SLOVENSKI STANDARD
oSIST prEN 17124:2020

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Vodik kot gorivo - Specifikacija izdelka in zagotavljanje kakovosti - Gorivne celice z membrano za protonsko izmenjavo (PEM) za cestna vozila

Hydrogen fuel - Product specification and quality assurance - Proton exchange membrane (PEM) fuel cell applications for road vehicles

Wasserstoff als Kraftstoff - Produktfestlegung und Qualitätssicherung - Protonenaustauschmembran (PEM) - Brennstoffzellenanwendungen für Straßenfahrzeuge

Carburant hydrogène - Spécification de produit et assurance qualité - Applications des piles à combustible à membrane à échange de protons (MEP) pour les véhicules routiers

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Hydrogen fuel - Product specification and quality assurance - Proton exchange membrane (PEM) fuel cell applications for road vehicles

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Contents

Page

European foreword 4
1 Scope 5
2 Normative references 5
3 Terms and definitions 5
4 Requirements 6
5 Hydrogen Quality Assurance Methodology 7
5.1 General Requirements – Potential sources of impurities 7
5.2 Prescriptive Approach for Hydrogen Quality Assurance 8
5.3 Risk Assessment for Hydrogen and Quality Assurance 8
5.4 Impact of impurities on fuel cell power train 10
6 Hydrogen Quality Control Approaches 12
6.1 General requirements 12
6.2 Spot sampling 12
6.3 Monitoring 12
7 Routine Quality Control 12
8 Non-routine Quality Control 12
9 Non compliances 13
Annex A (informative) Impact of impurities 14
A.1 General 14
A.2 Inert Gases: Argon, Nitrogen 14
A.3 Oxygen 14
A.4 Carbon Dioxide 14
A.5 Carbon Monoxide 14
A.6 Methane 15
A.7 Water 15
A.8 Total sulphur compounds 15
A.9 Ammonia 15
A.10 Total Hydrocarbons 15
A.11 Formaldehyde 16
A.12 Formic Acid 16
A.13 Halogenated Compounds 16
A.14 Helium 16
A.15 Solid and liquid particulates (Aerosols) 16
Annex B (informative) Example of Supply chain evaluation with regards to potential sources of impurities 18
B.1 Potential Sources of Impurities 18
B.2 Production 18
B.2.1 General 18
B.2.2 Reforming 18
B.2.3 Alkaline Electrolysis 19
B.2.4 Proton exchange membrane (PEM) electrolysis 19
B.2.5 Byproducts 19
B.2.6 New production methods 20
B.3 Transportation 20
B.3.1 General 20

B.3.2 Pipeline ... 20
B.3.3 Filling centre and tube trailer ... 20
B.4 HRS ... 21
B.5 Special operations: Commissioning, Maintenance ... 21
B.6 Particles ... 22
Annex C (informative) Example of Risk Assessment — Centralized production, pipeline transportation ... 23
Bibliography ... 31

European foreword

This document (prEN 17124:2020) has been prepared by Technical Committee CEN/TC 268 “Cryogenic vessels and specific hydrogen technologies applications”, the secretariat of which is held by AFNOR.

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1 Scope

This document specifies the quality characteristics of hydrogen fuel dispensed at hydrogen refuelling stations for use in proton exchange membrane (PEM) fuel cell road vehicle systems, and the corresponding quality assurance considerations for ensuring uniformity of the hydrogen fuel.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
constituent
component (or compound) found within a hydrogen fuel mixture

3.2
contaminant
impurity that adversely affects the components within the fuel cell system or the hydrogen storage system

Note 1 to entry: An adverse effect can be reversible or irreversible.

3.3
detection limit
lowest quantity of a substance that can be distinguished from the absence of that substance with a stated confidence limit

3.4
determination limit
lowest quantity which can be measured at a given acceptable level of uncertainty

3.5
fuel cell system
power system used for the generation of electricity on a fuel cell vehicle, typically containing the following subsystems: fuel cell stack, air processing, fuel processing, thermal management and water management

3.6
hydrogen fuel index
fraction or percentage of a fuel mixture that is hydrogen

3.7
irreversible effect
effect which results in a permanent degradation of the fuel cell power system performance that cannot be restored by practical changes of operational conditions and/or gas composition

3.8
on-site fuel supply
hydrogen fuel supplying system with a hydrogen production system in the same site

