Ammonia: raw syngas – primary reformer outlet

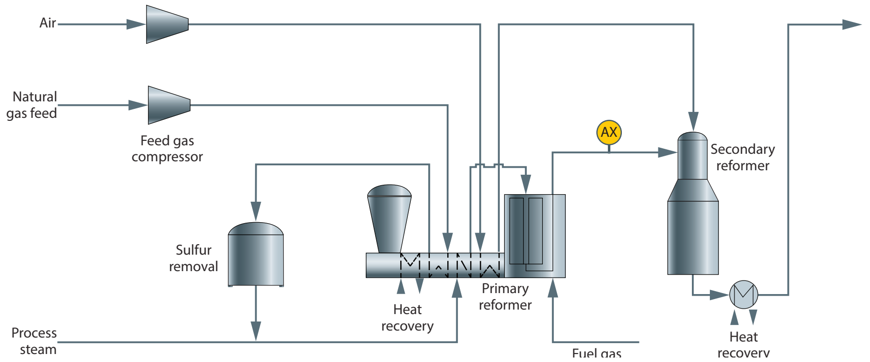

Figure 1: Primary steam reformer section of ammonia plant process units**

Benefits at a glance

- Unique spectroscopic capability to measure all syngas components, including H_2 and N_2
- Pipe-centric sampling and measurement at the sample tap
- Complete syngas speciation
- No valves, columns, or carrier gas
- No routine calibration required
- No interference from moisture vapor in the raw syngas sample when the sample is kept above its dewpoint

Raw syngas is the first intermediate product formed by the partial oxidation of natural gas in a steam methane reformer (SMR). Measurement of the syngas components (H_2, CO, CH_4 and CO_2) are used to monitor the H_2 and CO yield to allow adjustments of the steam/carbon ratio for controlling the reformer.* The major analytical challenge for measuring this raw syngas stream is the high temperature and steam saturated sample, which traditionally have been a major problem in performing reliable sampling and analysis.

Measurement of raw syngas

The Raman Rxn5 analyzer is a unique solution to the sampling and analysis of this particular process stream. A typical Raman spectrum for a steam reformer syngas stream is shown in the Figure 2. Note the simplicity and complete speciation of H_2, CO, CO_2 and CH_4 as individual spectral peaks in the spectrum. Any residual moisture present in the stream is not visible in the frequency range of the spectrum. Hence, it cannot interfere with the analysis, and a dry basis result is provided. The measurement is based on a normalized analysis, which makes it a very robust analysis against pressure, temperature, flow and other changes as well as any slow fouling that may occur.

Reliability Issues with traditional methods for syngas analysis

Syngas is typically measured with process gas chromatography (GC) or mass spectrometry (MS). Both technologies require transporting and conditioning the sample at both the sample tap and sample conditioning panel close to the analyzer. In the case of the primary reformer outlet stream, the use of a dynamic reflux sampler (DRS) or alternative liquid removal system is mandatory. Protecting the GC or MS analyzers from liquid carryover is the main challenge as this event can damage columns in a GC or damage the ionization chamber in a MS. The Rxn-30 probe cannot be damaged by liquid carryover or fouling and cleaning is simple and straightforward.

* See Ammonia: natural gas feed to the reformer
** See the general Ammonia: production analytics overview

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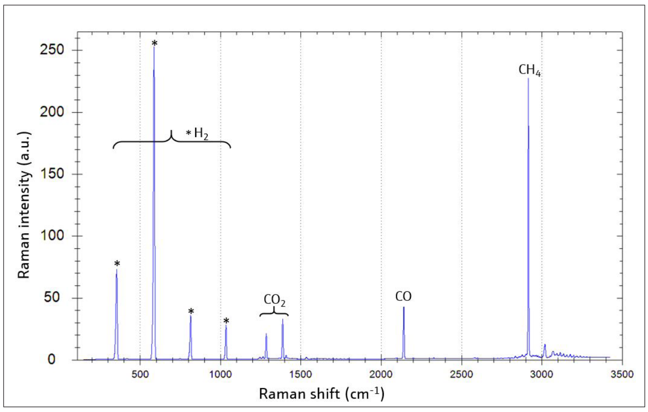

Figure 2: Typical Raman spectrum for syngas

Solution: Raman Rxn5 analyzer with the primary reformer outlet method

The use of a liquid removal system is mandatory for the primary reformer outlet stream (see Figure 1), which is saturated with steam at high temperatures (typically 700-800°C, but as low as 200-350°C at the sample tap). The Rxn-30 probe can be easily integrated into sample conditioning systems to measure process streams at higher temperatures and pressures. The ability to measure at higher pressures often allows the sample to be returned to the process, eliminating waste and costly flaring. The use of fiber optic cables allows the probe to be placed at the sample tap location, eliminating the need for long heated sample transfer lines and sample lag time.

The Raman Rxn5 for the raw syngas - primary reformer outlet contains the following per measurement point:
- Dedicated laser module
- Rxn-30 fiber optic probe
- Industrial hybrid electro-optical cable (up to 150 m long, customized to your plant requirements)
- Combined pressure and temperature sensor with cable (up to 150 m long, customized to your plant requirements)
- Dedicated syngas primary reformer outlet method

Typical process conditions	P (barg)	T (°C)
At sample tap	35	800
At Rxn-30 probe	35	55

Typical stream composition

Component	Range (Mol%)	Normal (Mol%)	Precision (Mol%) k=2	Cal gas (Mol%)	Precision (Mol%) k=2
Hydrogen	40-95	67.2	0.03	64	0.03
Nitrogen	0-35	0.7	0.01	16	0.03
Carbon monoxide	0-35	9	0.02	7	0.01
Carbon dioxide	0-30	10.6	0.02	10	0.02
Methane	0-35	12.5	0.01	3	0.01
Argon	0-2	0.7	N/M	0	N/M

Table 1: Typical process conditions and stream composition

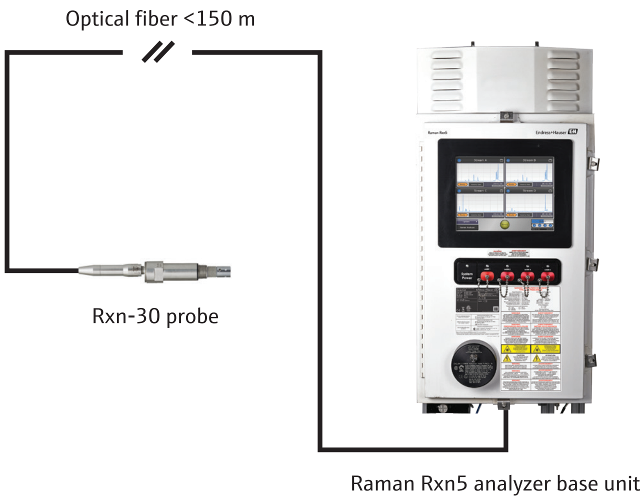

Figure 3: Recommended system configuration