12 toxic congeners using one column: the Zebron ZB-5ms column (Phenomenex, Inc., Torrance, CA, USA). The phase utilizes a Si-Arylene bonded polymer that has been demonstrated to provide enhanced resolution of multi-aromatic compounds.

Results and Discussion

All 12 WHO toxic congeners were resolved from other congeners having the same level of chlorination using the Zebron™ ZB-5ms column. Isomers 107, 123, and 144 showed close elution with surrounding isomers. However, separation of the isomers was within EPA Method 1668A guidelines. Improved resolution is expected when using a high-resolution mass spectrometer (HRMS) due to the fast scan rate possible with this type of instrument.

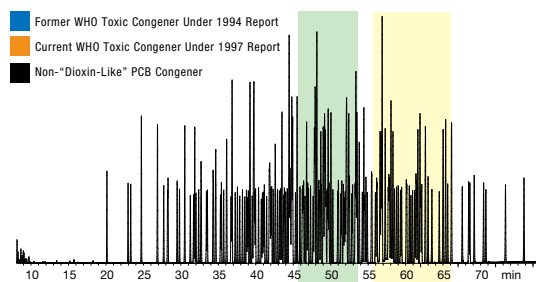
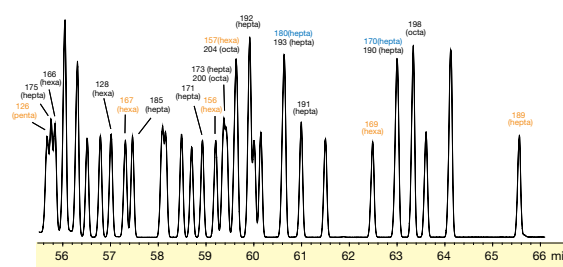
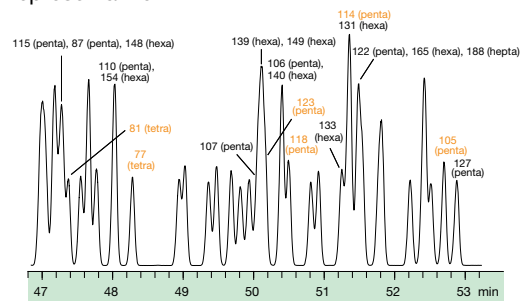
Separation of isomers with differing degrees of chlorination, such as a hexa vs. penta, was not necessary when using MSD. However, there are secondary ions, which are shared between certain chlorination levels, that affect quantitation when using low-resolution MS systems. HRMS instruments are capable of distinguishing congeners with different levels of chlorination without interference from secondary ions.

Method run time meets EPA Method 1668A specifications with decachlorobiphenyl (DCB) eluting past 55 minutes. Further work has been done that demonstrates this method can be shortened while maintaining similar resolution (data not shown).

Achieving separation of all toxic congeners using a single column eliminates the need for second column confirmation. The two columns identified by EPA Method 1668A are unable to resolve at least one pair of isomers each, including 118/106 and 156/157.

Congeners 118, 156, and 157 are environmentally abundant and can cause the Toxic Equivalent (TEQ) value of a sample to exceed the reporting limit, thereby requiring confirmation.

For additional information or to receive a copy of the full PCB analysis application note, please contact your local Phenomenex representative.



GC/MS Conditions

Column: Zebron ZB-5ms
Dimensions: 60 meter x 0.25 mm x 0.25 μm
Part No.: 7KG-G010-11
Injection: Splitless @ 280 °C for 0.5 min (1 μL)
Carrier Gas: Helium (UHP Grade) at 1.1 mL/min (constant flow)
Oven Program: 60 °C for one minute to 140 °C at 25 °C/min to 290 °C at 2 °C/min
Detector: MSD; 35-510 amu

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