International Hydrogen Infrastructure Workshop

Validation of Hydrogen Meter Testing Device in Europe

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Contents

1. Background Hydrogen Flow Metering

- Flow meters are not approved according to OIML R139 due to the absence of testing facilities in Europe (H2, 700 bar,...)
- Existing OIML R139-2014 is not adapted for hydrogen dispensers
  - Accuracy, MMQ, Durability test, Tests at constant flow rate
    → *Currently in revision (expected for beginning of 2019)*
- Until beginning of 2018 no certified reference testing device in Europe to determine the global accuracy → *of meters and dispensers*
- Up to now the sale of H2 without certified flow meter is *tolerated* by the authorities (demonstration projects, limited group of users)
- By entering the commercial phase with the extension of the HRS network the uncalibrated sale of H2 cannot be tolerated anymore
- Pressure of the Offices of Weights and Measures (Eichämter) is currently increasing in Germany

  → **Therefore, short-term solution for the approval H2 dispensers is necessary for the further ramp-up of the HRS network**

2. FCH-JU Study on Metering

FCH-JU Study "Development of a Metering Protocol for Hydrogen Refuelling Stations" (Contract No: FCH / OP / 196)

- **Objective:** Define an accelerated test protocol to quickly certify HRS without a certified meter
- **Scope:**
  - **Task 1:** Development of a testing protocol for HRS regarding compliance with OIML R-139
  - **Task 2:** Design and implementation of a test campaign
  - **Task 3:** Agreement from relevant national authorities/institutes
- **Organization:**
  - **Leader:** Air Liquide
  - **National Metrological Institutes:**
    - PTB (*Physikalisch-Technische Bundesanstalt*) in Germany
    - LNE (*Laboratoire national de métrologie et d'essais*) in France
    - NMi Certin in the Netherlands
  - **Laboratory expert in gaseous flow metering:** Cesame Exadebit

2. FCH-JU Study on Metering

Approach for the testing protocol:

- **OIML R139:2014** is the reference
- Main components of the measuring system (calculator and meter) are approved according to different standards:
  - OIML R139:2007
  - OIML R117-1:2007 or OIML R117-2:2014: "*Dynamic measuring systems for liquids other than water*"
  - OIML R137:2012: "*Gas meters*" (for meters only, not applicable to calculator)
- Assessment of deviations to OIML R139:2014 for these components for each category of tests required for Type Approval:
  - Electromagnetic compatibility (EMC)
  - Environment testing (climatic test, humidity, etc.)
  - Accuracy tests
  - Gas temperature accuracy tests
  - Durability tests
  - Software (WELMEC 7.2)

→ **Decision is made to require, or not, complete new tests or additional tests depending of the certification of the components**

2. FCH-JU Study on Metering

		Calculating & indicating device		Measurement transducer (electronics) & Measurement sensor	
		Certified according to: **OIML R117-1:2007** or **OIML R139:2007**	Certified according to: **OIML R117-2:2014** or **OIML R139:2014**	Certified according to: **OIML R117-1:2007** or **OIML R139:2007** or **OIML R137:2012**	Certified according to: **OIML R117-2:2014** or **OIML R139:2014**
Type approval tests	EMC	2 (3)	3	2 (3)	3
	Environment testing (climatic test, humidity)	3		3	
	Mechanical test (vibration)	3 if M1		3 if M1	
	Accuracy test	3		1	
	Accuracy gas temperature tests	3		4	
	Software (WELMEC 7.2)	4	3	4	3
	Durability test	3		4 (3)	
Initial verification	Adjustment on site	1		1	

Legend:
1 = Complete new tests
2 = Additional test required
3 = No test required
4 = No test required, but under conditions
( ) = specific for existing HRS

3. Metering Testing Device

Characteristics:

- Fulfills metrological requirements acc. to OIML R139 → Uncertainty $U < \frac{1}{5}$ MPE = 0,3 %
- High Precision Scale: resolution 0.2 g, ATEX certified
- Composite tank of 104L (i.e.: 4.0 kg of hydrogen at 700 bar)
- Trailer walls, doors and roof serve as protection against wind forces
- Independant vent stack for depressurization of the tank
- Test Bench is now CE-marked

3. Metering Testing Device

- Certified as first **reference standard** for calibration, conformity assessment and verification of hydrogen refuelling dispensers by PTB in March 2018
- Test Bench is also accepted by LNE and NMI as reference standard

PTB Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

Bericht
Report

METERING TEST BENCH
for hydrogen refuelling station
in accordance to SAE J2601

Messeinrichtung
für Wasserstoffbetankungsanlagen
nach SAE J2601

der/of

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Usage for the conformity assessment and verification
for legal metrology purposes
Einsatz für Konformitätsbewertungen und Eichungen
im Rahmen des gesetzlichen Messwesens

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Im Auftrag
On behalf of PTB
Dr. Roland Schmidt

Braunschweig, 2018-03-26
Siegel
Seal

Im Auftrag
On behalf of PTB
Dr. Rainer Kramer

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4. Test Campaign

Criteria for HRS testing

- All technologies and/or specificities should be tested
- HRS from different manufacturers in Europe: Air Liquide, Linde and Nel
- HRS in operation in minimum 3 different countries of the European Union

Selected HRS

Air Liquide: compressed gas

Flow Meter located in the station, which can be far away from the dispenser

- HRS Kamen, Germany → short distance between Flow Meter and dispenser (6 m)
- HRS Koblenz, Germany → long distance between Flow Meter and dispenser (25 m)
- HRS Versailles, France
- HRS Rhoon (Rotterdam), Netherlands

Linde: liquid hydrogen & compressed gas

- HRS Hannover → liquid
- HRS Cologne → compressed gas

Nel: compressed gas → HRS Rostock Germany


Kamen - Air Liquide

Cologne - Linde


Rostock - Nel

4. Test Campaign

Test Program for Accuracy Tests:

- 3 x Full Filling: 20-700 bar
- 3 x Partial Filling: 20-350 bar
- 3 x Partial Filling: 350-700 bar
- 3 x MMQ (1kg)

Recording further data:

- Environmental conditions : Ambiant temperature, wind velocity,
- Filling conditions: pressure ramp, temperature, flow rate)
- Start/final pressure and mass


HRS Koblenz

Duration for one Test Campaign:

- At least 3 days including installation due to long time for depressurization (1.5h for a full tank) are needed

4. Test Campaign

First Test Campaign in Kamen

5. Summary

Summary

- Good test results with a high repeatability
- Test Bench and test results are highly appreciated by PTB and the Offices of Weights and Measures
- Test results are good baseline for further discussions with the German Offices of Weigths and Measures

Next steps

- Developed test protocol has to be endorsed by further NMIs
- Finalize the type approval approval process for new HRS and start the on-site verification
- Modify existing HRS to be fully compliant with metrological requirements and start the conformity assessment

→ In the next years more than 100 HRS have to be certified!!!

Thank you for your attention!
#TeamWasserstoff