Hydrogen application technology

Enabling a clean-energy future with hydrogen-proven measurement solutions

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Process Gas chromatography analytical solution
Hydrogen industry
Green Hydrogen Production

Typical process flow / measuring points

# Green hydrogen production

Measuring points and ABB analyzer offering

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TCD = Thermal Conductivity Detector; NDIR = Non-Dispersive Infra Red; NDUV = Non-Dispersive Ultra-Violet; PMD = ParaMagnetic Detector
Impurity Measurement in Hydrogen

ABB Solution with PGC5000 Gas chromatography

The impurity measurement in Hydrogen is important

- to protect and expand the lifetime of a fuel cell catalyst
- to optimize the conversion rate
- Minimize the forming of byproducts which harm the environment or can be corrosive
Impurity Measurement in Hydrogen

ABB Solution with PGC5000 Gas chromatography

Main Impurities of interest to be measured at low ppm / ppb level are

- Oxygen
- Nitrogen
- CH4
- Total Hydrocarbons
- Total Sulphur
- NH3
- CO
- CO2

All of these components can be measured in low ppm down to ppb level with our PGC5000 Gas chromatograph and an FID, FPD and DBDID Argon or Helium Plasma Detector (Dielectric Barrier Discharge Ionization Detector)
Impurity Measurement in Hydrogen

ABB Solution with PGC5000 Gas chromatography

The ABB PGC5000 Process Gaschromatograph specification

- Rugged analyzers concept for ATEX Zone 1 or 2
- Sensitive DBDID Plasma Detector to measure down to ppb level
- Sensitive Flame Photometric Detector for Sulphur components
- Airless oven design without Instrument Air supply in Zone 2
- Integrated Oven design for small Footprint
- Communication capabilities – TCP/IP, MODBUS, Analog + Digital In-/ Outputs
- Dual Ethernet port
- Remote Control with wireless option
PGC 5000 Smart Oven™ – Airless Module

**Features**
- Compatible with B and C-class oven
- Multi-oven capability
- Complete line of detectors and applications
  - sTCD, mTCD, FID, FPD,
  - Liquid and vapor applications
- Common spares parts for all PGC5000 models
- No instrument air consumption in Div 2/Zone 2 installations

**Benefits**
- Reduced total cost of ownership
- No instrument Air consumption
- Lower cost of installation
  - No need to run extensive networks of instrument air tubing
- Ease of maintenance
  - Component accessibility of oven hardware
NGC 8200 Series Process Gaschromatographs
Hydrogen industry
NGC8206/PGC1000 Gaschromatograph

Hydrogen Measurement in Natural Gas

- C6+ application suitable for custody transfer of natural gas incl. H2 up to 0 to 10 % with Helium carrier gas
- **OIML R 140 / MID / WELMEC 8.8 2017 Certified by NMi Netherlands in April 2021**

- C6+ and 0 to 20 % H2 with Helium carrier gas available (NMi Certification will be extended available End of 2022)
NGC8206/PGC1000 - Specifications

- Small Footprint  D400 x W242 x H 225 mm
- Easy to install and Maintain
- ATEX  II 2G : Ex d, IIB+H2 T6;
- Four sample stream streams incl. manual calibration
  or
- Three sample streams incl. auto calibration
- Dual Calibration Streams possible
- Operating Temperature -18 to 55°C
- Power: 12 or 24 VDC
  7 watts nominal
  45 watts at start up
- Low carrier gas consumption, about 1 x 50L Helium bottle per year
Data Management System
Remote Network Communication Capability
Continuous Gas Analyzers
Hydrogen industry
Continuous Gas Analyzers
What can we learn from building houses in Norway?
Continuous Gas Analyzers

What can we learn from building houses in Norway?

1) Average 0.5 hour of sunshine in a day of less then 7 hours in Bergen during winter
   ➔ We want to have as much light and windows as possible.

2) It might get cold outside: maximum average temperature is 5°C
   ➔ So we need our windows to keep the cold outside.

So, what do we learn?

