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Gaseous hydrogen — Fuelling stations —

Part 8: Fuel quality control

Hydrogène gazeux — Stations de remplissage —

Partie 8: Contrôle qualité du carburant

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee TC 197, *Hydrogen technologies*.

This second edition cancels and replaces the first edition (ISO 19880-8:2019), which has been technically revised. It also incorporates the Amendment ISO 19880-8:2019/AMD 1:2021.

The main changes are as follows:

— aligned with the revision of ISO 14687, in particular the change in the specifications of Grade D, the indicators required for risk assessment have been mainly changed;

— due to the change in the document structure of ISO 14687, the rationale for each of the ISO 14687, Grade D specifications has been moved to ISO 14687.

A list of all parts in the ISO 19880 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document was developed to specify how the quality of gaseous hydrogen fuel for road vehicles which use proton exchange membrane (PEM) fuel cells can be assured to meet the impurity levels in Grade D of ISO 14687. The document discusses hydrogen quality control approaches for routine and non-routine conditions, as well as quality assurance plans. It is based upon best practices and experience from the gaseous fuels and automotive industry. ISO 21087 describes the requirements for analytical methods to measure the level of contaminants in ISO 14687, Grade D.[1] ISO 19880-9 outlines requirements for sampling from hydrogen refuelling stations for samples taken at the dispenser.

Gaseous hydrogen — Fuelling stations —

Part 8:
Fuel quality control

1 Scope

This document specifies the protocol for ensuring the quality of the gaseous hydrogen at hydrogen distribution facilities and hydrogen fuelling stations for proton exchange membrane (PEM) fuel cells for road vehicles.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19880-9, *Gaseous hydrogen — Fuelling stations — Part 9: Sampling for fuel quality analysis*

ISO 14687, *Hydrogen fuel quality — Product specification*

3 Terms and definitions

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

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

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

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

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

3.2
contaminant
impurity (3.7) that adversely affects the components within the *fuel cell powertrain* (3.4) or the hydrogen storage system

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

3.3
filter
equipment to remove undesired *particulates* (3.14) from the hydrogen

3.4
fuel cell powertrain
power system used for the generation of electricity on a *fuel cell vehicle* (3.5)

Note 1 to entry: The fuel cell powertrain typically contains the following subsystems: fuel cell stack, air processing, fuel processing, thermal management, and water management

3.5
fuel cell vehicle
FCV
vehicle which stores hydrogen on-board and uses a *fuel cell powertrain* (3.4) to generate electricity for propulsion

3.6
fuelling station
facility for the dispensing of compressed hydrogen vehicle fuel, including the supply of hydrogen, and hydrogen compression, storage, and dispensing systems

Note 1 to entry: Fuelling station is often referred to as hydrogen fuelling station or hydrogen filling station.

3.7
impurity
non-hydrogen component in the gas stream

3.8
indicator species
one or more *constituents* (3.1) in the gas stream which can signal the presence of other chemical constituents because it has the highest probability of presence in a fuel produced by a given process

3.9
monitoring
act of measuring the *constituents* (3.1) of a hydrogen stream or process controls of a hydrogen production system on a continuous or semi-continuous basis by on-site equipment

3.10
non-routine
not in accordance with established procedures

3.11
on-site supply
hydrogen fuel supplying system with a hydrogen production system in the same site

3.12
off-site supply
hydrogen fuel supplying system without a hydrogen production system in the same site, receiving hydrogen fuel which is produced out of the site

3.13
particulate
solid or liquid, such as oil mist, that can be entrained somewhere in the delivery, storage, or transfer of the hydrogen fuel entering a *fuel cell powertrain* (3.4)

3.14
purifier
equipment to remove undesired *constituents* (3.1) from the hydrogen

Note 1 to entry: Hydrogen purifiers may comprise purification vessels, dryers, *filters* (3.3), and separators.

3.15
quality assurance
part of quality management focused on providing confidence that quality requirements will be fulfilled

3.16
quality control
part of quality management focused on fulfilling quality requirements

3.17
quality plan
documentation of quality management

3.18
reversible damage
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

3.19
risk
combination of the probability of occurrence of harm and the *severity* (3.24) of that harm, encompassing both the uncertainty about and severity of the harm

3.20
risk assessment
determination of quantitative or qualitative value of *risk* (3.19) related to a specific situation and a recognized threat

Note 1 to entry: A recognized threat can also be referred to as a hazard.

3.21
risk level
assessed magnitude of the *risk* (3.19)

3.22
routine
in accordance with established procedures

3.23
sampling
act of capturing a measured amount of hydrogen for chemical analysis by external equipment

3.24
severity
measure of the possible consequences for fuel cell vehicles if filled with H_2 containing a higher level of *impurities* (3.7) than the threshold value

4 Abbreviated terms

Abbreviated term	Definition
ATR	autothermal reaction
Halogens	halogenated compounds
HDS	hydrodesulfurization
MS	molecular sieve
OC	occurrence class
PEM	proton exchange membrane
Pox	partial oxidation
PSA	pressure swing adsorption
PSL	process safety limit
SC	severity class
SMR	steam methane reforming
HC	hydrocarbons
S	sulfur compounds
TSA	temperature swing adsorption
UD	undetermined

5 Hydrogen specifications

The quality requirements of hydrogen fuel dispensed to PEM fuel cells for road vehicles shall comply with Grade D of ISO 14687.

