Ammonia: converter exit stream

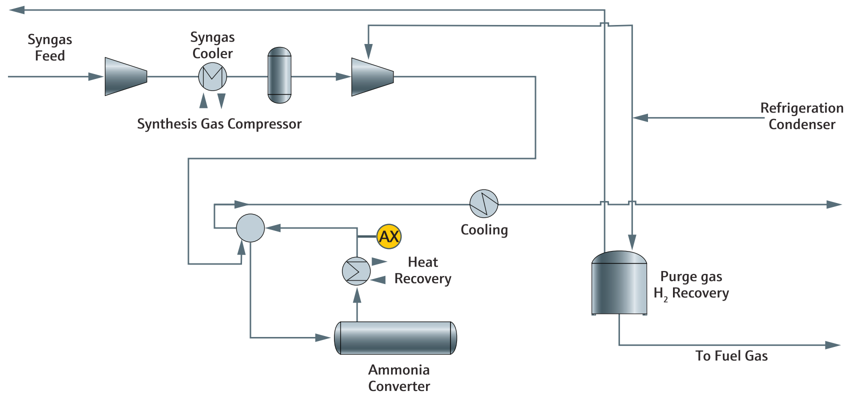

Figure 1: Typical ammonia converter exit measurement point**

The ammonia converter recycle, represents the non-condensed ammonia product, the depleted H_2 and N_2 compositions, and contaminants such as CH_4 and Ar which slowly build up in the ammonia synthesis loop. The H_2+N_2↔NH_3 reaction is driven toward product by liquefying the ammonia and removing it from the process. The depleted N_2 and H_2 is made-up from the controlled blending with the feed stream (see Figure 1). The CH_4 and Ar are regularly purged by sending them through a purifier unit, where H_2 is recovered and impurities are sent to a fuel gas stream.*

Measurement of the ammonia converter exit stream

The Raman Rxn5 analyzer is a unique measurement solution for the ammonia converter outlet stream. A typical Raman spectrum and the composition of this stream is shown in Figure 2 and Table 1. Note the simplicity, baseline separation and complete speciation of the individual H_2, N_2, NH_3 and CH_4 spectral peaks. Ar is not measured but inferred from the CH_4 analysis. 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 measured components, enhances 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 NH_3 recycle gas measurement

Typically, the ammonia converter exit 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 long analysis times for any given stream.

* See Ammonia: synthesis loop purge gas

** See the general Ammonia: production analytics overview

Benefits at a glance

- Unique spectroscopic capability to measure all ammonia converter effluent 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 exit 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

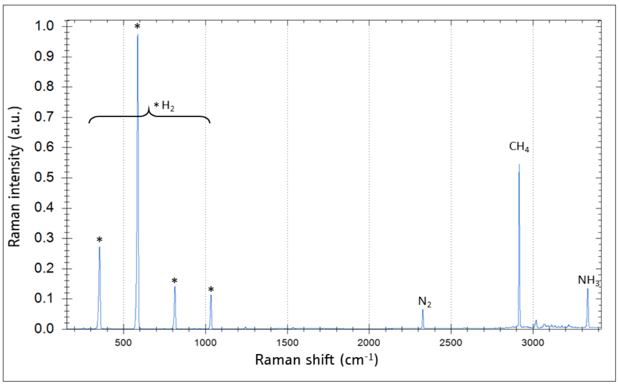

Figure 2: Raman spectrum of a typical ammonia converter exit stream

Solution: Raman Rxn5 analyzer with the ammonia converter exit 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 a typical operating pressure of 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 the ammonia converter exit 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 exit stream method

Typical process conditions	P (barg)	T (°C)
At sample tap	39	440
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	57	0.03	65	0.03
Nitrogen	5-35	15.3	0.02	20	0.02
Methane	0-20	11.8	0.01	9	0.01
Ammonia	0-25	12.2	0.02	6	0.01
Argon	0-12	3.7	N/M	0	N/M

Table 1: Typical process conditions and stream composition

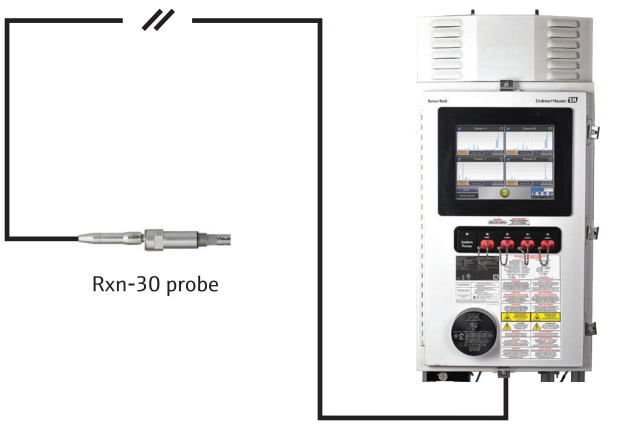

Figure 3: Recommended system configuration