Process Insights™
Premium Insights Into Process

REAL-TIME
GAS ANALYZERS

APPLICATIONS BULLETIN

UPDATED

Advanced Analytical Solutions for Fuel Cell Hydrogen Analysis

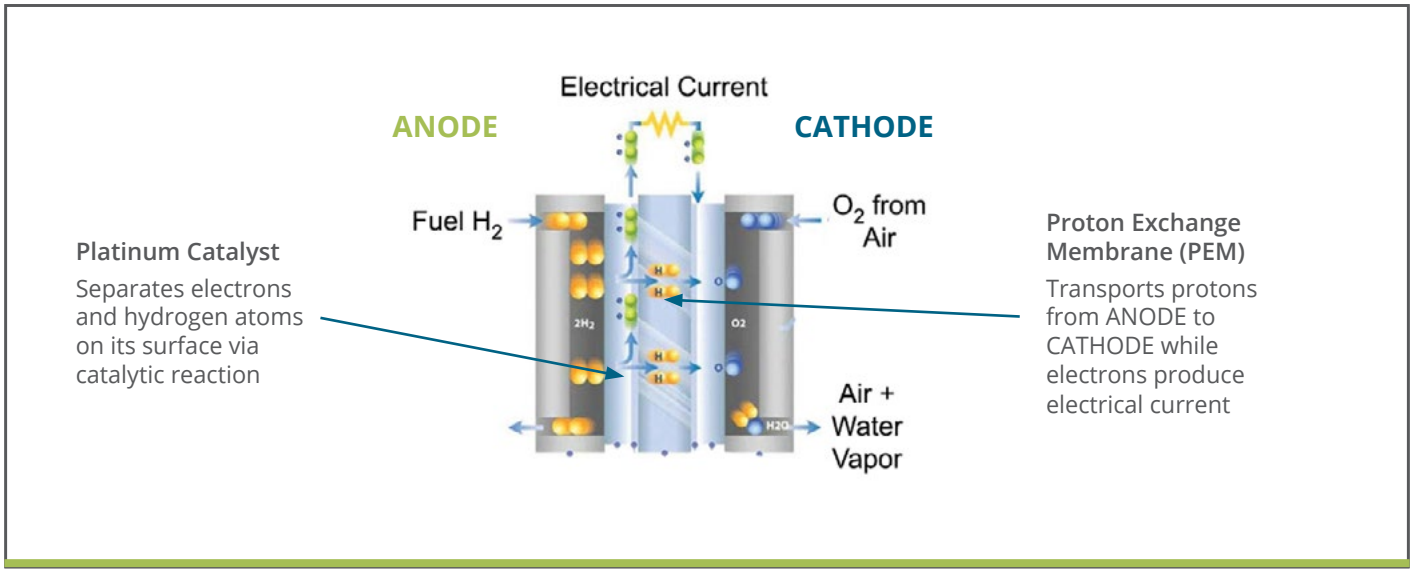
The combined portfolio of Process Insights' powerful analytic instruments for analysis of fuel-cell-grade hydrogen offers:

- Combination of three powerful analytical technologies: Cavity Ring-Down Spectroscopy (CRDS), Mass Spectrometry (MS) and Gas Chromatography (GC)
- Analysis of all critical contaminants listed in hydrogen purity standards ISO 14687 and SAE J2719: He, N_2, Ar, CH_4, H_2O, O_2, CO, CO_2, CH_2O, NH_3, HCl, sulfurs, and more
- Ideal detection limits from part-per-million (ppm) down to sub-part-per-billion (ppb) in line with requirements outlined in ISO 21087

Fuel Cells and Hydrogen Purity

High-purity hydrogen is crucial to the performance and lifetime of fuel cells. The critical components of the fuel cell are the platinum catalyst and the proton exchange membrane (PEM). Both can experience significant loss in performance or even irreversible damage in the presence of contaminants on the anode side (hydrogen side) of the fuel cell.

