Gas Composition Analysis During Tank Loading on a Ship Using an Agilent 490 Micro GC

Application Note

Micro Gas Chromatography, Mobile Measurement, Process Control

Authors

Capt. Deepak Tandel and Vikram Mutyala, Maersk Tankers, Singapore; Sheue-Wen Ong and Remko van Loon, Agilent Technologies, Singapore and the Netherlands.

Abstract

Bulk gaseous chemicals are not necessarily used close to their production site. Maersk Tankers operate a large fleet and transport these industrial chemicals globally. This application note describes how an Agilent 490 Micro GC was used on-board to monitor 1,3-butadiene levels in a tank during loading a cargo vessel.

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Introduction

Bulk chemicals are shipped around the world for multiple uses. Production of plastics is one of the applications for these industrial chemicals. Maersk Tankers owns and operates a large fleet of crude oil carriers, product tankers, and gas carriers; all built and operated in accordance with the highest standards for quality and reliability.

A 490 Micro GC was installed on-board of a Maersk tanker, a 154.7 meter long vessel with a total tank capacity of approximately 22.000 m^3. The 490 Micro GC was used for analysis of the gas composition during loading of the tanks. Vinyl chloride monomer (VCM), 1,3-butadiene and propylene are some of the compounds shipped and tested on the Maersk's tankers. This application note shows an example of 1,3-butadiene.

Micro GC setup and conditions

A 490 Micro GC equipped with a 10 meter PoraPLOT U column channel and portable field case was used for the analysis of the gas composition in the vessel's cargo tanks (Figure 1). The portable field case provides on-the-go measurements using built-in carrier gas cylinders and rechargeable batteries. A front inlet option was installed resulting in a luer-lock connection sample inlet at the front of the 490 Micro GC. Agilent OpenLAB CDS EZChrom Edition was used for data acquisition and results generation. Table 1 presents an overview of the 490 Micro GC method setting.

Figure 1. Agilent 490 Micro GC with portable field case.

Table 1. Micro GC Settings.

	Analytical column channel: PoraPLOT U, 10 m
Column temperature	120 °C
Carrier gas	helium, 150 kPa
Injection time	20 milliseconds
Sampling time	25 seconds

Results and Discussion

Before loading, the ship tanks were filled with nitrogen gas. The compound gas (vinyl chloride, 1,3-butadiene, or propylene) was injected into the tank to replace nitrogen. The specific gravity of these compounds was higher than nitrogen, as a result the compound gas sank to the bottom and the tank filled from bottom to top. During this process, which can take up to 18 hours, Maersk monitored the tank at three levels, as shown in Figure 2. The tank was slightly pressurized. After flushing the sample line, a sample was taken using a 10-mL luer-lock syringe and directly injected onto the 490 Micro GCs' front luer-lock sample inlet. The results from the 490 Micro GC were used to follow the filling process and, as a conformation, the tank was fully filled with compound gas.

When all nitrogen was replaced, the cargo tank was cooled below the compounds boiling point and liquid compound was injected to fill the tank. Nitrogen would not condense at this temperature; therefore it is very important that all nitrogen was replaced with compound gas.

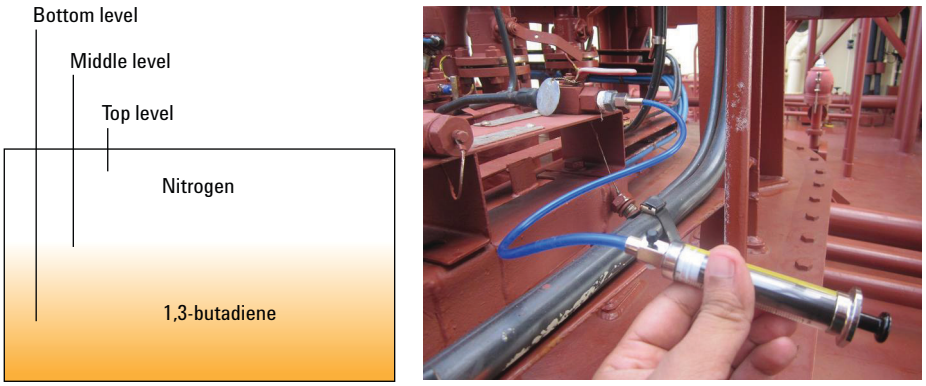

Figure 2. Schematic setup of the tank and its sampling points (left); taking a gas sample using a 10 mL luer-lock syringe (right).