When building houses in Norway, we use windows with insulating glass.
Continuous Gas Analyzers

Thermal conductivity of gases in relation to air = 100
Caldos27
Thermal conductivity detector (TCD)

Fast thermal conductivity detector

Capabilities
- Component: $\text{H}_2$
- Ranges: 0 – 3000 ppm up to 0 - 100 vol%
- Suppressed ranges: up to 99 – 100 vol%

Advantages
- Flexibility to cover wide variety of applications
- Fast response ($t_{90} < 2s$) for improved process control
- Easy to calibrate
- Easy to change measuring range
- Highest performance thermal conductivity detector at lowest cost
Continuous Gas Analyzer in hydrogen applications
Electrolyzers
Electrolyzer
Production of hydrogen and oxygen
Measuring tasks selector

Electrolysis occurs in a device known as an electrolyzer. The electrolyzer is used to split water into its constituent elements: hydrogen and oxygen. Hydrogen is produced at the cathode (negative pole) and oxygen at the anode (positive pole). The reactions are as follows:

**Cathode Reaction:**
\[ 4H^+ + 4e^- \rightarrow 2H_2 \]

**Anode Reaction:**
\[ 2H_2O \rightarrow O_2 + 4H^+ + 4e^- \]

- **Hydrogen production** includes monitoring purity and impurities of hydrogen using paramagnetic and thermal conductivity analyzers.
- **Oxygen production** involves checking purity and impurities of oxygen with a combined analyzer module.

This process is essential for various applications, including energy storage and new market trends with hydrogen.
Continuous Gas Analyzer for the oxygen side
Oxygen side electrolyzer – purity of oxygen
Analyzer selection table with Magnos28 (paramagnetic)

Area classification

Hazardous area
- ATEX Zone 1
  - EL3060
  - AO2020/AO2040
  - EL3040
- ATEX Zone 2
- Class1, Div2
  - AO2020/AO2040
  - EL3040

General Purpose
- AO2020/AO2040
- EL3020/EL3040
Oxygen side electrolyzer – impurity of hydrogen
Analyzer selection table with Caldos27 (thermal conductivity)
Continuous Gas Analyzer for the Hydrogen side
Hydrogen side electrolyzer – purity of hydrogen
Analyzer selection table with Caldos27 (thermal conductivity)
Hydrogen side electrolyzer – impurity of oxygen
Analyzer selection table with Magnos28 (paramagnetic)
Hydrogen side electrolyzer – impurity of oxygen
Analyzer selection table with Caldos27 (thermal conductivity)
(lowest range 0-2 vol% O₂ in H₂)

Area classification

- Hazardous area
  - ATEX Zone 1
    - EL3060
      - Caldos27
  - ATEX Zone 2
  - Class 1, Div 2
    - AO2020/AO2040
      - Caldos27
    - Safety Concept
      - Caldos27

- General Purpose
  - AO2020/AO2040
    - Caldos27
  - EL3020/EL3040
    - Caldos27

Back to measuring task selector
Continuous Gas Analyzer Configuration
Purity oxygen
Possible suppressed ranges
- 98 – 100 vol% \(O_2\)
- 99.5 – 100 vol% \(O_2\)

Purity hydrogen
Possible ranges
- 0 – 5000 ppm \(O_2\)
- 0 – 1 vol% \(O_2\)
- 0 – 2 vol% \(O_2\)
Important remark regarding safety measures to be taken by end-user for applying this analyzer above atmospheric conditions (or > 21 vol% $O_2$)

Possible suppressed ranges
- 98 – 100 vol% $O_2$
- 99.5 – 100 vol% $O_2$

Purity oxygen

Purity hydrogen
Possible ranges
- 0 – 5000 ppm $O_2$
- 0 – 1 vol% $O_2$
- 0 – 2 vol% $O_2$
AO2020/AO2040
Magnos28

Purity oxygen
– Possible suppressed ranges
– 98 – 100 vol% O₂
– 99.5 – 100 vol% O₂

Purity hydrogen
Possible ranges
– 0 – 1 vol% O₂
– 0 – 2 vol% O₂
AO2020/AO2040
Magnos28 – Safety Concept

Analyzer housing
Restricted breathing, purgeable

Sensor
Hermetically sealed SS piping, Direct connections interface

Purity hydrogen
Possible ranges
- 0 – 5000 ppm O₂
- 0 – 1 vol% O₂
- 0 – 2 vol% O₂
EL3020/EL3040
Caldos27

