# Application Note

# AM6: Low temperature shift converter outlet

**Industry: Ammonia**
**Application Note AM6**

## 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 LTS converter outlet sample after preconditioning by the OptoDRS

The Low Temperature Shift (LTS) Converter is the second stage of the water-shift conversion reactions to maximize the yield of $H_2$ by converting the remaining CO after the HTS into $H_2$ and $CO_2$. Steam injection flow is controlled by a feedback loop based on the measurement of the $H_2$ composition in the LTS effluent stream. The major analytical challenge for measuring this syngas type stream is the high temperature and steam saturated sample which traditionally have been a major problem in performing reliable sampling and analysis.

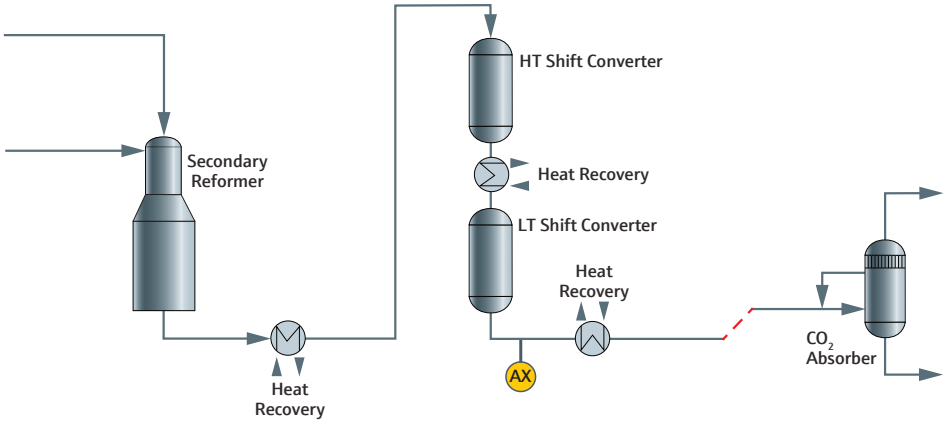


Figure 1: Shift Converter Process Diagram Sections*

**Measurement of LTS converter syngas** The Optograf™ Analyzer combined with an OptoDRS™ process and sampling interface is a unique solution to sample and measure this particular process stream. A typical Optogram for a LTS converter effluent stream is shown in Figure 2. Note the simplicity and complete speciation of individual spectral peaks in the Optogram. Any residual moisture still present in the stream after condensation in the OptoDRS sampling interface is not visible in the frequency range of the spectrum. Hence, it cannot interfere with 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 as well as any slow fouling that may occur.

**Reliability issues with traditional methods for LTS converter effluent analysis** The LTS converter outlet stream composition is typically measured with process Gas Chromatography (GC) or Mass Spectrometry (MS). Both technologies require transporting and conditioning the sample at both the sample tap and at the sample conditioning panel close to the analyzer. In the case of the LTS converter 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 the GC columns or MS ionization chamber. 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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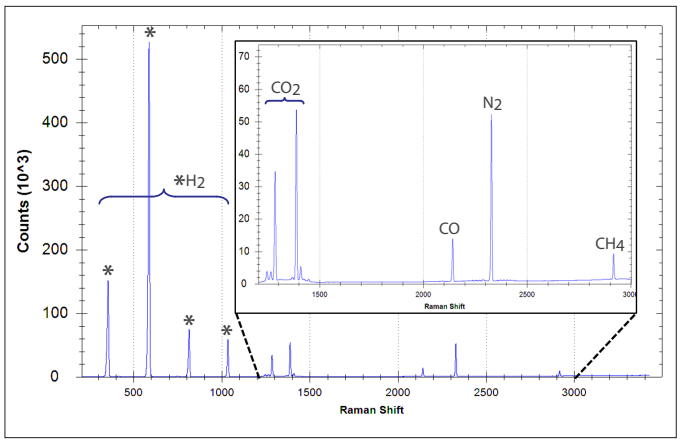


Figure 2: Typical Syngas for the LTS Converter Effluent Stream

| Typical Process Conditions | P (barg) | T (°C) |
|---|---|---|
| At Sample Tap | 31 | 220 |
| At AirHead™ Probe | 31 | 55 |

**Typical Stream Composition**

| Component | Range (Mol%) | Normal (Mol%) | Precision (Mol%) k=2 | Cal Gas (Mol%) | Precision (Mol%) k=2 |
|---|---|---|---|---|---|
| Hydrogen | 40-95 | 61.17 | 0.03 | 64 | 0.03 |
| Nitrogen | 0-35 | 19.6 | 0.03 | 16 | 0.03 |
| Carbon Monoxide | 0-35 | 0.2 | 0.01 | 7 | 0.02 |
| Carbon Dioxide | 0-30 | 18.3 | 0.03 | 10 | 0.02 |
| Methane | 0-35 | 0.43 | 0.01 | 3 | 0.01 |
| Argon | 0-2 | 0.3 | N/M | 0 | N/M |

Table 1: Typical Process Conditions and Stream Composition

**The solution: Optograf™ Analyzer low temperature shift converter outlet application kit.** The use of a liquid removal system is mandatory for the LTS converter outlet stream, which is saturated with steam at high temperature (typically 200-350°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

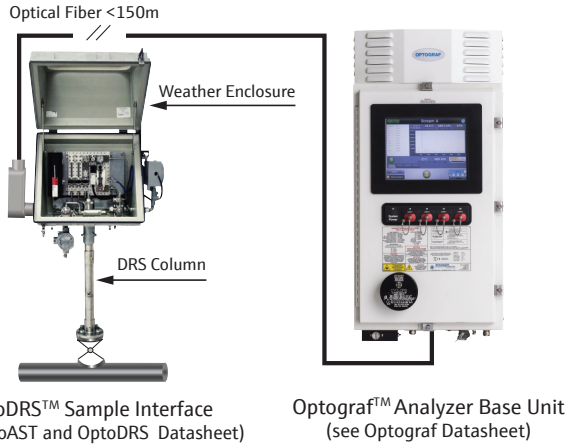


Figure 3: Recommended System Configuration