NPL

Final meeting

Metrology for sustainable hydrogen energy applications

Work package 1
Hydrogen purity measurements according to ISO 14687-2 and risk assessment for fuel cells

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21th May 2019

Hydrogen

Work package 1

- All the partners involved in standardization work at national or international level

10 partners: 5 NMI + 3 industrial and research centres

In-kind support of stakeholders and industry

Background of work package 1

- 2015: Hydrogen quality – Not standardised
  - No sufficient evidence on hydrogen quality (open access data)
    - HYCORA project – Hydrogen quality at HRS
    - No data on production method only
  - No sufficient understanding on quality control planning (ISO 19880-8 as draft)
    - Guidelines but no examples
  - Contaminants impact and threshold values
    - HYCORA project leading (Formaldehyde, CO, formic acid)
    - Lack of knowledge on halogenated (i.e. HCl, $C_4Cl_4F_6$) and NH_3

Objectives of work package 1

- **Aims:**
  - understand the real risk of contaminants in hydrogen from different production methods
  - Understand the negative impact of these impurities to a fuel cell system.

- **Final target:**
  - Provide technical evidences to the ISO TC 197 to justify the ISO 14687 revisions

Deliverables of work package 1

NPL National Physical Laboratory

- **D1** Report on risk assessment of impurities in hydrogen for fuel cells and recommendations on maximum concentration of individual compounds based on the new fuel cell degradation studies and on the probability of presence

  Report

  NPL, CEM, SP, VSL, AH2GEN, Air Liquide, CEA, FHA

  June 2018 (M25)

- **D2** Letter from ISO/TC197 confirming that the documentary report D1 on risk assessment results has been received for a potential incorporation in an approved Technical Specification or in the revised version of ISO 14687

  Letter from the Technical Committee

  NPL, LNE, CEM, SP, VSL, AH2GEN, Air Liquide, CEA, FHA

  May 2019 (M36)

Hydrogen purity measurements according to ISO 14687-2 and risk assessment for fuel cells

Probability of impurity presence from expert industrial knowledge

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Sampling hydrogen on sites and analysis campaign at NMIs

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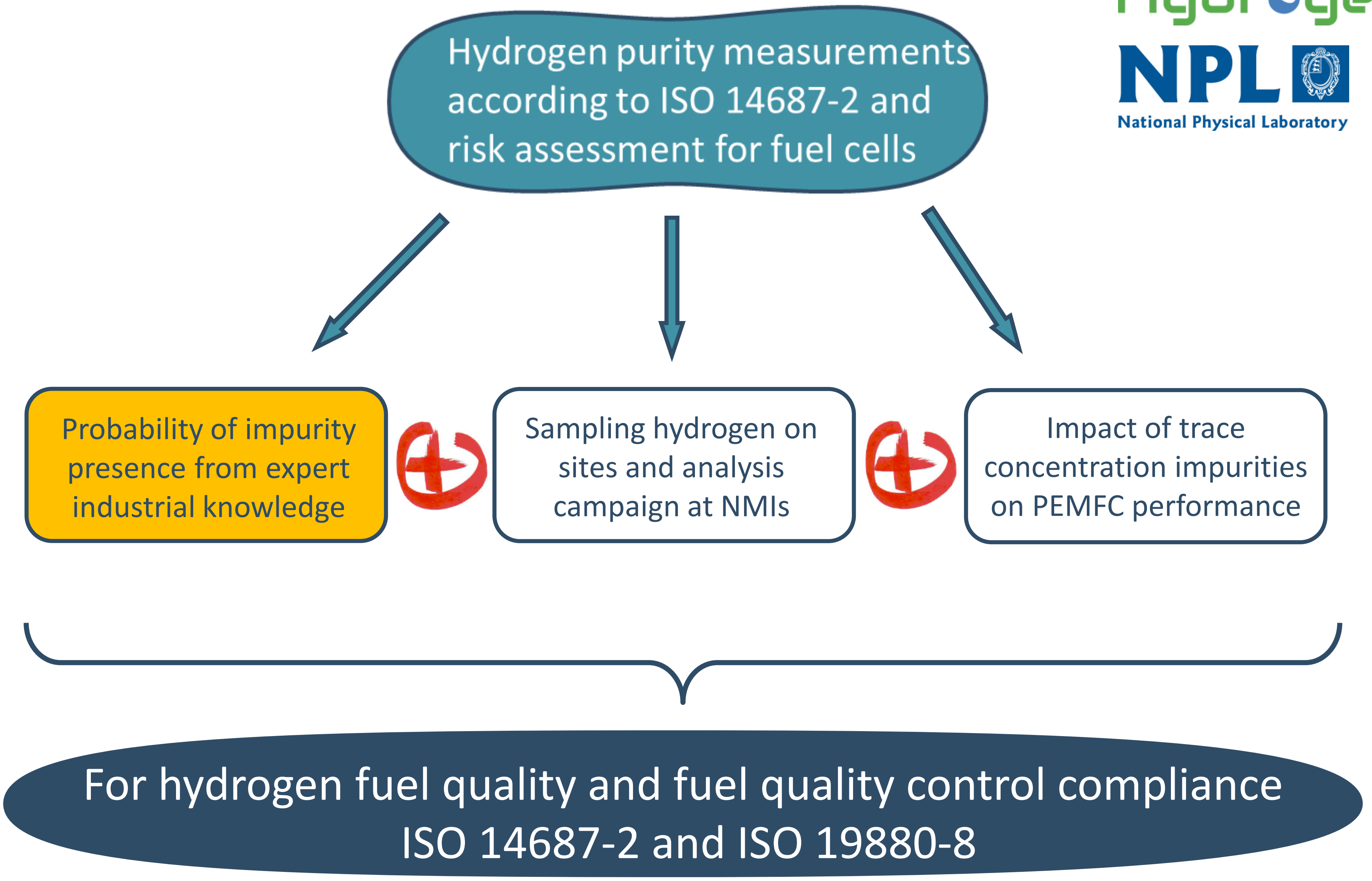
Impact of trace concentration impurities on PEMFC performance