Principle of a PEM Hydrogen Fuel Cell used in FCEVs



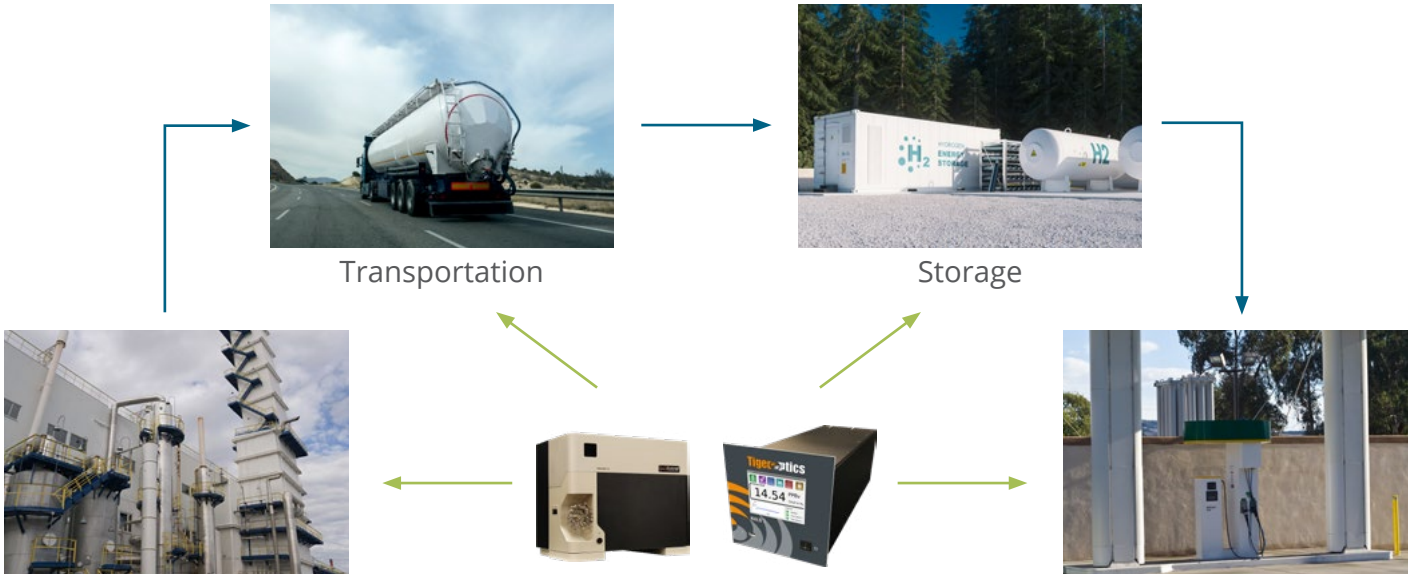
Hydrogen Purity and Measurement Standards

Most countries have adopted the international fuel cell hydrogen purity standard ISO 14687, which was developed from the orignal SAE J2719 (Society of Automotive Engineers). Both standards set strict limits for various molecular species that can potentially harm the fuel cell, depending on the severity of the potential harm. Limits range from high part-per-million levels for rather benign species like nitrogen (N_2) or Argon (Ar) to part-per-billions for the most dangerous contaminants, such as carbon monoxide (CO), sulfur compounds or formaldehyde (CH_2O).

We have also worked with ASTM International to create a standard test method for the analysis of fuel-cell hydrogen using CRDS to allow users to take advantage of this powerful analytical method for this application. The standard was finalized in 2014 and is designated as ASTM D7941/D7941M.

