

Hydrogen and Nitrogen Purity Measurements Using Quantum Cascade Laser (QCL) Gas Analyzers

Process Overview

Assuring hydrogen and nitrogen gas purity is critical across multiple processing industries and applications. For several key processes, the purity of the gas must be precisely monitored and controlled to ensure the product is within specification and avoid damage to equipment or process line. The purity of these gases also plays an important role in controlling reactions and reactor performance, avoiding contaminating valuable catalysts, and ensuring the efficiency of the synthesis process and resulting product quality.

Measurement Challenges

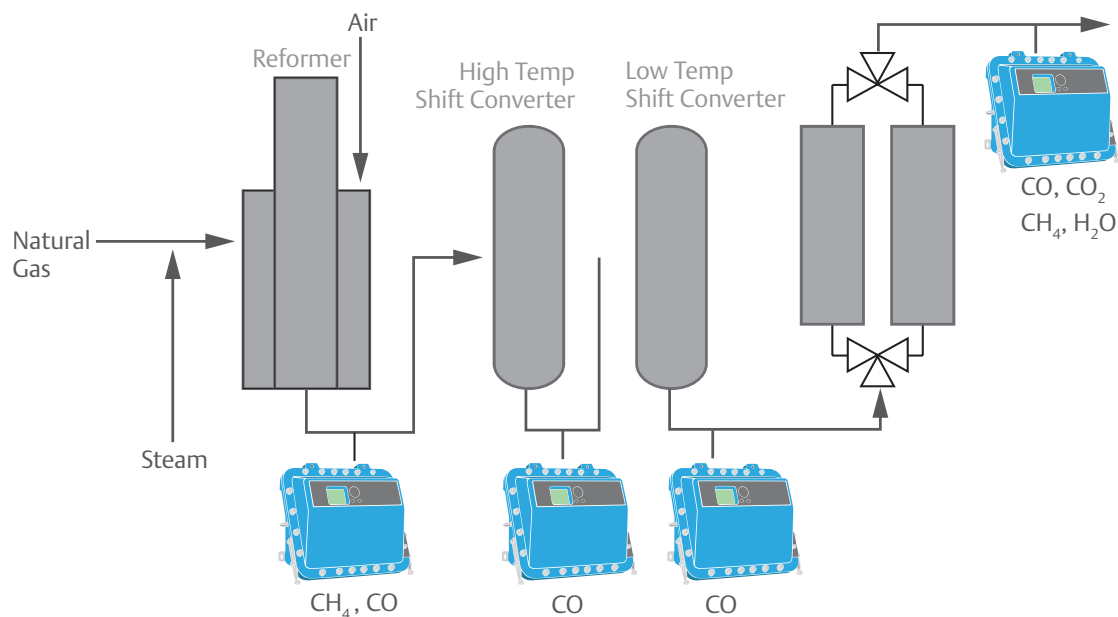
The success and profitability of many gas processing industries and applications rely on the accurate detection and removal of gas impurities in each stage of the reaction process. The process requires a gas analyzer that can monitor the complex and unique set of impurities in each gas stream and send reliable measurement data to the plant control system in real-time to enable better decision-making. Access to timely and reliable gas analysis data ensures gas quality for the next process steps, reducing the risk of catalyst poisoning, process line fouling, and guard against impurity in the feed gas stream that can lead to off-spec product quality.

The Emerson Solution

Laser Absorption Spectroscopy is a gas analysis method used to detect gas molecules and identify their concentrations. Rosemount™ Quantum Cascade Laser (QCL) Analyzers are continuous gas analyzers that utilize a unique hybrid laser spectroscopy technology which combines Quantum Cascade Lasers (QCL) with Tunable Diode Lasers (TDL) to provide fast, direct, and highly selective measurement of hydrogen and nitrogen impurities.

Combining QCL with TDL spectroscopy in a single instrument enables Rosemount Quantum Cascade Laser Gas Analyzers to broaden insight and monitor both the near and mid-infrared range of spectroscopic light. This hybrid approach uses QCLs to detect and identify gas molecules in the mid-infrared wavelength range, allowing the strongest absorption lines and highest sensitivities in addition to TDLs which work in the near-infrared spectral region where laser sources exhibit higher performance. The results of this hybrid approach are a highly selective identification of the desired molecules and high-resolution measurements with very fast response times.

Figure 1 - Typical H₂/N₂ Purity Process



Implementing the Rosemount CT5800 Continuous Gas Analyzer enables accurate and sensitive measurement of very low concentrations of impurities in gas streams. The device minimizes costs because it can house up to six Quantum Cascade Lasers to measure up to 9 gas components simultaneously in a single analyzer. It is also equipped with automated validation diagnostics to ensure reliable measurement performance.

The Rosemount CT5800 Continuous Gas Analyzer features a flameproof enclosure designed for hazardous areas and includes an intuitive local operator interface for easy access to all instrument functions.

Table 1 - Typical Measurement Ranges

Component	Measurement Range		
	Range	LOD	Repeatability*
CO	0-5 ppm	0.05	±1 %
CO ₂	0-5 ppm	0.02	±1 %
H ₂ O	0-10 ppm	0.1	±1 %
CH ₄	0-50 ppm	0.2	±1 %
NH ₃	0-10 ppm	0.05	±1 %

*Repeatability is ±1 % of reading or the Limit of Detection (LOD), whichever is greater. Other ranges are available. Please consult an Emerson application specialist.



Rosemount CT5800
Continuous Gas Analyzer

Benefits of the Hybrid QCL/TDL Gas Analysis Technology

As the world's only hybrid QCL and TDL analyzers, Rosemount Quantum Cascade Laser Gas Analyzers deliver the most sophisticated industrial gas sensing and analysis, enabling operators increased process control and minimized operational cost. Benefits of the Rosemount QCL technology include:

- Multiple QCL/TDL lasers in a single analyzer for fast detection and analysis of CO, CO₂, and NH₃, CH₄, and moisture
- Update time of <1 second delivers critical gas purity monitoring to ensure the integrity of the process
- High sensitivity and selectivity allow the detection of a variety of components and impurities, even in complex mixtures
- Patented laser chirp technique analyses gas continuously down to sub-ppm concentrations, to provide sub-second measurements in real-time
- No consumables, no calibration, and no in-field enclosure or shelters reduce cost and simplify maintenance and upgrades
- Easy-to-install instrumentation and fast technician training
- Interchangeable modular configuration of up to six lasers simplify field service

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