Sample Transport and Response Time Through 1000ft of Tubing

Background

The International Society of Beverage Technologists (ISBT) set guidelines for providing quality carbon dioxide for beverage manufacturers. These guidelines strive to set limits on common carbon dioxide impurities that may affect consumer health or quality of the product. Examples of these impurities include, but are not limited to, benzene (carcinogen), methane (carcinogen), and sulfur dioxide (affects taste). Beverage Grade carbon dioxide is often monitored in the beverage industry for low level impurities for compliance with ISBT standards.

Problem

In carbon dioxide production facilities, the gas analyzer may be located centrally to multiple gas sources. Gas suppliers may require up to 1000ft of tubing to transport carbon dioxide from the source to the analyzer. In beverage manufacturing facilities, carbon dioxide is often stored in large quantities outside. Prior to unloading a new batch of carbon dioxide from a delivery truck, the gas is tested for quality assurance at an interface near the carbon dioxide storage location. Depending on the facility layout, the carbon dioxide may have to travel long distances prior to reaching the carbon dioxide purity analyzer. Sample transport response time is critical to ensure a high quality yet efficient analysis of an incoming truck or a gas source.

Solution

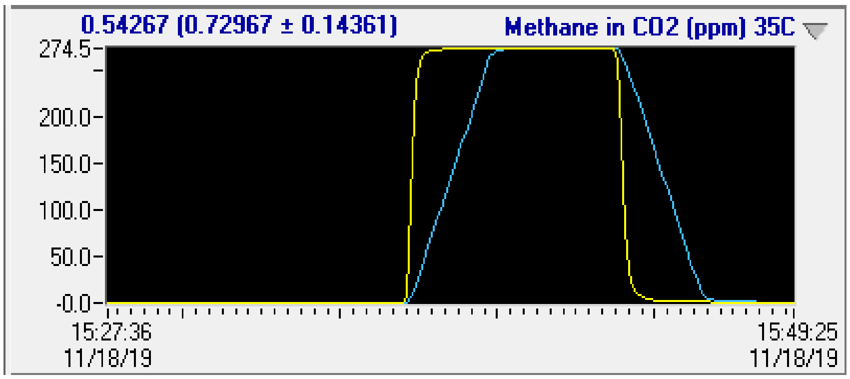
Max Analytical Technologies has developed the MAX-Bev™ to measure the purity of Beverage Grade carbon dioxide as well as low level impurities for compliance with ISBT standards. This FTIR-based system also utilizes a UV fluorescence analyzer to measure total sulfur content. The MAX-Bev™ FTIR is specially configured to run at 5.0 ± 0.1atm while flowing gas at 5.0L/min at 35°C.

Results

To demonstrate the response time in transporting gas to the MAX-Bev system, a surrogate sample gas, methane, was spiked into a sample line length of 1000ft. In this experimental setup, both nitrogen and methane were connected to a Swagelok tee that merged to 1000ft of HDPE tubing, which terminated at a MAX-Bev sample port. All components of the setup were purged thoroughly with nitrogen before methane flow was introduced into the sample line, controlled by a MFC. The methane concentration was monitored to determine the sample response time of the MAX-Bev. Once equilibrium was reached, the purge response time was determined by stopping the methane flow and initiating nitrogen.

Equilibrating response time is defined as the time for methane to reach >95% from 0%, and the purge response time is defined as 100% to <5%.

The FTIR was configured to scan approximately every seven seconds. Below is the concentration plot of methane in ppm. The instantaneous result (every 7 seconds) is depicted in yellow whereas a 20-point rolling average (140 seconds) is displayed in blue.



The methane first responded less than five minutes after the cylinder was opened. Less than thirty seconds later, the methane was at or above 95% of full scale. After the methane reached equilibrium, the cylinder was closed, and nitrogen flow was again initiated. After 5 minutes, the methane began to purge, and approximately 30 seconds later, the methane concentration reached 5% or less of full scale.

Sample Transport Response Time Over 1000ft Tubing to MAX-Bev		
Description	Time	Difference
Nitrogen Stopped; Start Methane	15:32:37	N/A
Methane Initially Detected	15:37:10	00:04:33
Methane ≥ 95% of Full Scale	15:37:32	00:00:22
Methane Stopped; Start Nitrogen	15:39:05	N/A
Methane Initially Decreased	15:43:48	00:04:43
Methane ≤ 5% of Full Scale	15:44:27	00:00:39

Conclusions

The table above displays the steps and response times of the methane transport experiment. These results demonstrate that it takes approximately five minutes for a sample to flow through 1000ft tubing and equilibrate to >95% of full scale. Similarly, the gas of interest can purge out of the 1000ft tubing and measure at less than or equal to 5% of the full scale in less than six minutes. Max Analytical recommends utilizing stainless steel tubing for transportation of carbon dioxide to reduce possible permeation through plastic lines.