Application note

Monitoring the purity of liquid carbon dioxide with the Antaris IGS Gas Analyzer

Authors

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Figure 1. Thermo Scientific Antaris IGS Gas Analyzer.

Figure 2. Ethanol plant.

Introduction

Liquid carbon dioxide (CO_2) is used in a variety of different industries. In the food industry, it is used to quickly freeze products for shipment and storage before sale, as well as other cooling and chilling applications. In the beverage industry, it provides the carbonation for beer, soda, and other beverages. In the medical industry, it is used for certain types of cryotherapy and specialized surgical procedures. It also provides an anaerobic environment for bacteriological studies. In the water treatment industry, it is used to balance pH. It is even used in oil field recovery efforts to build pressure and eject trapped oil reserves.

Depending on the application, the purity requirements of liquid carbon dioxide vary greatly. If you have high levels of hydrogen sulfide in your CO_2, and it is being injected into the ground, it is of no consequence. If mineral water tastes like rotten eggs, however, this is a problem. Liquid CO_2 can be specified as industrial, beverage, or medical quality, where each designation implies a different level of purity. For instance, beverage quality is 99.95% pure. The better the certified quality provided by the CO_2 supplier, the higher the price the product will bring. The number of impurities present in a given supply source varies by industry, so it is important for suppliers to acquire the product from the cleanest sources available.

With ever-increasing concerns over airborne pollutants and greenhouse gases produced through engine emissions, ethanol requirements in automobile gas have spurred a significant increase in the number of ethanol plants. Ethanol is produced in a number of different ways. Grains and corn are common feedstocks used in the ethanol production process. The starting product is ground into a fine powder or “meal,” which is then mixed with water and enzymes to extract the starch. The starch is then put through a saccharification process, converting it to sugar. Finally, yeast is used to ferment the sugar, yielding ethanol and CO_2. The CO_2 generated from this process is very clean and therefore an excellent candidate for high-grade CO_2 production and distribution. This is why CO_2 producers are building plants adjacent to the ethanol plants to capture, clean, and store the product. Ethanol producers benefit greatly from these partnerships. Not only do they avoid fines from environmental agencies for releasing CO_2 into the air, they also profit from the sale of the CO_2.

Figure 3. CO_2 plant.

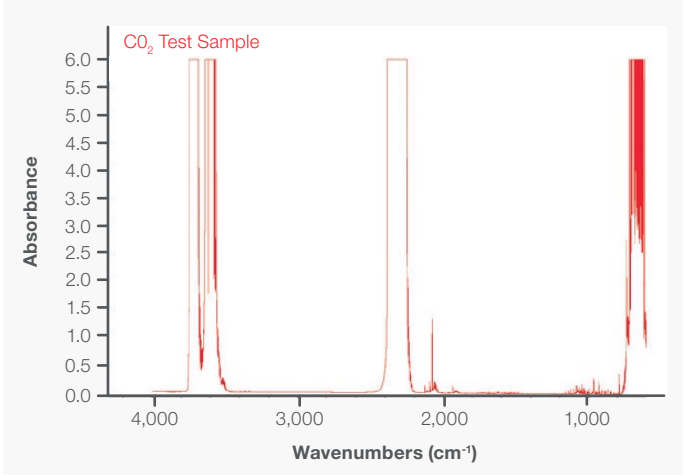

Figure 4. This spectrum is dominated by the contributions of CO_2. However, even if multiple spectral regions are rendered useless, there are still many viable regions for quantitative measurements.

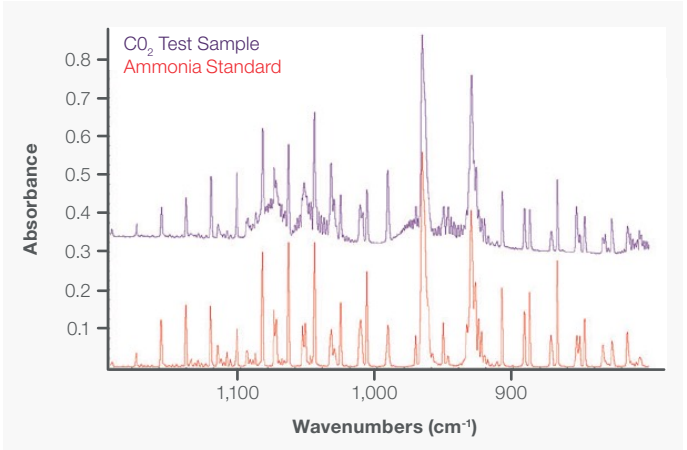

Figure 5. Looking at the region specific to ammonia, there is clear overlap with the ammonia reference spectrum. Along with the ammonia peaks, additional features from another gas component in the system will need to be monitored, as they could potentially interference with ammonia concentration calculations.

Experiment

Manufacturers use a number of different tests to certify the quality of CO_2, monitoring levels of SO_2, CO, NO_2, CH_4, H_2O, NH_3, NO, NO_2, C_6H_6, and PH_3. These tests are not only costly but time consuming as well. Using the Thermo Scientific™ Antaris™ IGS Gas Analyzer, the manufacturer can test all of these components simultaneously, quickly, and at a greatly reduced cost relative to conventional tests such as detector tubes.

Reviewing the data, it is clear that the high levels of CO_2 dominate the spectrum. If the infrared frequencies of a species of interest are selected, however, the effects of CO_2 absorbances are minimized and the contaminants can be isolated and measured quantitatively. This is demonstrated with ammonia. In the spectral data (Figure 4), the full range spectrum is overwhelmed by the CO_2 contributions; an expanded region (Figure 5) shows the contribution of the NH_3 absorbances to the total. Even though there is additional information present in the mixture spectrum, it is easy to identify where the ammonia contributions reside.

The Antaris IGS Gas Analyzer is a rugged, mid-infrared spectrometer designed specifically for the analysis of process gases in an industrial environment. Coupled with Thermo Scientific RESULT™ Software, this analysis becomes a push-button operation. Whether plant personnel or a driver is running the tests, there is little to no training required. The truck or railcar is connected to the input stream and the spectrometer does the rest.

Configuring the Antaris IGS Gas Analyzer with a 10M gas cell and a DTGS detector provides for low detection limit capabilities along with 24/7 operation. With RESULT Software OPC compatibility, the unit is able to control the data flow and alert plant personnel of potential issues. Compatible with most Microsoft applications, data fields can be populated automatically, and reports can be generated for drivers without the need for onsite personnel. Quality control becomes easier, more efficient, and less expensive.

Conclusion

The Antaris IGS Gas Analyzer offers an alternative to time-consuming and expensive tube tests for the monitoring of CO_2 contaminants in real-time at ethanol/ CO_2 production sites.

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