For hydrogen fuel quality and fuel quality control compliance ISO 14687-2 and ISO 19880-8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Work package 1 achievements: Probability of impurity presence from expert industrial knowledge

Rationale of impurities presence based on production process and following an approach in ISO 19880.

Probability of impurity presence	Steam methane reforming with PSA	PEM water electrolysis process with TSA	Chlor-alkali process (membrane cell process)
Frequent	CO	None identified	O_2
Possible	N_2	None identified	None identified
Rare	Ar, CH_4	N_2, O_2, H_2O	H_2O, N_2
Very Rare	HCHO	CO_2	CO_2
Unlikely	He, O_2, CO_2, HCOOH, NH_3, sulfur compounds, hydrocarbons (except CH_4), halogenated compounds	He, Ar, CO, CH_4, HCHO, HCOOH, NH_3, sulfur compounds, hydrocarbons (except CH_4), halogenated compounds	He, Ar, CO, CH_4, HCHO, HCOOH, NH_3, sulfur compounds, hydrocarbons (except CH_4), halogenated compounds

Achievements:

- 3 project reports
- Article published in International Journal of Hydrogen Energy:

Probability of occurrence of ISO 14687-2 contaminants in hydrogen: Principles and examples from steam methane reforming and electrolysis (water and chlor-alkali) production processes model, Thomas Bacquart, Arul Murugan, Martine Carré, Bruno Gozlan, Fabien Auprêtre, Frédérique Haloua, Thor A. Aarhaug. International Journal of Hydrogen Energy, 2018, 43 (11872-11883)

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Hydrogen

NPL National Physical Laboratory

Hydrogen purity measurements according to ISO 14687-2 and risk assessment for fuel cells

Probability of impurity presence from expert industrial knowledge

Sampling hydrogen on sites and analysis campaign at NMIs

Impact of trace concentration impurities on PEMFC performance

Aim:

- 10 SMR samples
- 10 PEM Water electrolyser samples
- 1 Chlor-alkali samples

Analysis scope

- ISO 14687-2
- National metrology institutes analysis

Analytical campaign for hydrogen production methods

Analytical method used by National Metrology Institutes

Compounds	ISO 14687-2 threshold [µmol/mol]	NPL	VSL	RISE	CEM
Water H_2O	5	Quartz crystal microbalance (LOD: 0.5 µmol/mol) CRDS (LOD: 0.5 µmol/mol)	-	OFCEAS (LOD: 2 µmol/mol)	-
Methane CH_4	2	GC-methaniser-FID (LOD: 0.01 µmol/mol)	-	GC-FID (LOD: 0.5 µmol/mol)	-
Non methane hydrocarbons	2	GC-methaniser-FID (LOD: 0.01 µmol/mol)	-	-	-
Oxygen O_2	5	GC-PDHID (LOD: 0.5 µmol/mol)	-	OFCEAS (LOD: 3 µmol/mol) GC-TCD ($Ar+O_2$ LOD: 25 µmol/mol)	GC-PDHID (LOD: 5 µmol/mol) GC-TCD (LOD: 25 µmol/mol)
Helium He	300	-	-	-	GC-TCD (LOD: 5 µmol/mol)
Nitrogen N_2	100	GC-PDHID (LOD: 1 µmol/mol)	-	GC-TCD (LOD: 25 µmol/mol)	GC-TCD (LOD: 80 µmol/mol) GC-PDHID (LOD: 25 µmol/mol)
Argon Ar	100	GC-PDHID (LOD: 0.5 µmol/mol)	-	GC-TCD (Ar+O2 LOD: 25 µmol/mol)	GC-TCD (LOD: 50 µmol/mol) GC-PDHID (LOD: 25 µmol/mol)
Carbon dioxide CO_2	2	GC-methaniser-FID (LOD: 0.01 µmol/mol)	-	OFCEAS (LOD: 0.1 µmol/mol) GC-TCD (LOD: 5 µmol/mol)	-

TD: Thermo-Desorption
MS: Mass spectrometry

CRDS: cavity ring down spectroscopy
TCD: Thermal Conductivity Detector
OFCEAS: Optical Feedback cavity enhanced absorption spectroscopy

GC: gas chromatography
PDHID: Pulse discharge helium ionisation detector
FID: Flame ionisation detector

Analytical campaign for hydrogen production methods

Analytical method used by National Metrology Institutes

Compounds	ISO 14687-2 threshold [µmol/mol]	NPL	VSL	RISE	CEM
Carbon monoxide CO	0.2	GC-methaniser-FID (LOD: 0.01 µmol/mol)	-	OFCEAS (LOD: 0.02 µmol/mol)	-
Total sulphur compounds	0.004	GC-SCD (LOD: 0.002 µmol/mol)	-	OFCEAS (LOD: 0.004 µmol/mol)	-
Formaldehyde HCHO	0.01	-	CRDS (LOD: 0.005 µmol/mol)	-	-
Formic acid HCOOH	0.2	-	CRDS (LOD: 0.1 µmol/mol)	-	-
Ammonia NH_3	0.1	-	CRDS (LOD: 0.1 µmol/mol)	-	-
Total halogenated (HCl)	0.05	-	CRDS (LOD: 0.005 µmol/mol)	-	-
C2 hydrocarbons	2	-	-	GC-FID (LOD: 0.5 µmol/mol)	-
C3 hydrocarbons	2	-	-	GC-FID (LOD: 0.5 µmol/mol)	-
C4 hydrocarbons	2	-	-	GC-FID (LOD: 1 µmol/mol)	-
C5 hydrocarbons	2	-	-	GC-FID (LOD: 1 µmol/mol)	-
C6 - C18 hydrocarbons	2	-	-	TD-GC-FID/MS (LOD: 0.05 µmol/mol)	-

CRDS: cavity ring down spectroscopy
TCD: Thermal Conductivity Detector
OFCEAS: Optical Feedback cavity enhanced absorption spectroscopy

GC: gas chromatography
PDHID: Pulse discharge helium ionisation detector
FID: Flame ionisation detector