3.9
off-site fuel supply
hydrogen fuel supplying system without a hydrogen production system in the same site, receiving hydrogen fuel which is produced out of the site

3.10
particulate
solid or liquid particle (aerosol) that can be entrained somewhere in the delivery, storage, or transfer of the hydrogen fuel

3.11
reversible effect
effect which results in a non-permanent degradation of the fuel cell power system performance that can be restored by practical changes of operational conditions and/or gas composition

4 Requirements

The fuel quality requirements at the dispenser nozzle applicable to the aforementioned grades of hydrogen fuel for PEM fuel cells in road vehicles shall meet the requirements of Table 1. The fuel specifications are not process or feedstock specific. Non-listed contaminants have no guarantee of being benign.

The fuel quality requirements at the dispenser nozzle shall meet the requirements of Table 1.

NOTE The fuel specification is not process or feedstock specific. Non-listed contaminants have no guarantee of being benign.

Table 1 — Fuel quality specifications for PEM fuel cell road vehicle applications

Constituent	Characteristics
Hydrogen fuel index (minimum mole fraction)[a]	99,97 %
Total non-hydrogen gases	300 µmol/mol
Maximum concentration of individual contaminants	
Water (H_2O)	5 µmol/mol
Total hydrocarbons (THC)[b] (Excluding Methane)	2 µmol/mol
Methane (CH_4)	100 µmol/mol
Oxygen (O_2)	5 µmol/mol
Helium (He)	300 µmol/mol
Nitrogen (N_2)	300 µmol/mol
Argon (Ar)	300 µmol/mol
Carbon dioxide (CO_2)	2 µmol/mol
Carbon monoxide (CO)[c]	0,2 µmol/mol
Total sulphur compounds (H_2S basis)	0,004 µmol/mol
Formaldehyde (HCHO)[c]	0,2 µmol/mol
Formic acid (HCOOH)[c]	0,2 µmol/mol
Ammonia (NH_3)	0,1 µmol/mol
Halogenated compounds[d] (Halogenate ion basis)	0,05 µmol/mol
Maximum particulates concentration	1 mg/kg
For the constituents that are additive, such as total hydrocarbons and total sulphur compounds, the sum of the constituents shall be less than or equal to the acceptable limit.	

[a] The hydrogen fuel index is determined by substracting the “total non-hydrogen gases” in this table, expressed in mole percent, from 100 mol percent.

[b] Total hydrocarbons include oxygenated organic species. Total hydrocarbons shall be measured on a carbon basis (µmolC/mol).

[c] Total of CO, HCHO, HCOOH shall not exceed 0,2 µmol/mol

[d] All halogenated compounds which could potentially be in the hydrogen gas (for example, hydrogen chloride (HCl), and organic halides (R-X)) should be determined according to the hydrogen quality assurance discussed in Clause 6 and the sum shall be less than 0,05 µmol /mol).

5 Hydrogen Quality Assurance Methodology

5.1 General Requirements – Potential sources of impurities

A quality assurance plan for the entire supply chain shall be created to ensure that the hydrogen quality will meet the requirements listed in Clause 4. The methodology used to develop the quality assurance plan can vary but shall include one of the two approaches described in this document. The general description of these two approaches are described in 5.2 and 5.3.

For a given HRS, the contaminants listed in the hydrogen specification referred to Table 1 could be present. There are several parts of the supply chain where impurities can be introduced. Annex B describes potential impurities at each step of the supply chain.

When a contaminant is classified as potentially present, it shall be taken into account in the Quality Assurance methodology (risk assessment or prescriptive approach) described below.

5.2 Prescriptive Approach for Hydrogen Quality Assurance

A prescriptive approach can be applied for clearly identified supply chains. The prescriptive approach is not defined in this document.

5.3 Risk Assessment for Hydrogen and Quality Assurance

Risk assessment consists of identifying the probability of having each impurity above the threshold values of specifications given in Table 1 and evaluating the severity of each impurity for the fuel cell car. As an aid to clearly defining the risk(s) for risk assessment purposes, three fundamental questions are often helpful:

— What might go wrong: which event could cause the impurities to be above the threshold value?

— What is the likelihood (probability of occurrence) that impurities could be above the threshold value?

— What are the consequences (severity) for the fuel cell car?

