

Analysis of Trace CO and CO₂ in Ultra-High Purity Gases Using Continuous Gas Analyzers

Process Overview

The measurement of trace CO and CO₂ levels in the production of high-purity gases is critical in many applications, including specialty gases, semiconductor, hydrocarbon processing, food, and the medical industries. The identification and quantification of the trace CO and CO₂ does not only affect the price of high purity gases itself, but also the processes and quality of the end products. In this regards, using an accurate and reliable analytical method for the measurement of CO and CO₂ at trace levels (ppm and sub-ppm) is important.

CO and CO₂ Monitoring

Rosemount X-STREAM Enhanced (XE) Series of Continuous Gas Analyzers are specially designed to measure ultra low carbon monoxide (ULCO) and carbon dioxide (ULCO₂) for gas purity applications with measurement ranges down to down to 0 – 5 ppm CO₂ / 0 – 10 ppm CO.

In gas purity measurement applications, new quality standards require ultra low CO measurement but not a high dynamic range and cross compensation compared to automotive or emissions monitoring measurements of low or ultra low CO. Therefore the 2nd bench of the analyzer offers another channel that can be used for ultra low carbon dioxide (ULCO₂) measurement.

The lowest ranges for the photometric measurement of CO is 0-10 ppm with a detection limit (4 σ) of 0.2 ppm, and CO₂ 0-5 ppm with a detection limit (4 σ) of 0.1 ppm. These measurements require a daily zero calibration, but span calibration can be performed in longer time intervals. This reduces the consumption of expensive test gases. With a micro-flow detector and high measurement frequency of 30.5 Hz, the Rosemount ULCO and ULCO₂ analyzers are quite immune to vibration and can handle tough installation conditions, which has been proven in direct comparison with other analyzer on the market (Figure 1). These ultra low measurements can be done in different background like N₂, H₂. To avoid any pre-absorption of ambient CO₂, the Rosemount ULCO₂ analyzer cell is purged on the reference side with N₂ or clean instrument air.

Applications

The Rosemount X-STREAM Enhanced (XE) Series of Continuous Gas Analyzers are ideal for trace CO and CO₂ monitoring in gas purity and air separation measurement applications. They can be installed near compressors with strong vibrations in PSA plants. With ultra low CO₂ measurement requirements for a flowing reference side, it is used for case purge to avoid pre-absorption while offering only 0.1 – 2 l/min CO₂-free or constant concentration purge gas.

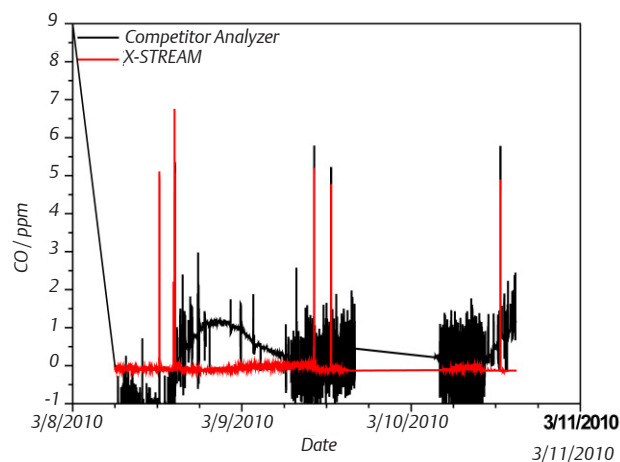


Figure 1 - Rosemount X-Stream Analyzer Noise Signal Comparison of Ultra Low CO Measurement

Detection Ranges

- Gas purity: up to four channels
- CO_{ultra low}
 - 0-10 ... 100 ppm
 - 0-20 ... 200 ppm
 - 0-20 ... 400 ppm
 - 0-50 ... 500 ppm
- CO_{2 ultra low}
 - 0-5 ... 100 ppm
 - 0-10 ... 100 ppm
 - 0-50 ... 100 ppm
- NDIR with microflow gas detector
- Auto calibration via digital I/O, serial interface, network, time- programmed interface
- Zero and span stability by means of auto-zero and automatic gain control
- Barometric pressure compensation
- Sample flow rate measurement
- Analog, digital and serial I/O (SIO/DIO) via man-machine

Table 1 - Special Performance Specifications for Gas Purity Measurements (ULCO and ULCO₂)

	0–10...< 50 ppm CO 0–5...< 50 ppm CO ₂	
Detection limit (4 σ) ^{(1) (2)}	< 2 %	
Linearity ^{(1) (2)}	< 1 %	
Zero-point drift ^{(1) (2) (3)}	< 2 % resp. < 0.2 ppm ⁽⁹⁾	
Span (sensitivity) drift ^{(1) (2) (4)}	< 2 % resp. < 0.2 ppm ⁽⁹⁾	
Repeatability ^{(1) (2)}	< 2 % resp. < 0.2 ppm ⁽⁹⁾	
Response time (t ₉₀) ⁽⁷⁾	< 10 s	
Permissible gas flow	0.2–1.5 l/min.	
Influence of gas flow ^{(1) (2)}	< 2 %	
Maximum gas pressure ⁽¹⁰⁾	≤ 1500 hPa abs. (≤ 7 psig)	
Influence of pressure ⁽⁵⁾	≤ 0.1 % per hPa	
– At constant temperature	≤ 0.01 % per hPa	
– With pressure compensation ⁽⁸⁾		
Permissible ambient temperature	+15 to +35 °C (59 to 95 °F)	+5 to +40 °C (41 to 104 °F)
Influence of temperature ⁽⁶⁾ (at constant pressure)		
– On zero point	< 2 % per 10 K resp. < 0.2 ppm per 10 K ⁽⁹⁾	
– On span (sensitivity)	< 2 % per 10 K resp. < 0.2 ppm per 10 K ⁽⁹⁾	
Thermostat control	none	60 °C (140 °F)

Note! 1 psi = 68.95 hPa

(1) Related to full scale

(2) Constant pressure and temperature

(3) Within 24 h; daily zero calibration requested

(4) Within 24 h; daily span calibration recommended

(5) Related to measuring value

(6) Temperature variation: ≤ 10 K per hour

(7) From gas analyzer inlet at gas flow of 1.0 l/min

(8) Barometric pressure sensor is required

(9) Whichever value is higher

(10) Limited to atmospheric if internal sample pump



Rosemount X-STREAM Enhanced (XE) Series of Continuous Gas Analyzers provide CO and CO₂ analysis down to 0 – 5 ppm CO₂ / 0 – 10 ppm CO measurement ranges

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