Where Hydrogen Purity Measurements are Important

Ensuring Contamination Control Throughout the Hydrogen Supply Chain

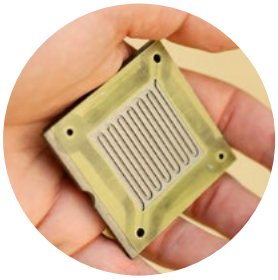


Measurement Challenges for the Fuel-Cell Hydrogen Economy


Electrolysis

Station Commissioning


Laboratory Testing

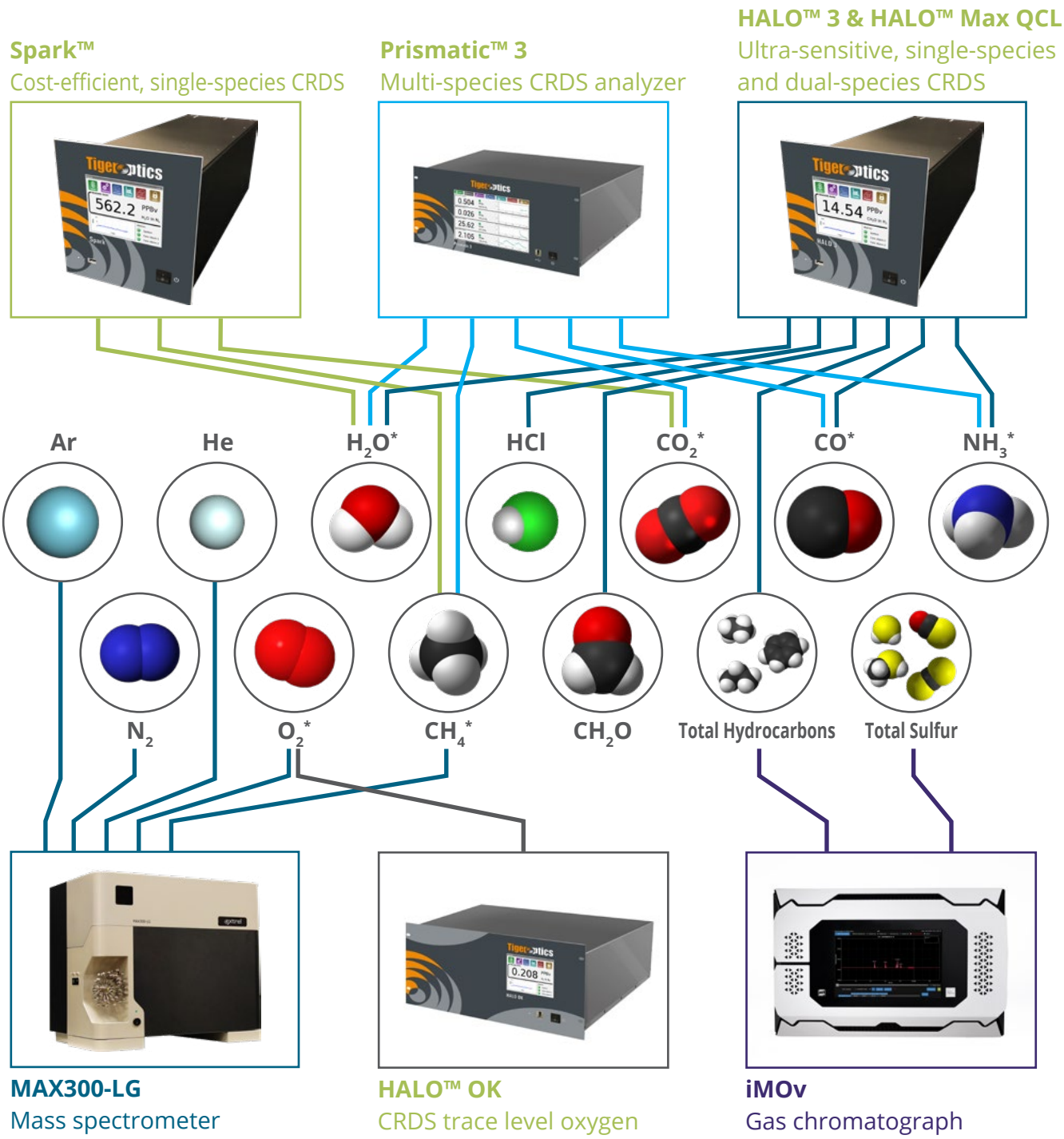

Fuel-Cell Research


Power Generation

Mobility

Products for Hydrogen Purity Analysis

Process Insights' analyzers offer detection limits that are ideally suited for the contaminant limits set by ISO and SAE hydrogen purity standards and fulfill the requirements for analytical techniques outlined in ISO 21087. All TIGER OPTICS CRDS systems are also optimized for H_2 analysis according to ASTM Standard Test Method D7941/7941M.



*For CH_4, NH_3, H_2O, O_2, CO and CO_2 detection, you can choose between dedicated single-species CRDS analyzers (Spark, HALO 3, HALO Max QCL and HALO OK) or the multi-species Prismatic 3 CRDS analyzer and MAX300-LG mass spectrometer. The recommended analyzer combination depends on your specific requirements. Please contact us to discuss your optimum solution.