TD: Thermo-Desorption
MS: Mass spectrometry

Hydrogen fuel quality from production methods – Steam methane reforming with PSA

Compounds	ISO 14687-2 threshold [µmol/mol]	SMR with PSA (8 samples) Results [µmol/mol]	Probability of occurrence [16]
Water H_2O	5	**< 2**	Unlikely (0)
Methane CH_4	2	**< 0.02 to 0.05**	Rare (2)
Non methane hydrocarbons	2	**< 0.05**	Unlikely (0)
Oxygen O_2	5	**< 1.0**	Unlikely (0)
Helium He	300	**< 54**	Unlikely (0)
Nitrogen N_2	100	**< 1.2 to 11**	Possible (3)
Argon Ar	100	**< 0.5 to 1.3**	Rare (2)
Carbon dioxide CO_2	2	**< 0.02 to 0.45**	Unlikely (0)
Carbon monoxide CO	0.2	**< 0.02**	Frequent (4)
Total sulphur compounds	0.004	**< 0.0036**	Unlikely (0)
Formaldehyde HCHO	0.01	**< 0.005**	Very rare (1)
Formic acid HCOOH	0.2	**< 0.1**	Unlikely (0)
Ammonia NH_3	0.1	**< 0.1**	Unlikely (0)
Total halogenated	0.05	**< 0.005**	Unlikely (0)
C2 hydrocarbons	2	**< 0.5**	Unlikely (0)
C3 hydrocarbons	2	**< 1**	Unlikely (0)
C4 hydrocarbons	2	**< 1**	Unlikely (0)
C5 hydrocarbons	2	**< 1**	Unlikely (0)
C6 - C18 hydrocarbons	2	**<0.05**	Unlikely (0)

Hydrogen fuel quality from production methods – PEMW electrolyser with TSA

Compounds	ISO 14687-2 threshold [µmol/mol]	PEM water electrolysis withTSA Results on 8 samples [µmol/mol]	Probability of occurrence
Water H_2O	5	**< 3**	Rare (2)
Methane CH_4	2	**< 0.02**	Unlikely (0)
Non CH_4 hydrocarbons	2	**0.08 to 0.2**	Unlikely (0)
Oxygen O_2	5	**< 0.5 - 2**	Rare (2)
Helium He	300	**< 9 to 45**	Unlikely (0)
Nitrogen N_2	100	**< 1.0 to 4.6**	Rare (2)
Argon Ar	100	**< 0.5**	Unlikely (0)
Carbon dioxide CO_2	2	**< 0.02 to 0.25**	Very rare (1)
Carbon monoxide CO	0.2	**< 0.02**	Unlikely (0)
Total sulphur compounds	0.004	**< 0.0036**	Unlikely (0)
Formaldehyde HCHO	0.01	**< 0.005**	Unlikely (0)
Formic acid HCOOH	0.2	**< 0.1**	Unlikely (0)
Ammonia NH_3	0.1	**< 0.1**	Unlikely (0)
Total halogenated	0.05	**< 0.005**	Unlikely (0)
C2 hydrocarbons	2	**< 0.5**	Unlikely (0)
C3 hydrocarbons	2	**<1**	Unlikely (0)
C4 hydrocarbons	2	**<1**	Unlikely (0)
C5 hydrocarbons	2	**<1**	Unlikely (0)
C6 - C18 hydrocarbons	2	**<0.05**	Unlikely (0)

Hydrogen fuel quality from production methods - PEMW electrolyser

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Analytical campaign – Summary – PEM water electrolysis

Compounds	ISO 14687-2 threshold [µmol/mol]	PEM water electrolysis with TSA [µmol/mol]	PEM water electrolysis Results on 5 samples [µmol/mol]
Water H_2O	5	< 3	> 100
Methane CH_4	2	< 0.02	< 0.02 to 0.1
Non CH_4 hydrocarbons	2	0.08 to 0.2	< 0.02 to 0 .09
Oxygen O_2	5	< 0.5 – 2	18- > 500
Helium He	300	< 9 to 45	< 9
Nitrogen N_2	100	< 1.0 to 4.6	1.2 to 4.5
Argon Ar	100	< 0.5	< 0.5
Carbon dioxide CO_2	2	< 0.02 to 0.25	0.2 to 5.4
Carbon monoxide CO	0.2	< 0.02	< 0.02
Total sulphur compounds	0.004	< 0.0036	< 0.0036
Formaldehyde HCHO	0.01	< 0.005	< 0.005
Formic acid HCOOH	0.2	< 0.1	< 0.1
Ammonia NH_3	0.1	< 0.1	< 0.1
Total halogenated	0.05	< 0.005	< 0.005
C2 hydrocarbons	2	< 0.5	< 0.5
C3 hydrocarbons	2	<1	<1
C4 hydrocarbons	2	<1	<1
C5 hydrocarbons	2	<1	<1
C6 - C18 hydrocarbons	2	<0.05	<0.05