6 Quality control approaches

6.1 General

There are two common methods to control the quality of hydrogen at a fuelling station, by periodic sampling and continuous monitoring. These methods can be used individually or together to ensure hydrogen quality levels.

6.2 Sampling

Periodic sampling at a fuelling station 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 sample of gas, it is typically done on a periodic basis and requires specialized sampling equipment and personnel to operate it. Sampling procedures shall conform to ISO 19880-9. The advantage of periodic sampling is that a more detailed laboratory analysis can be conducted on the sample. The disadvantage of periodic sampling is that it is not continuous and results in a detailed analysis at a single point in time.

6.3 Monitoring

A fuelling station 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 an indicator species or control parameter can be 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 fuelling station, as well as be calibrated on a periodic basis. Continuous monitoring complements periodic sampling by offsetting the disadvantages.

7 Potential sources of impurities

For a given fuelling station, the contaminants listed in the hydrogen specification referred to in Clause 5 may or may not be potentially present. There are several parts of the supply chain where impurities can be introduced. The potential impurities in each step of the supply chain are described in Annex C.

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 in Clause 8.

8 Hydrogen quality assurance methodology

8.1 General

A quality assurance plan for the entire supply chain shall be created to ensure that the hydrogen quality will meet the requirements described in Clause 5. The methodology used to develop the quality assurance plan can vary but shall include one of the two approaches described in this document. A prescriptive methodology may be used as described in 8.2 or a risk assessment methodology may be used (8.3). Examples of these approaches: a) risk assessment and b) prescriptive approach for hydrogen quality, are presented in Annexes A and B, respectively. The quality assurance plan for the fuelling station shall include the following to ensure hydrogen quality is properly maintained:

— identification of potential impurities;

— methods to control and remove these impurities;

- sampling impurities and frequency;
- monitoring of impurities or process controls;
- description of solid and liquid particulate filters;
- cleanliness and maintenance procedures.

It is important to understand that quality should be maintained throughout the complete supply chain of the product (from production source to fuelling station nozzle), such that the impurities that are given in the specification remain below the threshold values.

Each component of the supply chain shall be investigated taking into account the already existing barriers for a given contaminant.

NOTE An effective quality control approach can further ensure the quality of the hydrogen by providing a proactive means to identify and control potential quality issues which can include sampling and monitoring. Additionally, use of quality assurance can improve the decision making if a quality problem arises.

If a vehicle is found to have hydrogen with contamination that exceeds the specification in Clause 5 and the source is unknown, the procedures in Clause 11 shall be followed.

8.2 Prescriptive methodology

The prescriptive approach to hydrogen quality assurance considers potential sources of contaminants and establishes a fixed protocol for analysing and addressing potential contaminants. The prescriptive approach can be applied for the clearly identified supply chain.

The prescriptive quality assurance plan shall be determined taking into account all hydrogen production methods, hydrogen transportation methods and non-routine procedures which exists in the area where the assurance plan is applicable.

NOTE Annex B presents Japanese hydrogen quality guidelines which is an example of a prescriptive quality assurance plan.

8.3 Risk assessment methodology

The risk assessment approach determines the probability to have each impurity above the threshold values of specifications given in Clause 5 and evaluates severity of each impurity for the fuel cell vehicle. As an aid to clearly defining the risk(s) for risk assessment purposes, three fundamental questions are often helpful:

- What can go wrong: which event can cause the impurities to be above the threshold value?
- What is the likelihood (probability of occurrence expressed relative to the number of fuelling events) that impurities can be above the threshold value?
- What are the consequences (severity) for the fuel cell vehicle?

In doing an effective risk assessment, the robustness of the data set is important because it determines the quality of the output. Conservative values should be taken if the data is unknown or has a high level of uncertainty. The risk analysis should be updated as the data is updated. 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. To determine the probability of the occurrence that impurities in hydrogen exceed the threshold value, Table 1 defines the occurrence classes.

Table 1 — Occurrence classes for an impurity

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

[a] Based on a fuelling station supplying 100 000 fuellings per year. In case the actual refuelling use of the subject HRS is known at a yearly base, the occurrence corresponding to all the occurrence classes should be proportionally adjusted so that occurrence class 2 reflects one occurrence per year

If the occurrence class is unknown, then the risk assessment shall assume the worst case. In addition, the experience of the hydrogen supplier, station manufacturer/installer should be taken into account when performing the risk analysis.

The range of severity classes (level of damage for vehicle) is defined in Table 2.

Table 2 — Severity classes for an impurity

Severity class	FCV 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 — Vehicle still operates	Yes	No	No
2	— Reversible damage — Requires specific light maintenance procedure — Vehicle 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]	— Power loss or vehicle stop that compromises safety — Irreversible damage — Requires major repair procedure (e.g., stack change)	Yes	Yes	No
			No	Yes

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