Products for Hydrogen Purity Analysis—Detection Limit Summary

Summary of ISO/SAE Requirements and Single-Species Analyzer Detection Limits (LDL)

Impurity	ISO 14687/SAE J2719 Concentration Limit	Process Insights LDL (3σ)	Process Insights Analyzer(s)
Methane (CH_4)	100 ppm	0.2 ppm	Spark CH_4*
Moisture (H_2O)	5 ppm	0.0075 ppm	Spark H_2O
Oxygen (O_2)	5 ppm	0.003 ppm	HALO OK*
Carbon Dioxide (CO_2)	2 ppm	0.4 ppm	Spark CO_2
Carbon Monoxide (CO)	0.2 ppm	0.05 ppm 0.0002 ppm	HALO 3 CO HALO Max QCL CO
Formaldehyde (CH_2O)	0.2 ppm	0.006 ppm	HALO 3 CH_2O
Ammonia (NH_3)	0.1 ppm	0.0004 ppm	HALO 3 NH_3
Hydrochloric Acid (HCl)	0.05 ppm†	0.001 ppm	HALO 3 HCl†

Summary of ISO/SAE Requirements and Multi-Species Analyzer Detection Limits (LDL)

Impurity	ISO 14687/SAE J2719 Concentration Limit	Process Insights LDL (3σ)	Process Insights Analyzer(s)
Helium (He)	300 ppm	1.0 ppm	MAX300-LG
Nitrogen (N_2)	300 ppm	3.0 ppm	MAX300-LG
Argon (Ar)	300 ppm	1.0 ppm	MAX300-LG
Methane (CH_4)	100 ppm	0.1 ppm 1.0 ppm	Prismatic 3 MAX300-LG
Moisture (H_2O)	5 ppm	0.1 ppm 0.01 ppm	Prismatic 3 HALO 3 H_2O/NH_3
Oxygen (O_2)	5 ppm	0.5 ppm‡	MAX300-LG
Carbon Dioxide (CO_2)	2 ppm	0.32 ppm	Prismatic 3
Carbon Monoxide (CO)	0.2 ppm	0.05 ppm	Prismatic 3
Formaldehyde (CH_2O)	0.2 ppm	0.02 ppm	HALO 3 CH_2O/HCl
Ammonia (NH_3)	0.1 ppm	0.0075 ppm 0.005 ppm	Prismatic 3 HALO 3 H_2O/NH_3
Total Hydrocarbons, ex. CH_4	2 ppm	0.05 ppm	iMOv
Total Sulfur	0.004 ppm	0.002 ppm	iMOv
Hydrochloric Acid (HCl)	0.05 ppm†	0.002 ppm	HALO 3 CH_2O/HCl

*High-range model with extended detection range. †ISO/SAE spec is for Total Halogens. ‡Excellent vacuum required to achieve LDL.

Products for Hydrogen Purity Analysis—Single-Species Systems

Depending on the raw material and process of generating hydrogen, certain contaminants can be more of a concern than others. TIGER OPTICS single-species CRDS systems are design for highly sensitive and specific detection of a certain molecule of interest. Our Spark and HALO series systems enable effortless and maintenance-free analysis of contaminants, such as water, ammonia, carbon monoxide and more.

For detailed specifications and product datasheets, please visit www.process-insights.com.

Spark H_2O • Spark CH_4 • Spark CO_2

Our lowest-cost CRDS system is ideal to target contaminants with ISO limits in the ppm range, such as H_2O, CH_4 or CO_2. The Spark is compact, easy-to-use and highly specific to the target analyte. Typical applications include H_2O measurements in electrolysis processes and on-site analysis of hydrogen fuel.

HALO 3 NH_3 • HALO 3 CH_2O • HALO 3 CO • HALO 3 HCl

The highly sensitive HALO 3 series is the perfect solution to detect those contaminants that have ISO limits in the part-per-billion range, such as NH_3, CH_2O, CO and HCl. Single-species HALO 3s are used to augment traiditional lab setups that cannot achieve the low limits required for these analytes. The HALO 3 also offers user-friendliness and lack of maintenance.

HALO OK

The HALO OK is the only all-optical trace analyzer for O_2 on the market. It's 3 ppb detection limit easily meets ISO requirements. The HALO OK is a great choice to monitor H_2 from electrolysis, where oxygen contaminants are of particular concern.

HALO Max QCL CO

The HALO Max QCL CO offers the highest sensitivity CO detection with an LDL of 200 parts per trillion. This system is mainly used by fuel cell and catalyst developers to research carbon monoxide contamination at levels well below the ISO limits.