Importance of purification in quality control monitoring

CEM CENTRO ESPAÑOL DE METROLOGÍA

RISE Research Institutes of Sweden

VSL Dutch Metrology Institute

NPL National Physical Laboratory

Steam methane reforming with pressure swing adsorption - Analysis results

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8
CO (1)	< 0.053	< 0.053	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	< 0.02
CO (2)	< 0.2	< 0.2	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CO_2 (2)	< 0.1	< 0.1	< 5	< 5	< 5	< 0.5	n.a.	n.a.
CO_2 (1)	0.042 ± 0.016	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	< 0.02
CH_4 (1)	0.044 ± 0.007	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	< 0.02
CH_4 (3)	n.a.	n.a.	~ 0.01	~ 0.01	~ 0.01	n.a.	n.a.	n.a.
CH_4 (2)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Non CH4 hydrocarbons (1)	< 0.05	< 0.05	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	< 0.02
H_2O (1)	< 0.6	< 0.6	< 0.5	< 0.5	< 0.5	< 1.8	< 1.5	< 1.2
H_2O (2)	n.a	n.a.	n.a.	n.a.	n.a.	< 2	n.a.	n.a.
Total sulphur compounds (1)	< 0.002	< 0.002	< 0.0036	< 0.0036	< 0.0036	< 0.002	< 0.002	< 0.002
H_2S (2)	< 0.04	< 0.04	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
O_2 (4)	n.a.	< 5	n.a.	< 5	< 5	< 25	< 25	< 25
O_2 + Ar (2)	n.a.	n.a.	n.a.	n.a.	n.a.	< 50	< 50	< 50
O_2 (1)	0.39 ± 0.13	0.39 ± 0.13	< 0.5	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5
N_2 (4)	n.a.	n.a.	< 100	< 50	< 60	< 50	< 50	< 50
N_2 (2)	n.a.	< 25	n.a.	n.a.	< 80	< 25	< 25	< 25
N_2 (1)	1.5 ± 0.6	< 1.0	< 1.2	< 1.2	< 1.2	5.2 ± 0.6	10.4 ± 1.1	5.5 ± 0.6
Ar (2)	n.a.	n.a.	< 30	< 30	< 30	n.a.	n.a.	n.a.
Ar (4)	n.a.	< 25	n.a.	n.a.	< 80	< 25	< 25	< 25
Ar (1)	2.8 ± 0.1	< 0.5	< 0.5	< 0.5	< 0.5	1.00 ± 0.10	1.30 ± 0.10	1.11 ± 0.10
Total halogenated (HCl) (3)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
CH_2O (3)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
CH_2O_2 (3)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
NH_3 (3)	< 0.1	< 0.1	n.a.	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
He (4)	20 ± 4	12 ± 5	n.a.	n.a.	< 50	44 ± 10	43 ± 10	43 ± 8
C2 hydrocarbons (2)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
C3-hydrocarbons (2)	<1	<1	<1	<1	<1	<1	<1	<1
C4-hydrocarbons (2)	<1	<1	<1	<1	<1	<1	<1	<1
C5-hydrocarbons (2)	<1	<1	<1	<1	<1	<1	<1	<1
C6 – C18 hydrocarbons (2)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050

