European Metrology Research Programme

Delivering Impact

A new field test standard for hydrogen refuelling stations

Hydrogen is rapidly developing as a carbon-neutral alternative to fossil fuels, including as a fuel source for vehicles. Support is required to grow and maintain a robust hydrogen infrastructure and to meet the requirements of European legislation. However, these requirements were not being met as there was a lack of available hydrogen measurement methods and standards.

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

Hydrogen refuelling stations (HRS) must meet measurement requirements set out by legislation. Standards such as SAE J2601 and OIML R139 are in place to ensure safety at HRS. The former establishes process limits for light duty vehicles (e.g., cars) to ensure that tanks do not overheat or overfill during fuelling, while the latter details maximum permissible errors for hydrogen flow meters.

However, real-world conditions at the fuel pump are variable, with a range of possible temperatures and pressures inside vehicles' fuel tanks. During fuelling, pressure can vary from 0.1 – 70 MPa and hydrogen can be cooled to as low as -40 °C.

Therefore, Hydrogen Field Test Standards (HFTS) are required to verify and calibrate HRS under real-world conditions. These more realistic standards improve accuracy at HRS, allowing for accurate billing, and in turn improving customer confidence in the use of hydrogen as a viable alternative to fossil fuels.

Before the MetroHyVe project, although international requirements existed regulating meters used in HRS, only limited studies had been conducted on testing and verifying these stations, both in the lab and in the field.

Solution

During the project, METAS, the National Metrology Institute of Switzerland, developed an HFTS suitable for field verification and calibration of hydrogen dispensers inside refuelling stations. The method is based on a gravimetric principle: an empty pressure vessel is weighed, filled with hydrogen, and then weighed again, with the mass dispensed taken as the difference between the two. This method was chosen as it is well-established and projected to achieve an uncertainty of 0.3%, just one fifth of the 1.5% uncertainty required by legislation for flow meters. The standard created by METAS is applicable for hydrogen cooled to -40 °C and was confirmed by field tests, achieving an even lower uncertainty of 0.25%.

The development of this HFTS means that HRS can now be calibrated under realistic real-world conditions and also lays a foundation for future testing instruments that might be required to meet existing and future developments in hydrogen-related legislation.

Impact

Maximator are a leading name in high-pressure equipment up to 25,000 bar, with Maximator Hydrogen being established to address the company's growing hydrogen business. Their goal is to enable the development of hydrogen refuelling technology, with 100 HRS per year planned for construction until 2025.

Prior to the development of the HFTS by METAS, there were only 1-2 systems throughout Europe for measuring the quantity of hydrogen dispensed by an HRS. This led to difficulties for Maximator in validating their hydrogen dispensers, as is legally required. The new HFTS has allowed the company to overcome this, standardise their dispensers and gain International Organisation of Legal Metrology (OIML) type approval. The new standard has also lowered production costs as it can be used on multiple dispensers in one sitting, saving the price of repeated instances of validation. Using the HFTS for validation of their dispensers has also allowed the company to accept a contract with REH2 to supply HRS in Sweden, with the first planned for Autumn 2023 and more following in 2024.

Accurate dispensing at HRS ensures that customers are correctly billed for the fuel they buy. This improves customer confidence in hydrogen and encourages its use as a clean alternative to fossil fuels.

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

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

www.euramet.org/project-16ENG01

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11326/0223 - 16ENG01