Products for Hydrogen Purity Analysis—Multi-Species Systems

To build portable and stationary fuel-cell hydrogen QC systems, multiple contaminants have to be measured and monitored. Process Insights' multi-species systems lower the cost per analyte and add convenience due to fewer analyzer having to be installed and operated. Our portfolio of CRDS analyzers, mass spectrometers and gas chromatographs can cover all ISO 14687 target contaminants from part-per-million to part-per-billion concentrations.

For detailed specifications and product datasheets, please visit www.process-insights.com.

Prismatic 3

The all-optical Prismatic 3 CRDS system detects up to four molecules simultaneously in a single gas stream. H_2O, CH_4, CO, CO_2 and NH_3 are available as analytes of choice. The Prismatic 3 can be used as part of a complete H_2 QC system or as a stand-alone units for four key contaminants.

NEW! HALO 3 H_2O/NH_3 and HALO 3 CH_2O/HCl Dual-Species Systems

The newly developed dual-species HALO 3 models offer almost 50% cost saving for two specific combinations of detections in the ppb range: H_2O & NH_3, and CH_2O & HCl. The specific analyte measured can be selected manually or switched remotely. These systems are used in electrolyzer applications and as part of our total solution.

MAX300-LG Mass Spectrometer

The MAX300-LG, based on quadrupole mass spectrometry, is a perfect addition to our portfolio of CRDS systems as it can detect molecules that are undetectable with optical technologies, such as N_2, He, Ar. It can also detect CH_4 and O_2, allowing up to five critical contaminants to be covered by a single analyzer.

iMov Gas Chromatograph

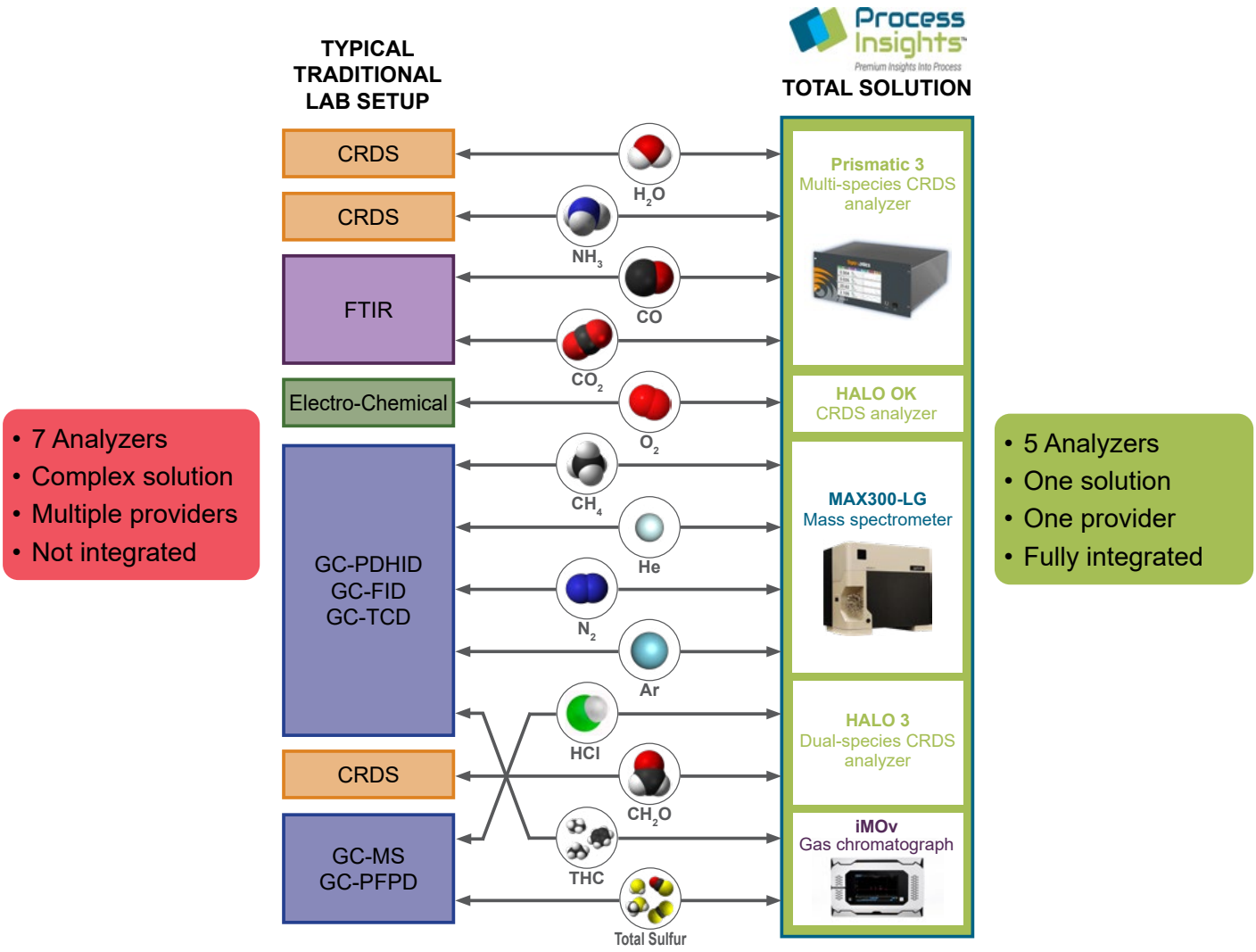
The compact iMOv gas chromatograph addresses the measurements of relevant sulfur compounds to determine total sulfur, as well as total hydrocarbons. This GC is manufactured by a Process Insights partner but comes fully integrated into our total solution.

