

Carbon Dioxide (CO₂) Measurement in Natural Gas

Application

Concentrations of carbon dioxide (CO₂) across gas pipelines and distribution networks is strictly enforced and kept at low levels. If CO₂ concentrations are higher than desired, removal techniques such as amine washers, polymeric membranes, or pressure swing absorptions (PSAs) are installed. To monitor CO₂ levels, the Rosemount Analytical X-STREAM flameproof analyzer can be equipped to provide continuous analysis of CO₂ for natural gas applications.

Background

Natural gas mainly consist of methane (CH₄ 70–90 %). Other components are ethane (C₂H₆), propane (C₃H₈), butane (C₄H₁₀) and higher hydrocarbons (up to 20 %). Carbon dioxide (CO₂) can go from several ppm up to 8 %. Further components are nitrogen (N₂), hydrogen sulfide (H₂S) and noble gases as helium (He), argon (Ar), and neon (Ne).

Pipeline transmission legislation sets limits for the CO₂ content of natural gas. Therefore, CO₂ has to be measured and, if necessary, reduced by technical processes.

CO₂ measurement in natural gas can be done with complex gas chromatographs (GC), as well as with optical non-dispersive infrared (NDIR) measurement, which allows a continuous measurement.

Gas Analyzer Application

Methane, ethane, propane and other hydrocarbons in natural gas are influencing the CO₂ measurement. This cross interference is low for methane (approx. 1:700), but larger for ethane (approx. 1:100) and higher hydrocarbons.

Natural Gas Composition		Interferences on the CO ₂ Measurement
C ₁	90 %	20 ppm
C ₂	4 %	10 ppm
C ₃ –C ₅	4 %	15 ppm
N ₂	2 %	No interference
H ₂ O	0.02 %	No interference
CO ₂	10 ppm	No interference

High CO₂ Content

If CO₂ has to be measured in the percent range, the error from cross interferences by the background gases is negligible. Calibration can be performed with the mean background concentration of the natural gas components. Even calibration in nitrogen might be possible.

Low CO₂ Content

For ppm CO₂ ranges, calibration with mixed background gases or in a nitrogen background is not possible. Varying gas composition in natural gas would lead to varying errors in CO₂ measurement, which are too high for ppm measurement ranges.

Solution for ppm CO₂ Measurement in Natural Gas

To overcome the problem of varying background in natural gas, a special gas analyzer setup with a CO₂ absorbing agent can be used.

In an external sample handling system the sample gas stream is split and the CO₂ in one stream is removed with a scrubber. This stream is flowing through the reference side. The other stream which still contains the CO₂ is applied to the measurement side of the analyzer cell.

With this configuration, variations in the background of natural gas will affect both sides of the analysis cell and will therefore be cancelled out. The external sample handling system is shown in Figure 1. The left vessel contains the CO₂ absorbing material, whereas the right vessel is a blank vessel filled with glass beads to equalize the flow.



Figure 1 - External Sample Handling System

System Configuration

CO₂ measurement for natural gas applications often takes place in hazardous areas and therefore an X-STREAM flameproof analyzer by Rosemount Analytical (Figure 2) is recommended. Depending of the application, an X-STREAM general purpose housing may be used instead as long as the analyzer is configured properly and meets the safety requirements specified.

The X-STREAM analyzer is equipped with a valve block and three-way valve. The gas handling with CO₂ scrubber and blank vessel (as shown in Figure 3) is optional and comes separately.



Figure 2 - X-STREAM X2FD for installation in hazardous areas

Operation

Figure 3 below shows a flow diagram of the recommended analyzer system. When measuring sample gas, V3 is open and the gas stream is divided into unscrubbed and scrubbed (CO₂ removed) gas streams. The unscrubbed gas stream is flowing through the de-energized (NO-C) three-way valve (V1) into the measurement side of the analysis cell. The scrubber gas stream is flowing into the reference side of the cell.

Calibration

For zeroing the analyzer, V3 is closed and V4 is opened. Now the unscrubbed gas stream is blocked by the energized (NC-C) three-way valve (V1) and the scrubber gas stream is divided to flow into the measuring and the reference side of the cell. For spanning with a CO₂ test gas in N₂, V2 is opened and the system is working in the measuring configuration described above.

Combination with Other Measurements

Trace O₂ measurement utilizing a fuel cell sensor or water vapor measurement based on Al₂O₃ sensor technology can also be added to the system.

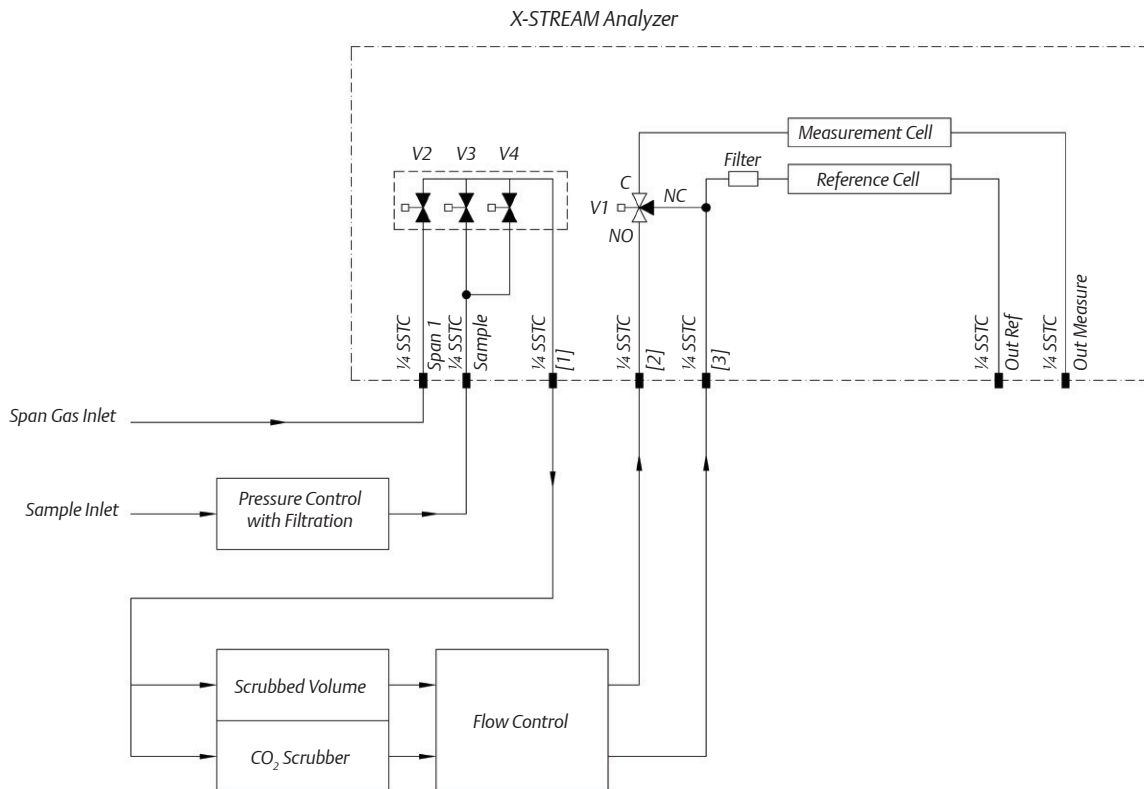


Figure 3 - External sample handling and internal tubing in X-STREAM flameproof analyzer for installation in hazardous areas

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