Purity oxygen
Possible ranges
- 0 – 3000 ppm \( \text{H}_2 \)
- 0 – 5000 ppm \( \text{H}_2 \)
- 0 – 1 vol% \( \text{H}_2 \)
- 0 – 2 vol% \( \text{H}_2 \)

Purity hydrogen
Possible ranges for oxygen
- 0 – 2 vol% \( \text{O}_2 \)
Possible ranges for hydrogen
- 98 – 100 vol% \( \text{H}_2 \)
- 99 – 100 vol% \( \text{H}_2 \)
Important remark regarding safety measures to be taken by the end-user for applying this analyzer above atmospheric conditions (or > 21 vol% O$_2$)

Possible ranges
- 0 – 3000 ppm H$_2$
- 0 – 5000 ppm H$_2$
- 0 – 1 vol% H$_2$
- 0 – 2 vol% H$_2$

Purity oxygen

Purity hydrogen
- Possible ranges for oxygen
  - 0 – 2 vol% O$_2$
- Possible ranges for hydrogen
  - 98 – 100 vol% H$_2$
  - 99 – 100 vol% H$_2$
AO2020/AO2040
Caldos27

Purity oxygen
Possible ranges
- 0 – 3000 ppm H₂
- 0 – 5000 ppm H₂
- 0 – 1 vol% H₂
- 0 – 2 vol% H₂

Purity hydrogen
Possible ranges for oxygen
- 0 – 2 vol% O₂
Possible ranges for hydrogen
- 98 – 100 vol% H₂
- 99 – 100 vol% H₂
Purity hydrogen
Possible ranges for oxygen
- 0 – 2 vol% O₂
Possible ranges for hydrogen
- 98 – 100 vol% H₂
- 99 – 100 vol% H₂
Combinations of analyzers in one housing
Combined solution – only possible with EL3000
Measurement of purity or impurities in the hydrogen and oxygen streams with one analyzer housing with two analyzer modules (*)

- Caldos27 purity H₂ in O₂ with Caldos27
- Caldos27 impurity H₂ in O₂ with Caldos27
- Magnos28 impurity O₂ in H₂ with Magnos28
- Caldos27 impurity H₂ in O₂ with Caldos27
- Caldos27 purity O₂ in H₂ with Caldos27
- Magnos28 purity O₂ in H₂ with Magnos28
- Magnos28 impurity O₂ in H₂ with Magnos28

(*) = multiple analyzer modules also possible in multiple analyzer housings with AO2000 series

Back to measuring task selector
New market trends with hydrogen
(Natural) Gas Turbine Overview
Fuel and its usage

Now... Natural gas

Future... Hydrogen
The existing natural gas infrastructure will be reused (in phases) for the transport of Green Hydrogen.

Most natural gas networks can handle various blends of Hydrogen, starting at 2%, then 10, 20% and eventually 100%.

There are systems already in operation that run high Hydrogen blends in their gas grids, such as Hong Kong which operates on town gas with 50% Hydrogen.
How to measure $\text{H}_2$ in natural gas?
Can we measure H2 in natural gas?

Thermal conductivity is measured in a binary gas mixture.

Natural gas is a mixture of mainly CH₄, C₂H₆, C₃H₈, and CO₂

The solution:
measure these 4 components and give the information to the thermal conductivity analyzer.
A smart algorithm will determine the thermal conductivity of this mixture and can calculate exactly the hydrogen content.

Continuous Gas Analyzers
We can measure $H_2$ in natural gas
Uras26

How to measure IR absorbing components
Measuring H2 in natural gas
A fast solution

Measure with Uras26
Concentrations of CH₄, C₂H₆, C₃H₈ and CO₂

Measure with Caldos27
Use background gas measurement to determine H2 concentration

Result
Fast measurement T90 in total 5 sec
(T90 Uras26 < 2,5 sec)
(T90 Caldos27 < 2 sec)

Calculation of CV, Wobbe and fast H2 measurement

No utility gases needed for analyzer operation

Ideal for monitoring process conditions, blending, safety, etc

Alternative to classic NGC or PGC1000 method
Continuous Gas Analyzers or Gas Chromatograph?

It is all-in the portfolio of ABB!
Thank you for your attention! Now it’s time for your questions.