Application Note

AM5: High temperature shift converter outlet

Industry: Ammonia
Application Note AM5

Key Points

- Unique spectroscopic capability to measure all syngas components, including H_2 and N_2
- Pipe-centric sampling and measurement at the sample tap
- The OptoDRS Sampling System is a unique front end to allow measurement at process P and T
- Complete syngas speciation
- No valves, columns, or carrier gas
- No routine calibration required
- No interference from moisture vapor in the raw syngas sample after preconditioning by the OptoDRS

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.

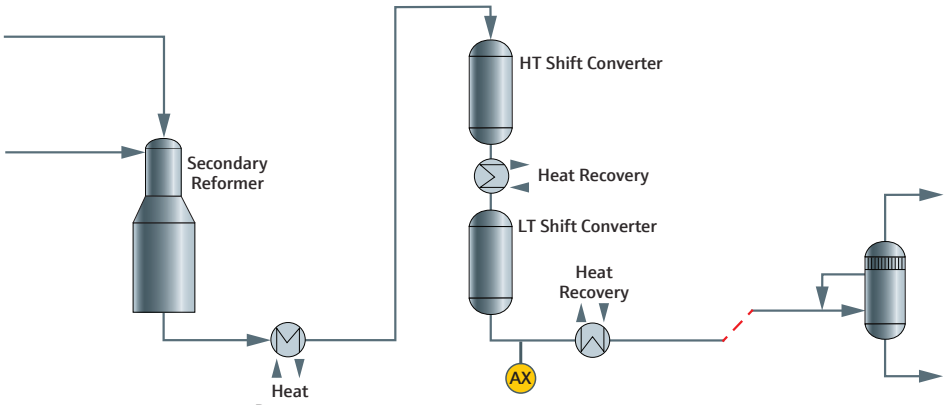

Figure 1: Shift Converter Process Diagram Sections of Ammonia Plant Process Units*

Measurement of HTS converter syngas The Optograf™ Analyzer combined with an OptoDRS™ process and sampling interface is a unique solution to the sampling and measurement challenges in analyzing the composition of this particular process stream. A typical Optogram 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 Optogram. Any residual moisture still present in the stream after condensation in the OptoDRS sampling interface 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 carry-over becomes the main sampling system challenge as this event can damage columns in a GC or damage the ionization chamber in a MS. The AirHead™ probe cannot be damaged by liquid carry-over and cleaning is simple and straightforward.

* See the general Ammonia Production Overview Application Note (AM0).

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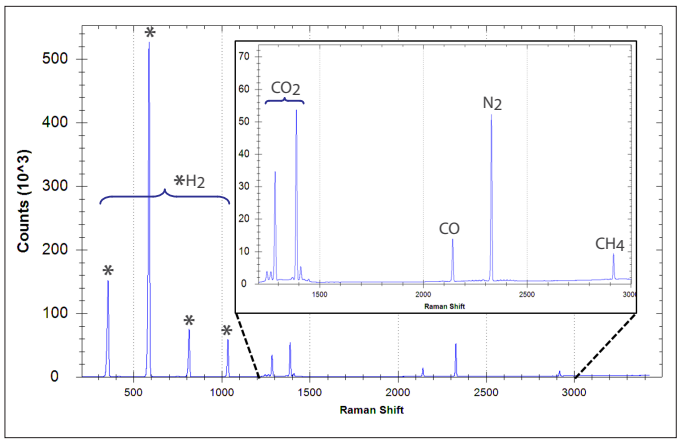

Figure 2: Typical Optogram for HTS Converter Syngas Effluent

Typical Process Conditions	P (barg)	T (°C)
At Sample Tap	33	400
At AirHead™ 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

The solution: Optograf™ Analyzer high temperature shift converter outlet application kit. 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 OptoDRS process and sampling interface is a preconditioning liquid condenser (typically vortex cooled using instrument air) and a sample conditioning system including an AirHead™ probe as a fully integrated sampling and sensor measurement system located at the sample tap. This pipe-centric solution is unique for this stream and essentially eliminates the potential for liquid carry-over. As such, it is a significantly more reliable sampling and measurement front-end which overcomes the traditional dilemma of the analyzer performance being totally dependent on the performance and reliability of the sampling system.

The Optograf Raw Syngas – primary reformer outlet application kit consists of the following:

- Laser Module with installation kit
- AirHead™ Fiber Optic Probe
- Fiber Optic Cable (length from 15 to 150 meters, customized to your plant requirements)
- Dedicated syngas primary reformer outlet Method

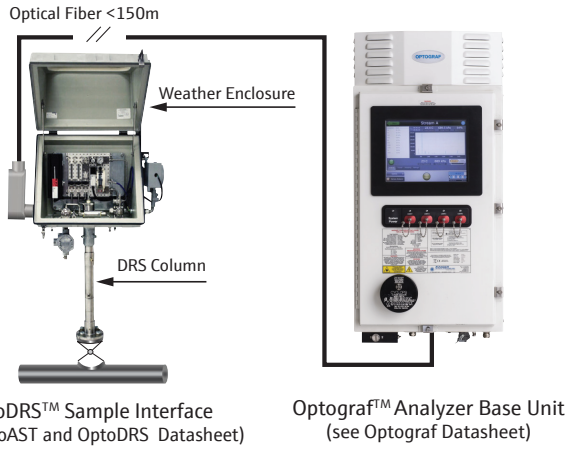

Figure 3: Recommended System Configuration

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