Ammonia: high temperature shift converter outlet

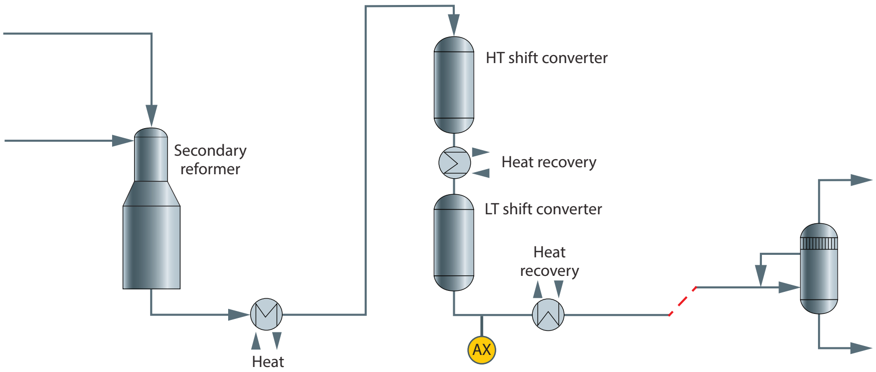

Figure 1: Shift converter process diagram sections of ammonia plant process units*

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

The high temperature shift (HTS) converter is the first stage of the water shift conversion reactions to convert the CO in the raw syngas from the secondary reformer. The water shift reaction converts CO in the presence of steam into H_2 and CO_2. Steam injection flow into the reactor is controlled by a feedback loop based on the measurement of the H_2 concentration in the HTS converter effluent stream. The major challenge for measuring this syngas converter stream is the high temperature and steam saturated sample, which traditionally have been a problem in performing reliable sampling and analysis.

Measurement of HTS converter syngas

The Raman Rxn5 analyzer is a unique solution to the sampling and measurement challenges in analyzing the composition of this particular process stream. A typical Raman spectrum for an HTS converter effluent stream is shown in 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 does not affect 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 that may occur.

Reliability issues with traditional methods for HTS effluent analysis

The HTS converter stream composition is typically measured with process gas chromatography (GC) or mass spectrometry (MS). Both technologies require transporting and conditioning the sample, both at the sample tap and sample conditioning panel close to the analyzer. In the case of the HTS 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 becomes the main sampling system 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 and cleaning is simple and straightforward.

* See the general Ammonia: production analytics overview

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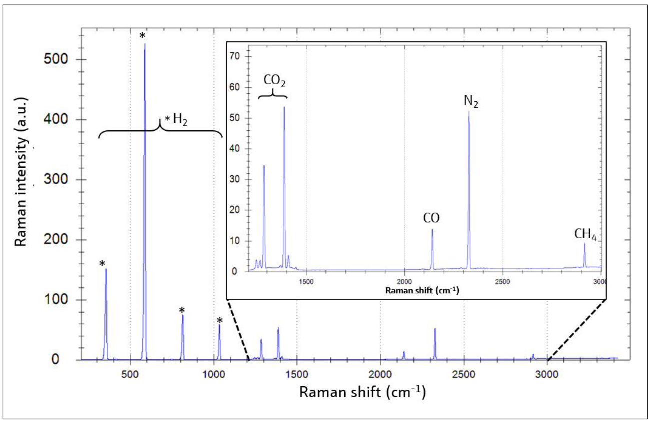

Figure 2: Typical Raman spectrum for HTS converter syngas effluent

Solution: Raman Rxn5 analyzer with the high temperature shift converter outlet method

The use of a liquid removal system is mandatory for the HTS converter outlet stream, which is saturated with steam at high temperature (typically 300-450 ˚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 high temperature shift converter 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	33	400
At Rxn-30 probe	33	55

Typical stream composition

Component	Range (Mol%)	Normal (Mol%)	Precision (Mol%) k=2	Cal gas (Mol%)	Precision (Mol%) k=2
Hydrogen	40-95	59.9	0.03	64	0.03
Nitrogen	0-35	21.2	0.03	16	0.03
Carbon monoxide	0-35	3	0.01	7	0.02
Carbon dioxide	0-30	15.67	0.03	10	0.02
Methane	0-35	0.03	0.01	3	0.01
Argon	0-2	0.2	N/M	0	N/M

Table 1: Typical process conditions and stream composition

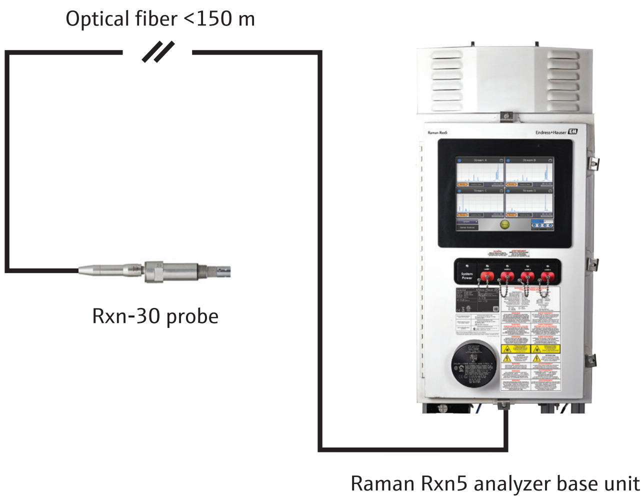

Figure 3: Recommended system configuration