Ammonia: converter feed stream

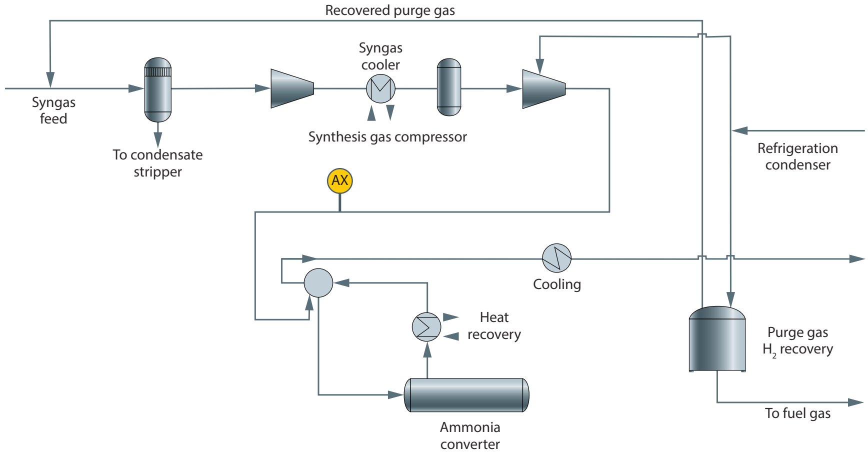

Figure 1: Typical ammonia converter feed measurement point*

Benefits at a glance

- Unique spectroscopic capability to measure all gas components, including H_2 and N_2
- Pipe-centric sampling and measurement at the sample tap requires no sample transport to the analyzer
- Sample can often be returned to the process - no sample flare
- Complete syngas speciation
- No valves, columns, or carrier gas
- No routine calibration
- No interference from moisture vapor in the raw syngas sample when the sample is kept above its dewpoint

The feed to the ammonia converter is primarily a binary mixture of H_2 and N_2 with small amounts of NH_3 (residual NH_3 vapor after the liquefaction stage) and CH_4 as an impurity, which is slowly concentrated in the synthesis loop. It is critical that the ratio of H_2 to N_2 in the feed be kept at 3:1. Therefore, the accurate measurement of this ratio is the main challenge for the analytical measurement.

Measurement of the feed gas to the ammonia converter

The Raman Rxn5 analyzer is a unique integrated sampling and measurement system for the NH_3 synthesis loop feed gas. A typical Raman spectrum and stream composition for the ammonia converter feed are shown in Figure 2 and Table 1. Note the simplicity, baseline separation and complete speciation of the H_2, N_2, NH_3, and CH_4 spectral peaks in the spectrum, which allows for a very accurate measurement of the H_2:N_2 ratio.
No other spectroscopic technique is capable of measuring the H_2 and N_2 diatomics in this stream. In addition, the measurement is based on a normalized analysis which improves the accuracy of the H_2:N_2 ratio, improves robustness against pressure and temperature changes, and significantly reduces the impact of any slow fouling that may occur.

Reliability issues with traditional methods for NH3 feed gas analysis

Typically, the NH3 feed gas is analyzed via process gas chromatography (GC) or mass spectrometry (MS). Both GC and MS technologies require substantial pressure reductions and very fast loop flows to try and minimize sample transport lag times. The complexity of the multistream configurations for both GC and MS installations significantly increases maintenance support requirements and cost. In the case of GCs, analysis update times suffer because of sequential stream switching on top of long analysis times for any given stream.

* See the general Ammonia: production analytics overview

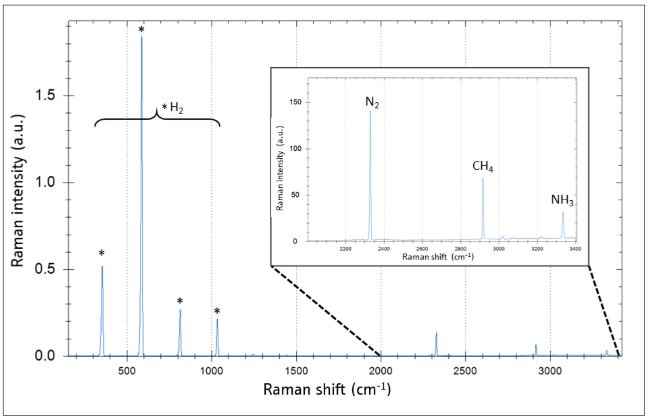

Figure 2: Raman spectrum of a typical ammonia converter feed stream

Solution: Raman Rxn5 analyzer with the ammonia converter feed stream method

In the case of relatively clean and dry streams like a natural gas feed, the Raman Rxn5 analyzer with an Rxn-30 probe allows for a wide range of sample pressure (70-800 psia typical) and sample temperature (-40 to 150 °C) (see Figure 3). The Rxn-30 probe can be easily integrated into sample conditioning systems to measure process streams at higher temperatures and pressures. The ammonia converter operates at high pressure and, in this case, some pressure reduction from typically 2200 psig to about 500 psig is required. This is still adequate pressure to allow the analyzer sample to be returned to a lower pressure process point, which avoids flaring the sample. This integrated solution provides an increase in analysis speed, since the sampling and measurement are done at the sample tap point and no sample transport is required.

The Raman Rxn5 analyzer for ammonia converter feed stream 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 ammonia converter feed stream method

Typical process conditions	P (barg)	T (°C)
At sample tap	57	400
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	35-90	71	0.03	65	0.03
Nitrogen	5-35	23.6	0.02	20	0.02
Methane	0-20	0.2	0.01	9	0.01
Ammonia	0-25	1.8	0.01	6	0.01
Argon	0-12	3.4	N/M	0	N/M

Table 1: Typical process conditions and stream composition

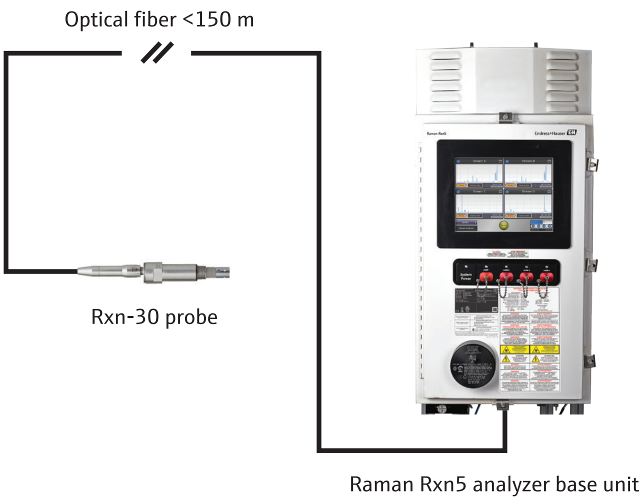

Figure 3: Recommended system configuration

AI01319C/66/EN/01.21

Endress+Hauser
People for Process Automation