1: NPL; 2: RISE; 3: VSL; 4: CEM

PEM water electrolyser with temperature swing adsorption - Analysis results

Hydrogen
NPL National Physical Laboratory

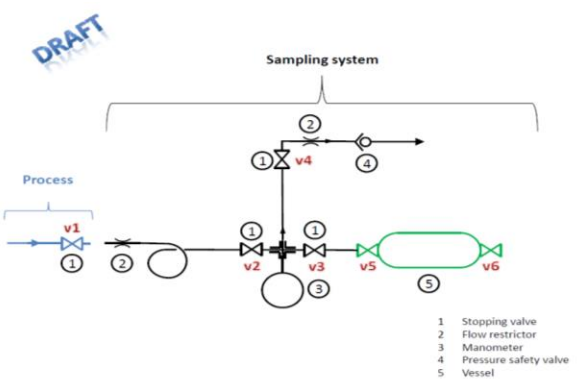
Compounds	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8
CO (1)	< 0.053	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
CO (2)	< 0.2	n.a.	< 0.02	< 0.02	< 0.02	n.a.	n.a.	n.a.
CO_2 (2)	< 0.1	< 5	< 5	< 0.4	< 0.4	< 5	n.a.	< 5
CO_2 (1)	0.443 ± 0.010	0.245 ± 0.010	0.229 ± 0.08	< 0.02	< 0.02	< 0.01	< 0.01	< 0.01
CH_4 (1)	0.031 ± 0.006	< 0.01	< 0.01	< 0.02	< 0.02	< 0.01	< 0.01	< 0.01
Non CH_4 hydrocarbons (1)	< 0.05	< 0.02	< 0.02	< 0.02	< 0.02	0.156 ± 0.030	0.126 ± 0.026	0.111 ± 0.024
CH_4 (2)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	n.a.	n.a.	n.a.
H_2O (1)	< 0.6	< 0.8	< 1.4	< 3	< 3	< 0.8	< 1.2	< 3
H_2O (2)	n.a.	n.a.	n.a.	< 3	< 5	n.a.	n.a.	n.a.
Total sulphur compounds (1)	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.0030	< 0.0030	< 0.0030
H_2S (2)	< 0.04	-	-	< 0.004	< 0.004	n.a.	n.a.	n.a.
O_2 (4)	< 5	< 5	< 5	< 5	< 5	< 5	n.m.	< 5
O_2 + Ar (2)	n.a.	< 5	< 11	< 5	< 3	< 25	n.a.	< 25
O_2 (1)	0.45 ± 0.13	< 0.5	< 0.5	< 0.6	< 0.6	1.39 ± 0.36	< 0.5	1.59 ± 0.45
N_2 (4)	n.a.	< 40	< 70	-	-	< 100	n.a.	< 100
N_2 (2)	< 25	< 50	< 50	< 50	< 50	< 80	n.m.	n.m.
N_2 (1)	2.0 ± 0.5	4.6 ± 0.3	4.2 ± 0.4	< 1.5	< 1.5	1.51 ± 0.2	< 1.0	1.86 ± 0.2
Ar (4)	< 25	< 50	< 50	< 50	< 50	< 80	n.m.	n.m.
Ar (1)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Total halogenated (HCl) (3)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	n.a.	< 0.005	< 0.005
CH_2O (3)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
CH_2O_2 (3)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
NH_3 (3)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	n.a.	n.a.	n.a.
He (4)	34 ± 5	< 5	< 5	15 - 45	< 5	< 9	< 9	< 9
C2 hydrocarbons (2)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	n.a.	n.a.	n.a.
C3-hydrocarbons (2)	<1	<1	<1	<1	<1	n.a.	n.a.	n.a.
C4-hydrocarbons (2)	<1	<1	<1	<1	<1	n.a.	n.a.	n.a.
C5-hydrocarbons (2)	<1	<1	<1	<1	<1	n.a.	n.a.	n.a.
C6 – C18 hydrocarbons (2)	<0.050	<0.05	<0.05	<0.05	<0.05	n.a.	n.a.	n.a.

