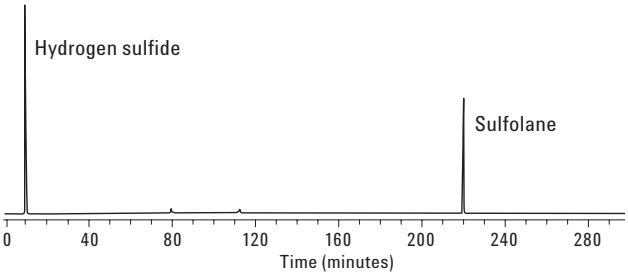
Agilent Model 355 Sulfur Chemiluminescence Detector (SCD): Sulfur Analysis Versus the Copper Strip Corrosion Test

Technical Overview

Introduction

The copper strip corrosion test (ASTM 1838) is commonly used as a product specification for liquid petroleum gases (LPGs). The test is designed to detect the presence of components that may be corrosive to copper and copper-alloy fittings that come into contact with the product. While the test is very simple to perform, its interpretation can be subjective. Furthermore, the test can produce erroneous results and it does not indicate the actual cause of corrosion, although it is generally assumed to be due to sulfur compounds.

Some situations where copper strip corrosion does not perform satisfactorily are as follows. While the presence of carbonyl sulfide does not cause corrosion in LPG systems, corrosive hydrogen sulfide is formed upon hydrolysis of carbonyl sulfide. Thus, an LPG could pass the copper strip corrosion test at its point of production and yet fail at its point of delivery or simply upon storage for a few days. [1] Different LPGs may each pass the copper strip corrosion test, but when commingled could fail. [2] This occurs because of hydrolysis as described or because one could contain a low level of hydrogen sulfide and the other could contain a low level of elemental sulfur. Hydrogen sulfide and elemental sulfur are known to have a synergistic effect on corrosivity. An LPG product could contain corrosive amounts of hydrogen sulfide and yet pass the copper strip corrosion test. This occurs when a masking agent is present in the LPG. Masking agents are polar compounds that preferentially chemisorb to the copper surface, preventing the formation of the copper tarnish. Amines, glycol amines, and other compounds such as sulfolane are known to have this effect. Mercaptans can also inhibit copper tarnish. The following chromatogram illustrates this masking effect. [3]



This particular LPG sample passed the copper strip corrosion test and yet contained over 40 ppm hydrogen sulfide by weight, according to stain tubes. Presence of polar compounds masked the corrosion effect of hydrogen sulfide. Their presence resulted from a unit upset in which gas treating chemicals were “burped” into a finished LPG storage jug. Presence of sulfolane also indicated the presence of amine treating compounds, since they are used simultaneously for sulfur compound removal.

Gas chromatography with a Model 355 sulfur chemiluminescence detector (SCD) was used to generate this chromatogram. Other chromatographic conditions were as follows: 0.5 µm liquid injection; column: 30 m, 0.32 mm id, 4 µm methyl silicone WCOT fused silica; temperature program: –10 °C for 3 minutes to the final required temperature at a rate of 10° C/minute. Gas chromatography with sulfur selective detection provides a rapid means to identify and quantify all of the various sulfur compounds that may be present in LPGs. This information is useful for explaining why a particular product passes or fails the copper strip corrosion test, and it provides the necessary information required to solve difficult product problems.

References

1. R. L. Shearer, E. B. Poole, and J. B. Nowalk, "Application of Gas Chromatography and Flameless Sulfur Chemiluminescence Detection to the Analysis of Petroleum Products," *Journal of Chromatographic Science*, Vol 31, p 82–87, March 1993.
2. C. M. Pyburn, F. P. Cahill, and R. K. Lennox, "The Effect of Sulfur Compound Interactions on the Copper Corrosion Test in Propane," Proceedings of the Fifty-Seventh Annual Convention, Gas Producers Association, p 46–51.

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