Process Insights Total Solution

In the past, a complete monitoring solution for H_2 purity, which can cover all species listed in ISO 14687 or SAE J2719 involved a complex setup using as many as seven or more different analyzers from multiple providers, with no integration.

Introducing Process Insights' total solution: Only five analyzers are required, and these can be fully integrated into one single-provider system.

Comparison: Traditional Lab Setup vs. Process Insights Total Solution



Product Links and References

Product Links

Spark H_2O	process-insights.com/products-3/products-industrial/spark-h2o/
Spark CH_4	process-insights.com/products-3/products-industrial/spark-ch4/
Spark H_2O	process-insights.com/products-3/products-industrial/spark-co2/
HALO 3 NH_3	process-insights.com/products-3/products-high-purity/crds-gas-analyzers-for-high-purity/halo-3-nh3/
HALO 3 CH_2O	process-insights.com/products-3/products-high-purity/crds-gas-analyzers-for-high-purity/halo-3-ch2o/
HALO 3 CO	process-insights.com/products-3/products-high-purity/crds-gas-analyzers-for-high-purity/halo-3-co/
HALO 3 HCl	process-insights.com/products-3/products-high-purity/crds-gas-analyzers-for-high-purity/halo-3-hcl/
HALO OK	process-insights.com/products-3/products-high-purity/halo-ok/
HALO Max QCL CO	process-insights.com/products-3/products-high-purity/crds-gas-analyzers-for-high-purity/halo-max-qcl-co/
Prismatic 3	process-insights.com/products-3/products-industrial/prismatic-3/
MAX300-LG	process-insights.com/products-3/products-industrial/mass-spectrometers-gas-analyzers/max300-lg/

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SAE J2719, "Hydrogen Fuel Quality for Fuel Cell Vehicles," Society of Automotive Engineers, sae.org/standards/content/j2719_202003/

ISO 14687:2025, "Hydrogen Fuel Quality – Product Specification," International Organization for Standardization, iso.org/standard/82660.html

ISO 21087:2019, "Gas analysis – Analytical methods for hydrogen fuel – Proton exchange membrane (PEM) fuel cell applications for road vehicles," International Organization for Standardization, iso.org/standard/69909.html

GAIN REAL-TIME INSIGHT INTO YOUR PROCESS

Process Insights delivers premium analytical sensors, analyzers, instrumentation, software and solutions that are mission-critical to keep your operations, personnel, and the environment safe. Our commitment to customer satisfaction is evident through our diverse range of products, programs, and services, designed to accommodate various budgets and application needs.

CENTERS OF EXCELLENCE | PROVIDING PROVEN SOLUTIONS

Process Insights – The Americas
14400 Hollister Street, Suite 800B, Houston, TX 77066, USA +1 713 947 9591

Process Insights – EMEA
ATRICOM, Lyoner Strasse 15, 60528 Frankfurt, Germany +49 69 20436910

Process Insights – APAC
Wujiang Economic and Technology, Development Zone, No. 258 Yi He Road, 215200 Suzhou, Jiangsu Province, China +86 400 086 0106

Visit www.Process-Insights.com