Ammonia: raw syngas – secondary reformer outlet

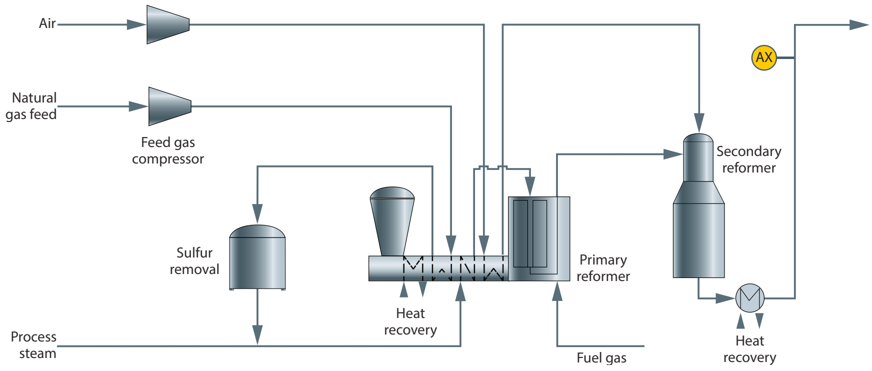

Figure 1: Steam reformer section of ammonia plant process units*

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 reforming of natural gas in a steam methane reformer (SMR). A secondary reformer is typically employed to ensure complete conversion of CH_4 to syngas (e.g. H_2, CO, CH_4 and CO_2). Measuring the syngas composition in the secondary reformer effluent stream allows feedforward control of the steam injection into the high temperature shift (HTS) converter. The major challenge for measuring the secondary reformer syngas stream is the high temperature and steam saturated sample which have been a problem in performing reliable sampling and analysis.

Measurement of secondary reformer syngas

The Raman Rxn5 analyzer is a unique solution to the sampling and measurement challenges to analyze the composition of this particular process stream. A typical Raman spectrum for the secondary reformer syngas stream is shown in Figure 2. Note the simplicity and complete speciation of individual H_2, CO, CO_2 and CH_4 as 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 very robust against pressure and temperature changes as well as any slow fouling that may occur.

Reliability issues with traditional methods for syngas analysis

Syngas may be 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 streams, the use of a dynamic reflux sampler (DRS) or alternative liquid removal system is mandatory. Protecting the GC or MS analyzer from liquid carryover is the main sampling system challenge as it can damage GC columns or the MS ionization chamber. The Rxn-30 probe cannot be damaged by liquid carryover and cleaning is simple and straightforward.

* See the general Ammonia: production analytics overview

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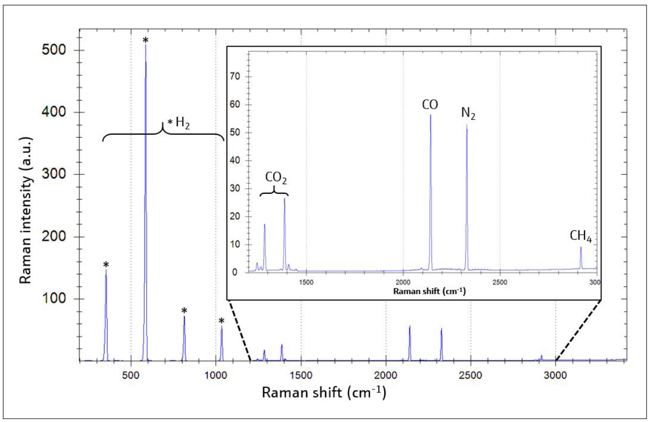

Figure 2: Typical Raman spectrum for secondary reformer syngas

Solution: Raman Rxn5 analyzer with the secondary reformer outlet method

The use of a liquid removal system is mandatory for the secondary reformer outlet stream (see Figure 1), which is saturated with steam at high temperature (typically 250-380˚C). 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 - secondary 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 secondary reformer outlet method

Typical process conditions	P (barg)	T (°C)
At sample tap	35	370
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	57.8	0.03	64	0.03
Nitrogen	0-35	21.5	0.03	16	0.03
Carbon monoxide	0-35	12.7	0.02	7	0.01
Carbon dioxide	0-30	7.7	0.02	10	0.02
Methane	0-35	0.3	0.01	3	0.01
Argon	0-2	0.7	N/M	0	N/M

Table 1: Typical process conditions and stream composition

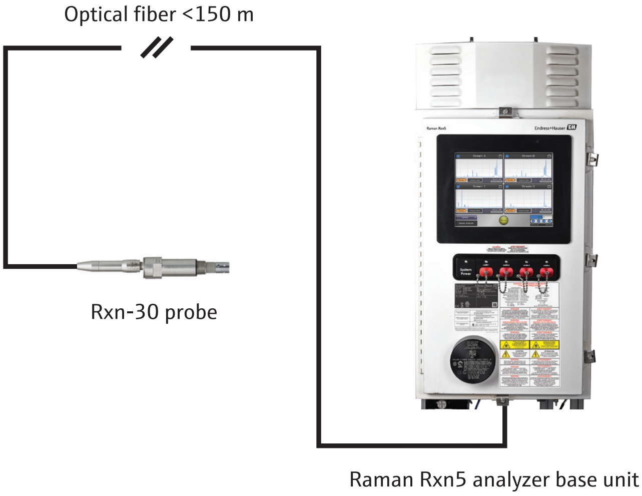

Figure 3: Recommended system configuration

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