Improving Safety, Productivity, and Decreasing Waste in the Chemical Industry with the Polyarc® Reactor

A Dow Chemical Poster Review

Summary

Chemical analysis is essential in the production and formulation of chemicals. As such, the chemical industry is one of the largest users of gas chromatography, most often utilizing flame ionization detection (FID) due to its high sensitivity, wide linear range over 7 orders of magnitude, robustness, and low cost of operation and maintenance.

In this article, we highlight recent advances in the chemical industry to improve productivity, increase safety, and reduce waste through the concept of compound independent calibration using the Polyarc® reactor. The concepts and findings are gleaned from poster #I-15[1], presented at the 42nd International Symposium on Capillary Chromatography (ISCC) in Riva del Garda, Italy on May 13-18th, 2018 by researchers at the Dow Chemical Company (Dow).

Problem

In the chemical industry, the determination of product quality, purity, and safety require the quantification of complex mixtures in various difficult matrices. These analyses remain a significant challenge due to the complexity of the samples and the need for multi-level calibration to account for the varied response of molecules in the detector. The most common detector, the FID, responds to organic molecules with a response that depends on the chemical structure of the analyte, and this response cannot be determined a priori. In addition, highly functionalized molecules, such as carbon monoxide, carbon dioxide, formaldehyde, carbon disulfide, and formic acid, have marginal response by the FID.

Solution

In poster I-15, researchers at Dow described their work with the Polyarc® system. The performance of the Polyarc was evaluated in terms of conversion efficiency (Figure 1), universal carbon response, impact on separation efficiency, and robustness. The researchers demonstrated the utility of this post-column reactor through a number of challenging chromatographic conditions across various industrial applications.

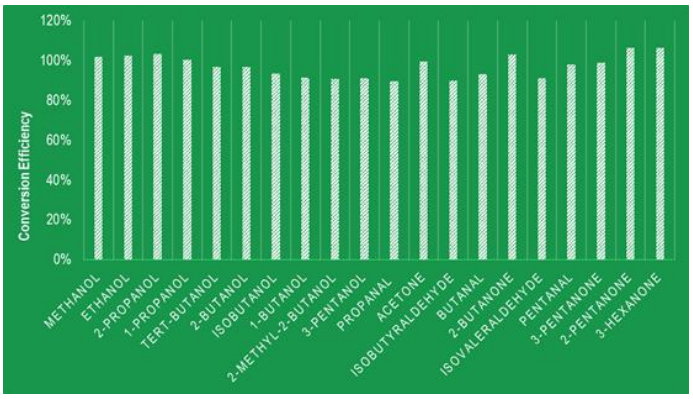

Figure 1. Conversion efficiencies of oxygenate mixture in water[1]

Conclusion

Key findings reported in the poster include:

1. The Polyarc ® system provides a universal response for carbon-containing molecules with relative response factors close to 1 (±10%). This allows for the capability of compound independent calibration for quantifying organic compounds with various functionalities, using one reference compound, saving time, and cost associated with calibrations.

2. The Polyarc ® technique can enhance sensitivity for compounds with low or no response in traditional FID.

3. Polyarc system's unique internal geometries and catalyst design maintain separation performance and peak symmetry.

Additional Considerations

Through this study, researchers at Dow also reported a few constraints encountered when using the Polyarc system. The performance of the Polyarc should be monitored periodically with control standards for indication of catalyst degradation and oxidation of inert transfer lines in the system. The catalytic cartridge needs to be replaced when it reaches the end of its life to maintain proper performance. The cartridge has a performance warranty for six months. Finally, the researchers observed that acetylene had a low conversion efficiency; this could be due to adsorption or carbonation.

® = Polyarc is a registered trademark of Activated Research Company

Reference:

[1]Hua, Y.; Gras, R.; Yang, P.; Luong, J. Post Column Reaction Gas Chromatography with a 3D Printed Steel Dual Stage Microreactor. International Symposium on Capillary Chromatography (ISCC), Riva del Garda, Italy, May 13-18th, 2018. I-15.