APPLICATION NOTE

Chemical

Consumption measurement of hydrogen (H_2) at a chemical plant

- Ultrasonic flow measurement of H_2 from syngas production
- Reliable and safe monitoring of hydrogen supply to production units
- Drift-free measurement over a wide dynamic range up to 1300 Nm^3/h

1. Background

A manufacturer of organic and inorganic chemicals operates a production site in the Czech Republic. For chemical synthesis processes, the company uses hydrogen (H_2), which is produced on site from synthesis gas (syngas) and fed to individual production units.

2. Measurement requirements

Syngas, a gas mixture of hydrogen and carbon monoxide, is produced by steam methane reforming (SMR), which is still by far the most applied method to cost-effectively produce hydrogen. During steam reforming, an endothermic reaction process of natural gas feedstock with water/steam (H_2O) is applied to react methane (CH_4) to carbon monoxide (CO) and H_2. The equilibrium reaction taking place is dependent on pressure and temperature and is controlled in such a way that a particularly large amount of hydrogen can be obtained. The residual CO is then removed from the Syngas stream by adsorption and can be further oxidised to CO_2, forming additional H_2 using the water-gas shift reaction (WGS) to further increase hydrogen yield.

The purified hydrogen is subsequently transported to the production plants via a pipeline (size DN100) at pressures of 4...6 barg / 58...87 psig and temperatures of +5...+25°C / +41...+77°F. The operator required a flowmeter to measure hydrogen consumption accurately and reliably. The flow instrument had to be field proven in the measurement of hydrogen and have a wide dynamic measuring range to be able to measure the fluctuating flow rate of 20...1300 Nm^3/h.

Steam methane reforming (SMR) reaction

$CH_4 + H_2O \rightarrow CO + 3H_2$

Water-gas shift reaction (WGSR):

$CO + H_2O \rightarrow CO_2 + H_2$

KROHNE

3. KROHNE solution

The chemical company opted for the OPTISONIC 7300 ultrasonic flowmeter to measure higher flow rates of hydrogen at moderate pressures. The KROHNE gas flowmeter has a long track record in challenging flow applications involving methane, methane/hydrogen mixtures and high purity hydrogen. It is field proven for H_2 measurement and meets the demanding requirements in this application. As a full-bore flowmeter without moving or protruding parts, it causes only a negligible pressure loss. It measures from virtually zero flow and features a wide measuring range while easily handling fluctuating flow rates.

Hydrogen, with its peculiar behaviour and medium properties, always deserves special attention when engineering a flowmeter. That's why KROHNE engineers carried out a detailed sizing check, taking into account the prevalent on-site conditions at the measuring point. It turned out that the most suitable transducer design for this application was based on a Duplex steel material composite, installed in a standard steel pipe – a cost effective and suitably safe choice.

Flow measurement of hydrogen with the OPTISONIC 7300 ultrasonic flowmeter

The flowmeter was calibrated with air at atmospheric pressure prior to delivery and installed in the DN100 pipeline located in an outdoor hazardous area. The ultrasonic flowmeter was therefore supplied in an intrinsically safe design. Due to its 2-path configuration, the straight inlet run of the flowmeter was only 10DN, reducing the installation effort. The readings from the OPTISONIC 7300 are transmitted via 4…20 mA to the control room, where the flow rate is converted to standard conditions using existing pressure and temperature measurements.

4. Customer benefits

The customer benefits from reliable, safe and accurate hydrogen consumption measurement. Due to the wide measuring range of the OPTISONIC 7300, the hydrogen gas flow measurement is maintained in all operating modes of the plant. Using the transit-time differential principle, the ultrasonic flowmeter provides drift-free measurement. Unlike flowmeters with rotating parts, there is no need for periodical recalibration and maintenance, giving the KROHNE ultrasonic flowmeter an advantage over, e.g. positive displacement meters and meters with similar measuring principles. As hydrogen has a relatively high sound velocity, the OPTISONIC 7300 can also be used to detect impurities or an increase in the amount of other gases in the hydrogen stream by using its integrated sound velocity measurement.

Whether it is process measurements or custody transfer measurements, KROHNE has mastered many facets of hydrogen applications and applications with natural gas /hydrogen mixtures. These include syngas plants, but also power-to-gas (P2G) plants and transport lines. It has a hydrogen-ready portfolio of flow, pressure and temperature instruments as well as metering and pipeline leak detection systems for hydrogen. Next to the supply of the instruments, KROHNE offers the full scope of pre- and after-sales services from planning, engineering and calibration to commissioning and verification.

5. Product used

OPTISONIC 7300

- Ultrasonic flowmeter for natural gas, hydrogen and other gases
- 2-path meter for standard volume flow, independent of media properties
- No maintenance, no pressure loss, large dynamic range
- Flange: DN50…1000 / 2…40", max. PN450 / ASME Cl 2500; also weld-in connections

ETA Process Instrumentation
www.etapii.com
sales@etapii.com
tel 978.532.1330
New England

Martech Controls
www.martechcontrols.com
sales@martechcontrols.com
tel: 315.876.9120
Upstate New York