

METROLOGY *for* HYDROGEN VEHICLES

WP 3 'Hydrogen Quality Control'

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Aim

- To develop and validate continuous online analysers for measuring key impurities, particulates and humidity in hydrogen at the refuelling station following the implementation of quality control techniques specified in ISO 19880-8.
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- Candidate methods include spectroscopic and low-cost sensor technology. The development of the analysers will be focused on the key impurities specified in ISO 14687: water, CO, O₂ and H₂S
 - A similar development and validation approach will be used for the humidity measurements in hydrogen using online hygrometers and particulate concentration and size using online particulate analysers
 - Perform an instrument intercomparison for online purity analysers against laboratory reference gas standards of hydrogen sulfide, carbon monoxide, oxygen and water

WP3 Tasks



Task 3.1: **Online measurement of gaseous impurities – M1-M22**

(NPL, AP2E, CT, Shell)

Task 3.2: **Online measurement of humidity– M14-M29**

(NPL, ITM, AP2E, CT)

Task 3.3: **Online measurement of particulate mass concentration and seizing– M1-M36**

(NPL, ITM)

Task 3.4: **Low costs sensors for hydrogen purity– M1-M31**

(AL, VSL)

Task 3.5: **Intercomparison of online purity analysers– M1-M31**

(VSL, AL, AP2E, CT, Shell, NPL)



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Development and validation of instruments: current status

Component	Required LOD	Cascade Technologies	AP2E	Shell
CO	0.2 $\mu\text{mol/mol}$	OK	OK	OK
Water	5 $\mu\text{mol/mol}$	OK	OK	OK
O ₂	5 $\mu\text{mol/mol}$	Development needed	OK	X
H ₂ S	4 nmol/mol	Development needed	OK	OK

NPL will supply 3 gas mixtures for analyser validation

Composition: according to specifications only amount fraction H₂S has to be decided upon

Online measurement of gaseous impurities (3.1) and intercomparison of online purity analysers (3.5)

- These 2 tasks are closely related
- Instrument developed in 3.1 will take part in the intercomparison (January. – June 2019)
- The intercomparison will take place at NPL and is open to other instrument suppliers
- If anyone wants to participate now is a good time to show interest as the protocol for the intercomparison is being discussed

Online Measurement of Humidity

- Progress is dependent on task 2.3.4 development of NPL's multi-gas, multi-pressure humidity calibration facility
- Michell Instruments, GE Sensing, Alpha Moisture Systems, Tiger Optics, Shaw Moisture Meters, SUTO –iTec have been contacted to confirm if they are willing to loan instruments for calibration in hydrogen - (July 2018 – December 2018)
- The measurements will be performed in hydrogen :
 - at pressures up to 20 bar in hydrogen
 - at a flow rate of 0.5 slpm
 - at dew-point temperatures from -65 °C to -20 °C
 - (corresponding to amount fractions of water vapour from 0.5 $\mu\text{mol/mol}$ upto 50 $\mu\text{mol/mol}$ at 20 bar)

Online Measurement of particulate mass concentration and sizing

- Risk evaluation for using a TEOM with hydrogen has been performed but NPL is waiting on confirmation from the supplier before purchasing the instrument
- NPL will add concentrations of particles (nominally 1000 to 5000 particles/mL and 2 μm to 10 μm) to pure hydrogen from a gas cylinder in a laboratory environment to produce a stream of particle laden hydrogen at close to atmospheric pressure
- This stream will be assessed for particle size and number concentration using an OPC and then used to carry out direct comparisons of particulate mass using TEOM and traditional offline filter techniques. The method developed in task 2.2.1 will be used for the filter weighing element. (January 2018 – December 2018)
- Field measurements at a HRS will be performed and a good practice guide will be written (NPL and ITM) (July 2019 – May 2020)

Aim: Evaluate the feasibility to use online continuous “quality sensors” at HRSs in order to

- Measure canary species – key impurities that guarantee global quality of H₂ in accordance with risk assessment conclusions
- Improve the efficiency of the quality survey of H₂ supply chain
 1. Cost of quality assurance
 2. Minimize delays (sampling + delivery + analysis on lab)
- Perform a survey (questionnaire) which will be sent to relevant research organisations, universities and sensor manufacturers to investigate the options and availability of low cost sensors for performing online measurement of impurities at HRSs and write a review on the results.
- Test a sensor at VSL when a sensor can be bought or borrowed

Low cost sensors for hydrogen purity

Safety considerations		Performances & Characteristics	
Including vent system		Sensitivity under the specification	
Including sealed system		Sensitivity at the specification	
Including leak detection		Sensitivity at a High concentration	
Other request		Accuracy	
Definition of a "sensor"		Linearity	
Low Cost		Response delay at the specification (< 1 mn)	
Small Size		Response delay at a high concentration (< 1 mn)	
Plug & Play		Other request (interferences, drift, calculation interval?)	
TRL Level (Prototype or existing material)		Impurities to monitor	
Including data treatment		CO	
Other request		H ₂ O	
Management of alarm by HRS operator		H ₂ S	
At the Specification concentration		O ₂	
At the High concentration		Other request	
Reset option		Characteristics	
External Relay		No Spare part	
Other request		Utilities included	
Measurement mode		Monitoring data	
Cumulative		No Metrology program	
Instantaneous		No Purging integrated	
Other request		Other request	

THANK YOU

Any Remark or Question?