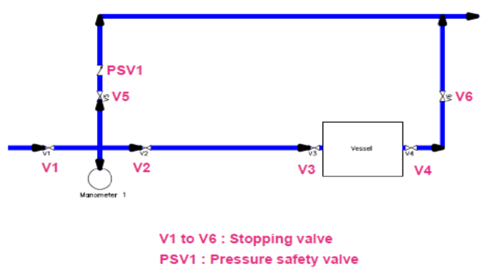
1: NPL; 2: RISE; 3: VSL; 4: CEM

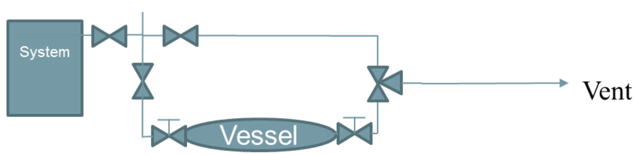
Additional challenges - Sampling procedure

- Development of sampling strategy (Air Liquide, AREVA H2Gen, NPL)
  - Pressure (14 – 100 bar)
  - Flow
  - Location of sampling (as close as hydrogen production process)
  - Sampling material
  - Sampling procedure

→ **EMPIR Hydrogen consortium**
Hydrogen producer procedure







- Cycling purge
- Purge through cylinder
- Cleanliness of cylinder
- Absence of leak

Example of contaminants observed in project samples

Compounds	ISO 14687-2 threshold [µmol/mol]	Contaminated sample 1	Contaminated sample 2	Contaminated sample 3
		Chlor-alkali membrane electrolysis feedstock	SMR feedstock	SMR feedstock
		Results [µmol/mol]	Results [µmol/mol]	Results [µmol/mol]
Water H_2O	5	**13.2 ± 1.7**	2.48 ± 0.25	**17.1 ± 3.5**
Methane CH_4	2	14.28 ± 0.07	< 0.02	0.038 ± 0.004
Non CH_4 hydrocarbons	2	**> 200**	< 0.05	< 0.040
Oxygen O_2	5	< 0.5	**35 ± 2**	1.35 ± 0.07
Helium He	300	< 20	12 ± 5	n.a.
Nitrogen N_2	100	**579 ± 23**	**134 ± 2**	14.6 ± 0.8
Argon Ar	100	< 1.0	1.43 ± 0.10	4.2 ± 0.3
Carbon dioxide CO_2	2	0.316 ± 0.007	0.101± 0.004	< 0.04
Carbon monoxide CO	0.2	< 0.02	< 0.053	< 0.02
Total sulphur compounds	0.004	< 0.0036	< 0.002	<0.002
Formaldehyde HCHO	0.01	< 0.005	< 0.005	< 0.005
Formic acid HCOOH	0.2	< 0.1	< 0.1	< 0.1
Ammonia NH_3	0.1	< 0.1	< 0.1	n.a.
Total halogenated	0.05	< 0.005	< 0.005	< 0.005
		HRS maintenance contamination suspected	Improper purging (air)	Improper purging (humidity)

Work package 1 – sampling campaign achievements

- 27 hydrogen samples analysed according to ISO 14687-2 (Target: 21)
  - 8 / 11 sample analysed of SMR with PSA
    - Reason: 3 samples contaminated during sampling by third party
  - 8 / 15 sample analysed of PEMW electrolyser with TSA
    - Reason: 5 samples from PEMW electrolyser (no purification)
  - 0 / 1 sample analysed of chlor-alkali membrane electrolysis process
    - Reason: 1 sample contaminated by HRS infrastructure/operation

- No contaminants observed above ISO 14687-2 threshold
  - 8 different samples from steam methane reformers with PSA
  - 8 different samples from PEM water electrolyser with TSA

- Difference in process expert evaluation and sampling campaign
  - Contamination within short time line (spike) – Difficult to spot with point sampling
  - Conservative approach from expert group due to lack of analytical measurement

Hydrogen purity measurements according to ISO 14687-2 and risk assessment for fuel cells

Probability of impurity presence from expert industrial knowledge

+

Sampling hydrogen on sites and analysis campaign at NMIs

+

Impact of trace concentration impurities on PEMFC performance

For hydrogen fuel quality and fuel quality control compliance ISO 14687-2 and ISO 19880-8

Hydrogen purity measurements according to ISO 14687-2 and risk assessment for fuel cells

- Probability of impurity presence from expert industrial knowledge
- +
- Sampling hydrogen on sites and analysis campaign at NMIs
- +
- Impact of trace concentration impurities on PEMFC performance

