SLOVENSKI STANDARD
SIST EN 17124:2018

01-december-2018

Vodik kot gorivo - Specifikacija izdelka in zagotavljanje kakovosti - Membrane za protonsko izmenjavo (PEM) - Gorivne celice 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 routier

Ta slovenski standard je istoveten z: EN 17124:2018

ICS:

27.075	Tehnologija vodika	Hydrogen technologies

SIST EN 17124:2018 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 17124

October 2018

ICS 27.075; 71.100.20

English Version

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

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 17124:2018 E

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European foreword

This document (EN 17124:2018) has been prepared by Technical Committee CEN/TC 268 “Cryogenic vessels and specific hydrogen technologies applications”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2019, and conflicting national standards shall be withdrawn at the latest by April 2019.

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1 Scope

This document specifies the quality characteristics of hydrogen fuel and the corresponding quality assurance in order to ensure uniformity of the hydrogen product as dispensed for utilization in proton exchange membrane (PEM) fuel cell road vehicle systems.

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 http://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.

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 Control Approaches

5.1 General requirements

Quality verification requirements for the qualification tests shall be performed at the dispenser nozzle under the applicable standardized sampling and analytical methods where available. Alternatively, the quality verification requirements may be performed at other locations in accordance with the quality assurance risk assessment.

There are two kinds of quality control at a Hydrogen Refueling Stations (HRS): on line monitoring or off line analysis after sampling. These methods can be used individually or together to ensure hydrogen quality levels.

5.2 Sampling

Spot sampling at an HRS involves capturing a measured amount for chemical analysis. Sampling is used to perform an accurate and comprehensive analysis of impurities, which is done externally, typically at a laboratory. Since the sampling process involves drawing a gas sample, it is typically done on a periodic basis and requires specialized sampling equipment and personnel to operate it. The sampling procedure shall ensure and maintain the integrity of the sample.

NOTE ISO/TS 19880-1 includes recommendations for sampling procedure.

5.3 Monitoring

An HRS can have real time monitoring of the hydrogen gas stream for one or more impurities on a continuous or semi-continuous basis. A critical impurity can be monitored to ensure it does not exceed a critical level, or monitoring of canary species are used to alert of potential issues with the hydrogen production or purification process. Monitoring equipment is installed in-line with the hydrogen gas stream and shall meet the process requirements of the HRS, as well as be calibrated on a periodic basis.

6 Hydrogen Quality Assurance Methodology

6.1 General Requirements – Potential sources of impurities

For a given HRS, the contaminants listed in the hydrogen specification referred to Table 1 may or may not 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.

6.2 Prescriptive Approach for Hydrogen Quality Assurance

A prescriptive approach can be applied for clearly identified supply chains. An approach to conducting a quality analysis of the contaminants listed in Clause 5 is to consider the potential sources of contaminants, and establish protocol for analysing potential contaminants.

Taking into account all existing hydrogen production methods, hydrogen transportation methods and non-routine procedures, prescriptive quality assurance plan shall be determined.

6.3 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
0	**Very unlikely (Practically impossible)**	Contaminant above threshold never been observed for this type of source in the industry	Never
1	**Very rare**	Known to occur in the Industry for the type of source/ Supply chain considered	1 per 1 000 000 refueling
2	**Rare**	Has happened more than once/year in the Industry	1 per 100 000 refueling
3	**Possible**	Has happened repeatedly for this type of source at a specific location	1 out of 10 000 refueling
4	**Frequent**	Happens on a regular basis	Often

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

Table 3 — Severity levels 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 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 4 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.