Ammonia: natural gas feed to primary reformer

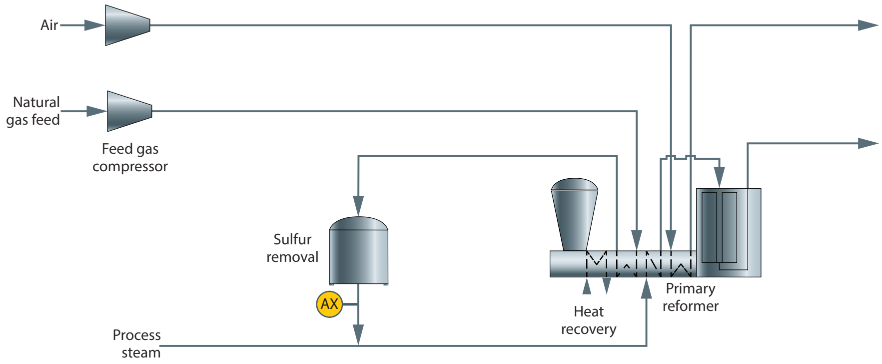

Figure 1: Typical natural gas measurement point*

Benefits at a glance

- Unique spectroscopic capability to measure Btu in natural gas
- Pipe-centric sampling and measurement at the sample tap
- Sample can often be returned to process, avoiding disposal to flare header
- Complete natural gas speciation
- No valves, columns, or carrier gas
- No routine calibration
- Fouling cannot damage the Rxn-30 probe and cleaning is easy
- No interference from moisture vapor

Ammonia production is typically based on the partial oxidation of natural gas in a steam methane reformer (SMR) to produce raw syngas as the very first intermediate product of the ammonia production process. The most common analytical control parameter for a steam reformer is based on the carbon/steam ratio. Measurement of the natural gas (typically $C_1 - C_4$) at this sampling point is required to calculate the carbon mole number based on the hydrocarbon compounds, of which methane is typically the major component.

Measurement of natural gas composition

The Raman Rxn5 analyzer is a unique solution to the sampling and measurement of the natural gas feed stream to the reformer. A typical Raman spectrum and stream composition for a natural gas feed stream is shown in Figure 2. Peaks and combination of peaks for all the $C_1 - C_4$ hydrocarbons (HCs) allow all the main C-containing components to be speciated and quantified for the carbon mole number measurement. The ability of the Raman Rxn5 analyzer to also measure non-C and non-HC species, such as N_2 and CO_2, at the same time improves the overall accuracy of the measurement. In addition, as the Raman Rxn5 is essentially transparent to moisture, any residual moisture leakage into the process stream after the desulfurization and dryer units does not interfere with the analysis or present a long term maintenance issue.

Reliability issues with traditional methods for natural gas analysis

In general, natural gas Btu is analyzed via speciation and calculation of Btu property using process gas chromatography (GC) or mass spectrometry (MS). Alternatively, it is measured as a bulk physical property (e.g. Wobbe Index analyzers correlate Btu with excess O_2 monitored during a combustion process internal to the analyzer). Both technologies require a low pressure sample and sample transportation if the analyzer cannot be located close to the sample tap point, adding lag time to the speed of analysis. In addition, while some bulk property analyzers provide fast analysis times, whenever there is a change in the Btu value, it is not possible to validate or troubleshoot the cause as no speciation of the components is available.

* See the general Ammonia: production analytics overview

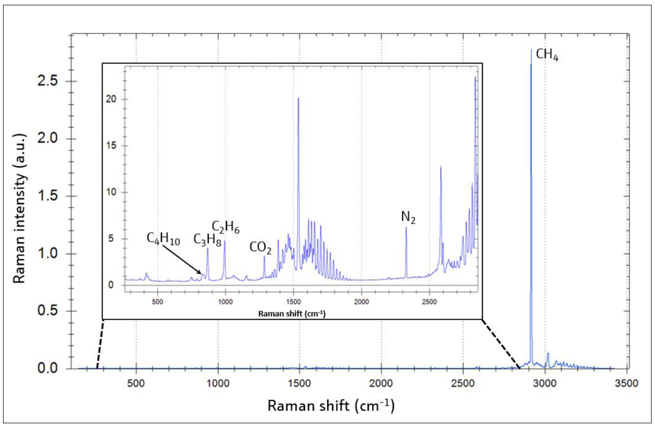

Figure 2: Typical Raman spectrum for natural gas

Solution: Raman Rxn5 analyzer with the natural gas feed to primary reformer

In the case of relatiavely 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). 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 analyzer for the natural gas feed to the primary reformer 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 natural gas feed to primary reformer method

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

Typical stream composition

Component	Range (Mol%)	Normal (Mol%)	Precision (Mol%) k=2	Cal gas (Mol%)	Precision (Mol%) k=2
Methane	75-100	94	0.07	90	0.07
Ethane	0-5	2	0.01	3	0.01
Propane	0-2	1	0.01	1.5	0.01
Butane	0-2	1	0.01	1.5	0.01
Nitrogen	0-2	1	0.01	2	0.01
Carbon dioxide	0-2	1	0.01	2	0.02

Table 1: Typical process conditions and stream composition

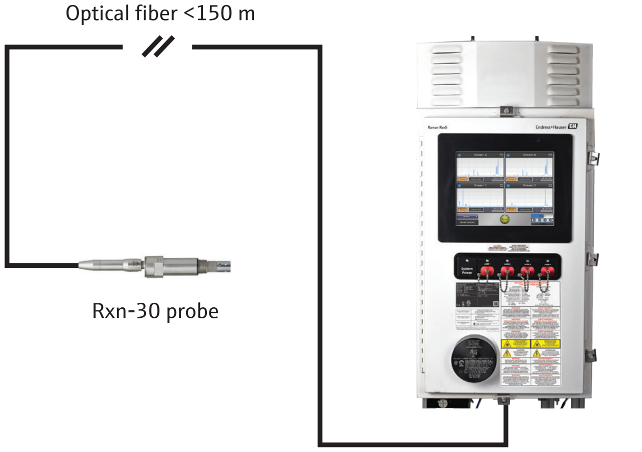

Figure 3: Recommended system configuration

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