European Metrology Research Programme

Delivering Impact

Developing the technology to support hydrogen as a clean energy fuel

To reduce reliance on fossil fuels and mitigate the worst effects of climate change requires the adoption of alternative sources of energy. Integral to this transition is the use of the clean energy gas hydrogen. This however relies on improved methods to detect unwanted contaminants that can potentially damage both the gas infrastructure and hydrogen vehicles.

Europe's National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

Challenge

Europe aims to be climate neutral by 2050, achieving this will not only reduce the need for imported energy but also eliminate the use of fossil fuels that drive climate change. Hydrogen is a 'clean' energy gas, and its use has been named by the EU as a central pillar for this transition.

Regardless of hydrogen's production method – the electrolysis of water, conversion from fossil fuels or the microbial digestion of plant materials - variable amounts of contaminants are present. These could include ammonia, carbon monoxide or carbon dioxide which can potentially cause expensive damage to gas pipelines, storage facilities or hydrogen refuelling stations for vehicles. Hydrogen fuel cells are particularly sensitive, becoming 'poisoned' by even extremely low levels of impurities.

Purity requirements for hydrogen are stipulated by European standard EN 17124 (equivalent to ISO 14687 Grade D) which set stringent permissible levels for the impurities present. Previously, no validated, on-line purity analysers existed capable of assessing hydrogen quality at the point of use. These types of instruments are required as a quality control measure, to reduce the risk of key impurities reaching the hydrogen tank.

To support the use of hydrogen as a clean fuel new instrumentation was required, capable of measuring hydrogen quality in real-time at impurity levels required by quality standards.

Solution

During the MetroHyVe project, partner AP2E developed a hydrogen purity analyser based on the company's patented 'optical feedback cavity enhanced adsorption spectroscopy' technology (OFCEAS).

Impurities in hydrogen are analysed by the absorption of a laser that is internally reflected through the gas repeatably, providing an effective measurement path length of up to 20 km. This 'laser-feedback' phenomenon increases the signal intensity up to 1,000x, providing 1 measurement every 100 ms in high spectral resolution.

A comprehensive review was performed comparing the OFCEAS analyser to over thirty other techniques including gas chromatography, high performance liquid chromatography, cavity ring-down spectroscopy and Fourier transform infrared spectroscopy.

Results indicated that the OFCEAS analyser could detect more hydrogen impurities than most other measurement techniques identified during the review, matched only by Fourier transform infrared spectroscopy, but OFCEAS had much lower limits of detection and considerably below the levels required by standards. During the work AP2E also developed new gas measurements for formic acid, formaldehyde and ammonia using the OFCEAS.

Impact

AP2E, based in France, is a leading manufacturer of gas analysers for continuous emission control, and monitoring of processes for industrial gases, petrochemical refineries and pollutants in ambient air.

From knowledge gained in the MetroHyVe project the company developed a new gas analyser – the ProCeas H2 PURITY. Based on APE2's patented OFCEAS technology, with specifications validated by top metrology institutes in Europe, it is capable of performing online measurements of a wide range of impurities below the levels required by ISO 14687 and EN 17124.

As it provides measurements in real-time it can allow AP2E's customers a better control of their hydrogen production processes or be used at hydrogen refuelling stations to guarantee gas quality for the fuel cells used to power cars and trucks.

The development of on-line gas analysers, such as the ProCeas H2 PURITY, will reduce the need for regular off-line analysis in commercial laboratories – greatly reducing the cost and time involved in assessing hydrogen quality, accelerating the uptake of this clean fuel and aiding Europe in its goal of becoming the first carbon-neutral continent.

New metrology for hydrogen vehicles

The MetroHyve project developed the first primary standards for calibrating flow meters at 700 bar hydrogen refuelling stations (HRS). Four online hydrogen purity analysers were developed and validated to prove that they are suitable for use by industry.

A good practice guide was produced for the calibration and use of hygrometers for the measurement of humidity of hydrogen fuel at HRS.

The project led the first global laboratory comparison on the performance of hydrogen purity laboratories across Europe, USA and Asia in performing ISO 14687 analysis. The project also supported the development of ISO 14687 and ISO 21087 by providing new state-of-the-art methods and standards for performing hydrogen purity analysis.

An online Hydrogen Measurement Service Hub was established, detailing the various metrological services across Europe that have been developed by the project.

These results supported the uptake of low-emission hydrogen vehicles and the growth of Europe's hydrogen economy by increasing confidence among both manufacturers and consumers.

EMPIR EURAMET

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