For hydrogen fuel quality and fuel quality control compliance ISO 14687-2 and ISO 19880-8

Deliverables of work package 1

- **D1** Report on risk assessment of impurities in hydrogen for fuel cells and recommendations on maximum concentration of individual compounds based on the new fuel cell degradation studies and on the probability of presence

  Report

  NPL, CEM, SP, VSL, AH2GEN, Air Liquide, CEA, FHA

  June 2018 (M25) → **March 2019**

- **D2** Letter from ISO/TC197 confirming that the documentary report D1 on risk assessment results has been received for a potential incorporation in an approved Technical Specification or in the revised version of ISO 14687

  Letter from the Technical Committee

  NPL, LNE, CEM, SP, VSL, AH2GEN, Air Liquide, CEA, FHA

  May 2019 (M36) → **April 2019**

Achievements of work package 1

- **Involvement of Hydrogen community**
  - 6 institutes and industries provided in-kind support / samples
- **Training on quality control and ISO 19880-8**
  - More than 20 attendees
- **Open access data**
  - 4 reports
  - 1 peer-review article (2 peer-review articles in draft)
- **Communication to standardisation committees**
  - Presentations at ISO TC 197 meetings
- **Demonstration of new capabilities**
  - New PRM gas standards, analytical capabilities

Recommendations and futures perspectives

- Quality control for hydrogen – ISO 19880-8
  - Study other production methods (i.e. alkaline electrolyser, chlor-alkali, biomass, NH3 feedstock)
  - Study other part of supply chain (i.e. HRS infrastructure, pipeline)
  - Provide training and guidance on the implementation of probability of presence of contaminants according to ISO 19880-8
  - Establish the hydrogen quality monitoring plan on real case scenario and its benefit in term of cost and reliability of the HRS

- Hydrogen specification – ISO 14687
  - Investigate new contaminants (as $C_4Cl_4F_6$) to allow the industry to evaluate its real impact
  - Propose revision of the three contaminants threshold or further studies

- Sampling and analysis of hydrogen
  - Standardise or provide guideline on sampling
  - Evaluate stability of contaminant over time to define if there is an impact of late analysis.
  - Analytical methods → Improvement needed (LOD close to ISO threshold)

Hydrogen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Hydrogen

Hydrogen, as an energy source, is a clean and storable solution that could meet the worldwide energy demands.

...ectives in the transport and energy ... Horizon 2020 Research and Innovation ... ourage the decarbonisation of the transport sector in ... uce the green-house gases effect.

The overall objective of the *Hydrogen* project is to address the standardisation needs in the hydrogen-energy sector that meet the requirements of the European Directive on the deployment of Alternative Fuels Infrastructure 2014/94/EU in order to bring forward the standardization in R&D related to metrology.

The project aims at supplementing the revision of two ISO standards that ... generic to enable a sustainable implementation in the fast emer... at contributing to the elaboration of two new standards.

Revisions of these two ISO standards (ISO 1... *...cification – Part 2: Proton exchange membran... ...icles* and ISO 16111:2008 *Developing tra... ...n absorbed in reversible metal hydride)* ar... *...7 Hydrogen technologies* and CEN/TC 268 ... *...gen technologies applications.*

The two new s... ...elaboration within the ISO/TC 197 standardization activities are ISO 21087 *H... – Analytical methods – Proton exchange membrane (PEM) fuel cell applications for ...ad vehicles* and ISO 19880-8 *Gaseous hydrogen – Fueling stations – Part 8: Fuel quality control.*

The EMPIR project *Hydrogen* runs from 1 June 2016 to 31 May 2019.

A workshop related to the project is planned in November 2018. More info here!

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

NEWS

Workshop at Air Liquide R&D Centre: November 7 & 8, 2018

Hydrogen quality: publication in International Journal of Hydrogen Energy, April 2018

Upcoming events

Past events

DOWNLOAD

- Publication in *International Journal of Hydrogen Energy*, April 2018
- Flyer Hydrogen JRP
- EURAMET 3rd Publishable Summary (January 2018)
- Publication in *Measurement*

THE PROJECT

WORKPACKAGES

https://projects.lne.eu/jrp-hydrogen/

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