Application Data Sheet
ADS 103-1000.A01
February, 2009

On-line Gas Analysis In Hydrogen Plants

APPLICATION

Emerson provides Rosemount Analytical gas analyzer technology for on-line analysis of hydrogen plant streams. Strategically placed gas analyzers improve the process efficiency and the purity of the end product.

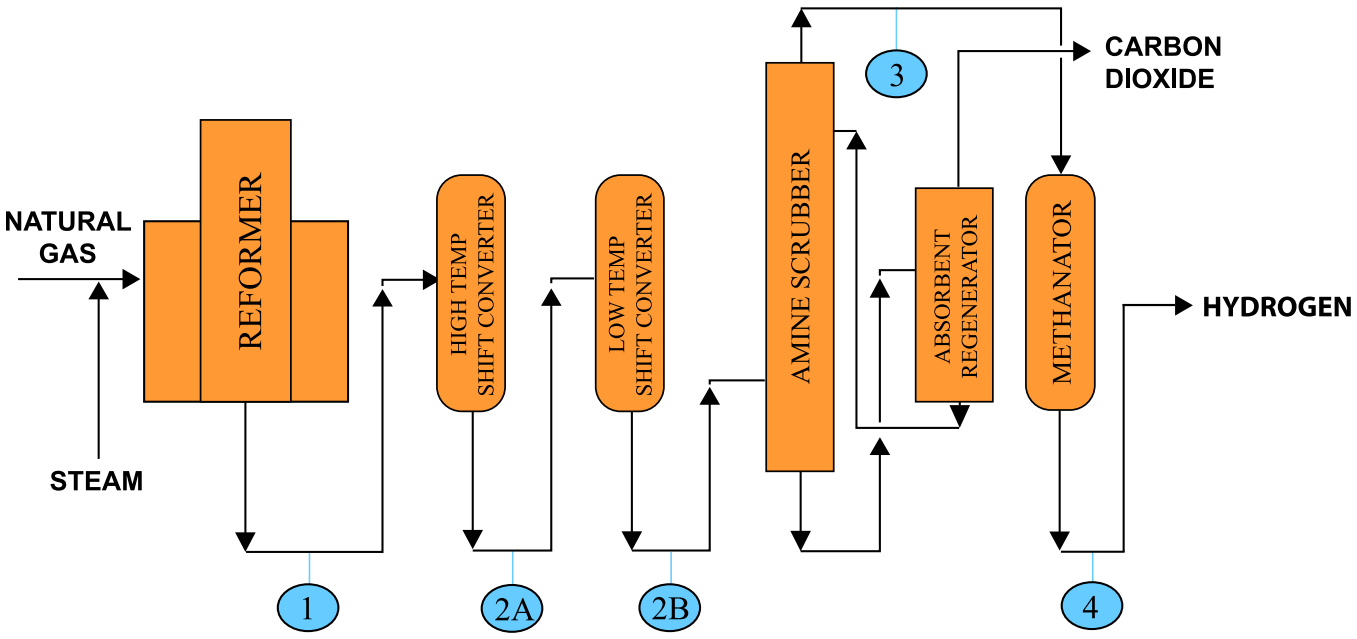
BACKGROUND

Large quantities of hydrogen (H_2) are needed for refining crude oil into various products such as gasoline, jet fuel and heating oil. The largest refinery applications for H_2 are the “upgrading” of crude oil in the hydrotreating and hydrocracking processes. Other uses of H_2 include production of chemicals such as ammonia, hydrochloric acid and methanol; as a reducing agent for metallic ores and also for hardening and heat treating of metals; as a hydrogenating agent for foods such as margarine and peanut butter; for cooling of electrical generators at power plants (because H_2 has the highest thermal conductivity of any gas); and for cryogenic research including superconductivity studies.

Hydrogen is primarily produced by reacting natural gas or methane (CH_4) with steam in a reformer. In the process of reforming natural gas or methane to hydrogen, carbon monoxide (CO) and carbon dioxide (CO_2) are formed as by-products. Even at low concentrations, both CO and CO_2 adversely affect catalysts in many refining and chemical processes. Therefore, to prevent downstream problems the removal and measurement of CO and CO_2 on a continuous basis is required before the hydrogen can be used in these processes.

GAS ANALYZER APPLICATIONS

During the production of hydrogen, the gases pass through the steam reformer, high- and low-temperature shift converters, amine scrubber and methanator.



1 = measuring point.

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Measuring Point 1: Steam Reformer

Natural gas and steam react over catalyst to form H_2 and CO:

$CH_4 + H_2O \rightarrow 3H_2 + CO$

Also present is CO_2 and unreacted CH_4. Reformer efficiency is monitored by measuring unconverted CH_4. CO is also measured in preparation for the shift converters.

Measuring Points 2A and 2B: High- and Low-Temperature Shift Converters

The shift converters remove CO by reacting with steam to form H_2 and CO_2:

$CO + H_2O \rightarrow H_2 + CO_2$

The CO content is measured to determine the efficiency of the shift converters.

Measuring Point 3: Amine Scrubber

CO_2 is absorbed in the amine scrubber. The CO_2 is measured to determine scrubber efficiency.

Measuring Point 4: Methanator

The methanator removes the remaining traces of CO and CO_2 by converting them to methane:

$CO + 3H_2 \rightarrow CH_4 + H_2O$

$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$

Trace CO and CO_2 are measured because they must be removed before the hydrogen can be used in many refining and chemical processes. Typical analysis ranges after the Methanator are 0 to 10 ppm CO and 0 to 5 ppm CO_2. Abnormally high concentration levels should be alarmed. The CH_4 is also often measured as is suppressed range H_2 (95 – 100%) to determine the purity of the H_2 product.

The X-STREAM analyzer is extremely well-suited to make the CH_4, CO and CO_2 measurements described above using NDIR (non-dispersive infrared) photometric detectors. The H_2 measurement is made using a thermal conductivity detector in an X-STREAM analyzer.

Summary

Emerson can supply either Rosemount Analytical X-STREAM Flameproof analyzers or X-STREAM Field Housings with purge/pressurization systems for these applications. The analyzers are used to insure more efficient production and higher quality product.

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