In doing an effective risk assessment, the robustness of the data set is important because it determines the quality of the output. Revealing assumptions and reasonable sources of uncertainty will enhance confidence in this output and/or help identify its limitations. The output of the risk assessment is a qualitative description of a range of risk. The probability of an occurrence, in which each hydrogen impurity exceeds the threshold value, is defined by the following table of occurrence classes:

Table 2 — Occurrence classes for an impurity

Occurrence class	Class name	Occurrence or frequency	Occurrence or frequency (example) [a]
0	**Very unlikely (Practically impossible)**	Contaminant above threshold never been observed for this source / supply chain / station	1 per 10 000 000 refueling
1	**Unlikely**	Known to occur at least once for this source/ Supply chain/ station	1 per 1 000 000 refueling
2	**Possible**	Has happened once a year for this source/ Supply chain/ station	1 per 100 000 refueling
3	**Likely**	Has happened more than once a year for this source/supply chain/ station	1 out of 10 000 refueling
4	**Very likely**	Happens on a regular basis for this source/supply chain/ station	More than 1 out of 1 000 refueling

[a] Based on a refueling station supplying 100 000 refuelings per year.

The range of severity class (level of damage for vehicle) is defined in Table 3.

Table 3 — Severity classes for an impurity

Severity class	FCEV Performance impact or damage	Impact categories		
		Performance impact	Hardware impact temporary	Hardware impact permanent
0	— No impact	No	No	No
1	— Minor impact — Temporary loss of power — No impact on hardware — Car still operates	Yes	No	No
2	— Reversible damage — Requires specific light maintenance procedure — Car still operates	Yes or No	Yes	No
3	— Reversible damage — Requires specific immediate maintenance procedure . Gradual power loss that does not compromise safety	Yes	Yes	No
4[a]	— Irreversible damage — Requires major repair (e.g. stack change) — Power loss or Car Stop that compromises safety	Yes	Yes	Yes or No

[a] Any damage, whether permanent ornon-permanent, which compromises safety will be categorized as 4, otherwise non-permanent damage will be categorized as 1, 2 or 3.

The final risk is defined by Table 4, titled “Acceptability table”, and which combines results from Tables 2 and 3.

Table 4 — Acceptability table

		Severity				
		0	**1**	**2**	**3**	**4**
Occurrence as the combined probabilities of occurrence along the whole supply chain	**4**					
	3					
	2					
	1					
	0					
Key	Acceptable risk area Existing controls acceptable		Further investigations are needed to ensure the risks as low as reasonably practicable: existing barriers or control might not be enough		Unacceptable risk ; additional control or barriers are required	

For each impurity of the specification and for a given HRS (including the supply chain of hydrogen), a risk assessment shall be applied to define the global risk. Risk control includes decision making to reduce and/or accept risks. The purpose of risk control is to reduce the risk to an acceptable level. The amount of effort used for risk control should be proportional to the significance of the risk. Decision makers might use different processes, including a benefit-cost analysis, for understanding the optimal level of risk control. Risk control might focus on the following questions:

— Is the risk above an acceptable level?

— What can be done to reduce or eliminate risks?

— What is the appropriate balance among benefits, risks and resources?

For each level of risk, decision shall be taken in order to either refuse the risk and then find mitigation or barriers to reduce it, or accept the risk level as it is. Risk reduction focuses on processes for mitigation or avoidance of quality risks when it exceeds an acceptable level (yellow or red zone in Table 5). Risk reduction might include actions taken to mitigate the severity and/or probability of occurrence.

In the yellow zone, the risk could be acceptable but redesign or other changes should be considered if reasonably practicable. Further investigation should be performed to give better estimate of the risk. When assessing the need of remedial actions, the number of events of this risk level should be taken into consideration in order to be As Low As Reasonably Practicable (ALARP).

An example of such approach is given in Annex C.

5.4 Impact of impurities on fuel cell power train

The severity level of each impurity shall be determined. Indeed, the impact on the car if each impurity exceeds the threshold values given in Table 1 will depend on the concentration of the contaminant. The following Table 5 shows the summary of the concentration based impact of the impurities on the fuel cell.

In the first two columns the contaminants with their chemical formulas are given. An estimate of the exceeded concentration above the threshold value for each impurity is named “Level 1” and is given in column 5. According to this concentration, a severity class is given in column 4 for each impurity. This severity class covers the impact of this impurity above the threshold value up to this limit.

If higher concentrations that exceed Level 1 can be reached, the Severity Class is given in column 6.