Captive hydrogen: PSA unit H_2 stream

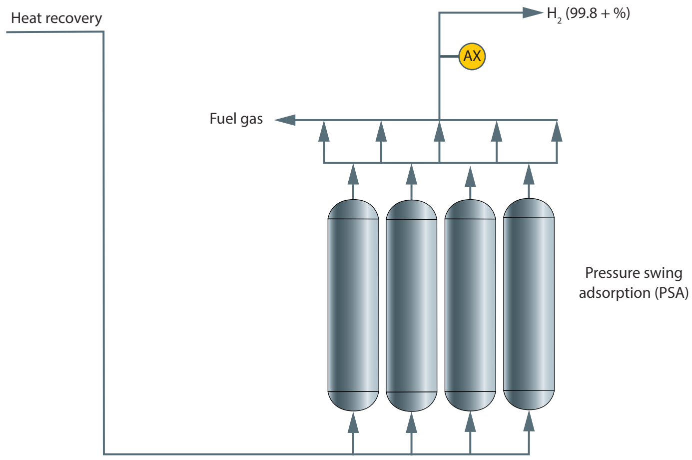

Figure 1: Typical PSA outlet measurement point*

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
- Complete sample speciation
- No valves, columns, or carrier gas
- No routine calibration
- No interference from moisture

Introduction

The final stage in purifying the syngas stream is typically done via a pressure swing adsorption (PSA) unit. See Figure 1 for a simplified process overview of the PSA hydrogen purification process. Special adsorbent material removes the main impurities in the stream such as CH_4, CO, CO_2 and N_2. Multiple adsorber units are typically employed to allow one or more units to be on the adsorption process while other units are being regenerated, which is accomplished by purging them with hot air or N_2. Cycling of the PSA adsorbers is relatively fast (typically less than 10 minutes), requiring fast analysis to prevent breakthrough of any of the contaminants.

Measurement of the PSA unit H_2 outlet stream

The Raman Rxn5 analyzer is a unique integrated sampling and measurement solution for the PSA outlet stream. A typical Raman spectrum and stream composition for a PSA unit H_2 outlet stream is shown in Figure 2. Note the simplicity, baseline separation, and complete speciation of the individual H_2, N_2, CH_4, and CO_2 spectral peaks in the Optogram. No other spectroscopic technique is capable of measuring the H_2 and N_2 diatomics in this stream. In addition, 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 PSA H_2 stream analysis

The PSA H_2 stream is measured with process gas chromatography (GC) or mass spectrometry (MS). Both technologies require transporting the sample and doing sample conditioning at both the sample tap and at the sample conditioning panel close to the analyzer. Protecting the GC or MS analyzers from even small amounts of liquid carryover becomes the main sampling system challenge, as this event can damage columns in a GC or damage the ionization chamber in a MS. The Rxn-30 probe cannot be damaged by liquid carryover or fouling and cleaning is simple and straightforward.

*See the Captive hydrogen: production analytics overview

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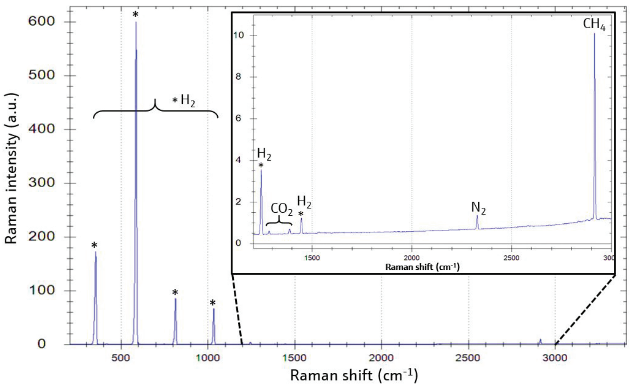

Figure 2: Raman spectrum of a typical PSA unit H_2 stream

Solution: Raman Rxn5 analyzer with the PSA Unit H_2 stream method

In the case of a clean and dry sample like the PSA purified H_2 stream, the Raman Rxn5 analyzer with Rxn-30 probe allows for a wide range of sample pressure (70 to 800 psia) and a 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 PSA unit H_2 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 PSA unit H_2 stream method

Typical process conditions	P (barg)	T (°C)
At sample tap	17	50
At Rxn-30 probe	17	55

Typical stream composition

Component	Range (Mol%)	Normal (Mol%)	Precision (Mol%) k=2	Cal gas (Mol%)	Precision (Mol%) k=2
Hydrogen	80-100	99	0.05	97	0.05
Nitrogen	0-2	0.4	0.02	1	0.02
Carbon dioxide	0-1	0.1	0.01	1	0.01
Methane	0-2	0.5	0.01	1	0.01

Table 1: Typical process conditions and stream composition

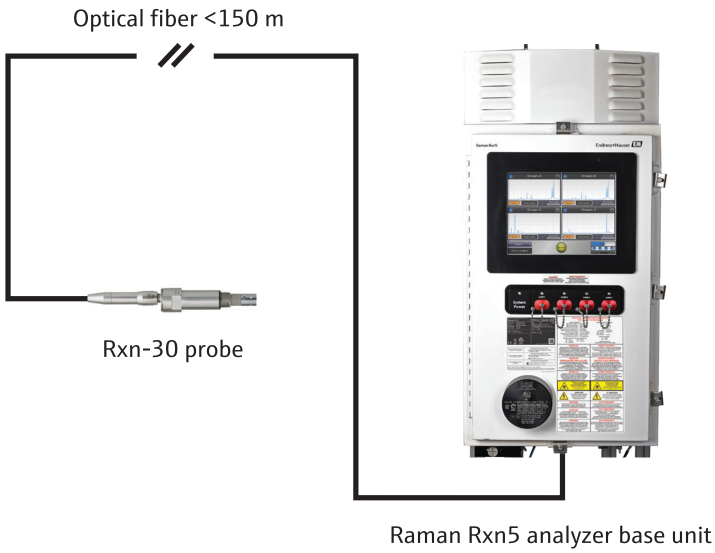

Figure 3: Recommended system configuration