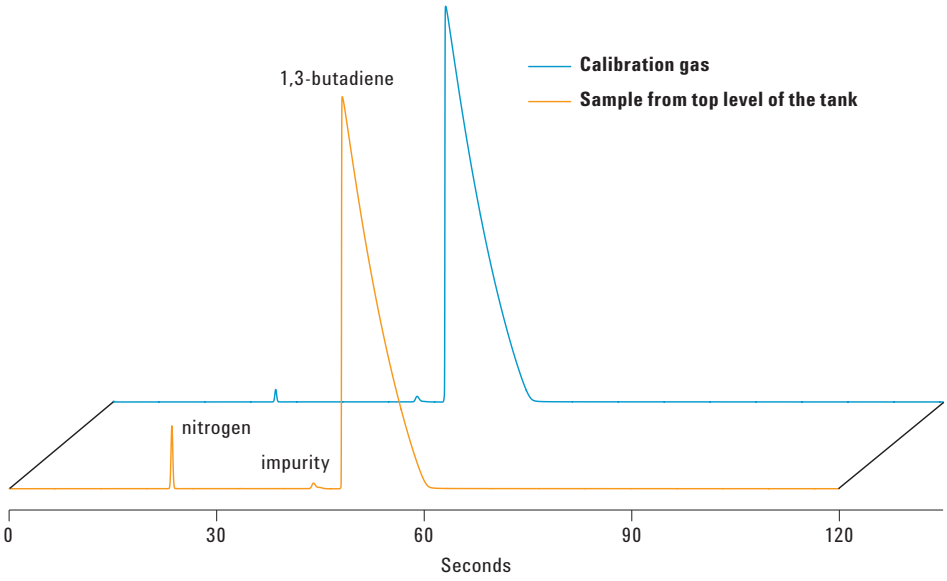

Figure 3. Overlay chromatograms calibration gas and a sample from top of the tank during loading of 1,3-butadiene.

In this example, the vessel was loaded with 1,3-butadiene. The inlet stream of the vessel was used to calibrate the 490 Micro GC; the gas from this stream was analyzed and the 1,3-butadiene concentration was set to 100%. All samples from the tank were correlated to this calibration. Figure 3 shows an overlay of a calibration gas chromatogram and a chromatogram taken from the top level of the tank at the point the tank was almost filled (98.9%) with gaseous 1,3-butadiene. The sample chromatogram and external calibration result shows the tank was almost filled with 1,3-butadiene, with only a small amount of nitrogen left in the tank.

After analysis, an external standard report was displayed on the screen, showing the percentage level of 1,3-butadiene in the cargo tank (Figure 4).

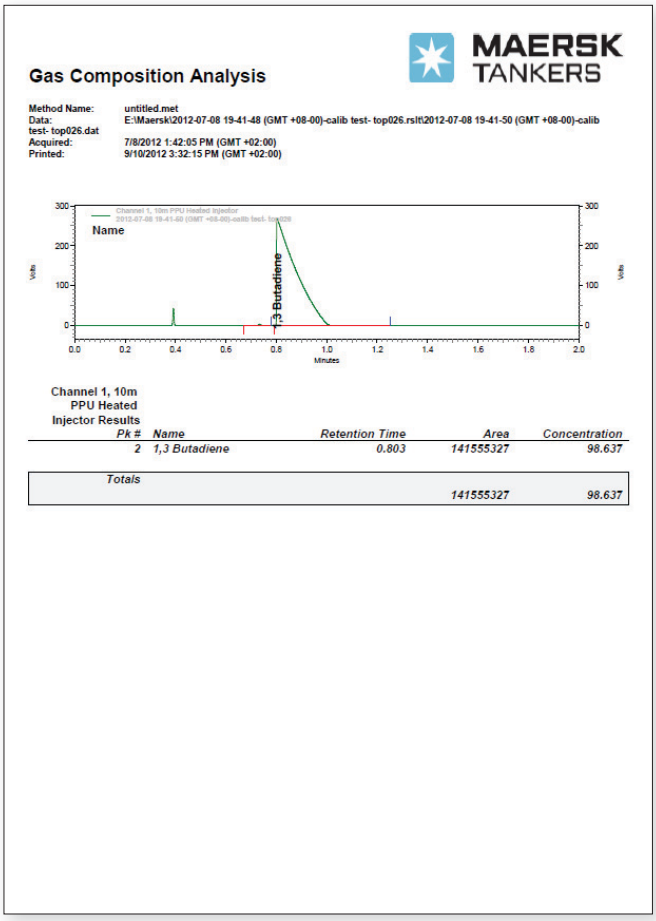

Figure 4. External standard report from OpenLAB CDS EZChrom Edition.

Conclusion

This application note clearly shows the advisability of using 490 Micro GC when analyzing the gas composition in an on-board cargo tank during the loading of 1,3-butadiene. Fast and precise results were obtained, resulting in better informed decision making.

For Maersk, it is very important to use the full capacity of the tanks, therefore, fast and accurate analysis of gas composition in the tanks during loading of the vessels was required. The 490 Micro GC was used to check that nitrogen was fully replaced with component gas before the tanks were chilled and loaded with liquid chemical.

With the 490 Micro GC, out-of-the-lab gas analysis is made easy. Compact in size and weight, the instrument can easily be transported in the portable field case.

For More Information

These data represent typical results. For more information on our products and services, visit our Web site at www.agilent.com/chem.

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