Ammonia: synthesis loop purge gas

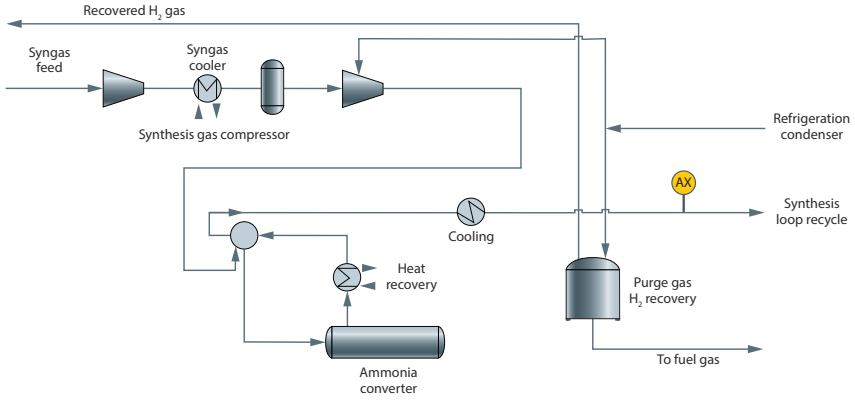

Figure 1: Typical ammonia synthesis loop purge gas measurement point*

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
- Sample can often be returned to the process, avoiding disposal to flare header
- Speciation like a chromatograph
- Complete purge gas speciation
- No valves, columns, or carrier gas
- No interference from moisture vapor in the raw syngas sample when the sample is kept above its dewpoint

The ammonia converter operates with a continuous feed and recycle synthesis loop. CH_4 and Ar are present in very low levels as contaminants in the purified feed but slowly build up over time due to the recycling of the synthesis loop gas. As these contaminants are not removed during the NH_3 liquefaction step, purging is used to limit contaminant levels. In many cases, a portion of the synthesis loop recycle stream is diverted to a purification unit, which recovers H_2 at high purity. As illustrated in Figure 1, the recovered H_2 is blended back into the H_2 feed stream, while the off-gas is either vented to flare or blended with the fuel gas stream.

Measurement of the synthesis loop purge gas

The Raman Rxn5 analyzer is a unique measurement solution for the synthesis loop purge gas stream. A typical Raman spectrum and the stream composition of the purge gas stream to a PSA unit is shown in Figure 2. Note the simplicity, baseline separation and complete speciation of the individual H_2, N_2, NH_3 and CH_4 spectral peaks. No other spectroscopic technique is capable of measuring the H_2 and N_2 in this stream. 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 the purge gas analysis

Typically, the synthesis loop purge 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 increases maintenance support requirements and cost. In the case of GCs, analysis update times suffer because of sequential stream switching on top of relatively long analysis times for any given stream.

* See the general Ammonia: production analytics overview

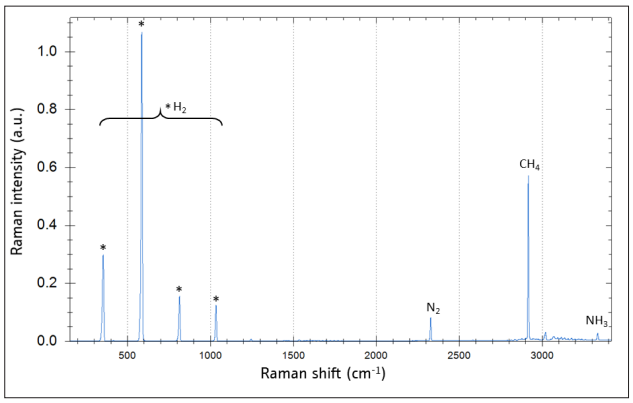

Figure 2: Raman spectrum of synthesis loop purge gas

Solution: Raman Rxn5 analyzer with the synthesis loop purge gas 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 a typical operating pressure of 2200 psig, 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 synthesis loop purge gas 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 synthesis loop purge gas method

Typical process conditions	P (barg)	T (°C)
At sample tap	39	25
At Rxn-30 probe	39	55

Typical stream composition

Component	Range (Mol%)	Normal (Mol%)	Precision (Mol%) k=2	Cal gas (Mol%)	Precision (Mol%) k=2
Hydrogen	35-90	62.4	0.03	65	0.03
Nitrogen	5-35	19.3	0.03	20	0.03
Methane	0-20	12.4	0.01	9	0.01
Ammonia	0-25	2.2	0.01	6	0.01
Argon	0-12	3.7	N/M	0	N/M

Table 1: Typical process conditions and stream composition

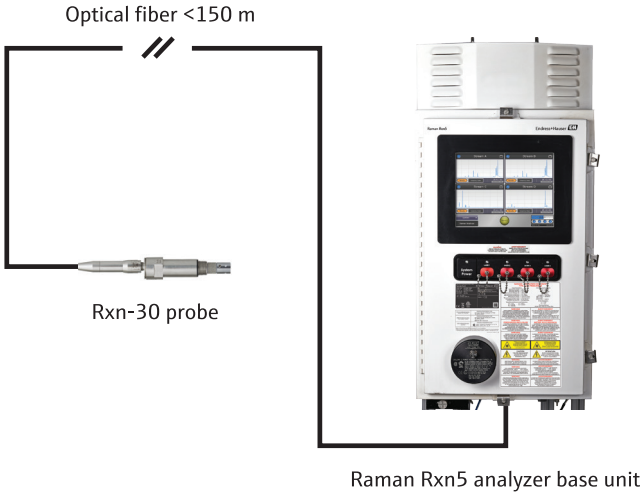

Figure 3: Recommended system configuration

AI01321C/66/EN/01.21

Endress+Hauser
People for Process Automation