Compilation of comments received on ISO/DTS 14687-2 *Hydrogen Fuel — Product Specification — Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles*

Date:2007-01-17	ISO/TC 197 **N363 Annex 1**
Reference doc.: ISO/TC 197 **N352**	

1	2	(3)	4	5	(6)	(7)
MB[1]	**Clause No./ Subclause No./ Annex** (e.g. 3.1)	**Paragraph/ Figure/ Table/ Note** (e.g. Table 1)	**Type of comment**[2]	Comment (justification for change) by the MB	Proposed change by the MB	**Secretariat observations** on each comment submitted
CA		page ii:	ed	Indicate the full address, telephone number, fax number, telex number, and electronic mail address, as appropriate, of the Copyright **Manger** of the ISO member body responsible for the secretariat of the TC or SC within the framework of which the working document has been prepared.	1. Needs the address, etc. of Copyright Manager 2. Manager is misspelled.	
CA		Page iii:	ed	The content numbering is inconsistent, all subsections are listed except for # 3	What is standard format?	
CA	Introduction	Para 2	te	In addition, there may be performance implications in the fuel cell system if certain hydrogen constituent levels are not controlled. Statement does not make sense.	In addition, there may be performance implications **on the vehicle** if certain **non-**hydrogen constituent levels are not controlled.	
US	Introduction	Para 2	te	In addition, there may be performance implications in the fuel cell system if certain hydrogen constituent levels are not controlled. Statement does not make sense.	In addition, there may be performance implications **on the vehicle** if certain **non-**hydrogen constituent levels are not controlled.	
CA	3.1		ed	Constituent - component (or compound) found within a hydrogen fuel Phrasing needs to be reworked.	Constituent should be changed to Non-Hydrogen Constituents. The present definition of constituent states a component found in H2 fuel which would make non-hydrogen constituents obsolete	
US	3.1		ed	Constituent - component (or compound) found within a hydrogen fuel Phrasing needs to be reworked.	Constituent should be changed to Non-Hydrogen Constituents. The present definition of constituent states a component found in H2 fuel which would make non-hydrogen constituents obsolete	

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US	5.1.3	Paragraph one	TE	Most of the analytical methods cited in column 4 of Table 1 are not proven, consensus tested methods for the contaminants listed at the minimum levels cited. This gives the reader a very false impression that these test methods are suitable for the type and level of contaminant listed.	Change wording in 5.1.3 to : The published, consensus-based proven test methods and their numbers as well as detectable limits for analytical methods and instruments shall be reported along with the results from each test in terms reflecting the accuracy and precision of the test used. These detectable limits shall be below the threshold limit plus the reproducibility of the test for each constituent. At a minimum, the threshold limit shall be of a factor of 10 or greater than the lower detectability limit of the test. (Remainder wording as-is follows)	
US	5.2	Table 1 Footnote h)	te	The proposed new method will NOT work for ALL contaminants in hydrogen. In particular, this method will have problems with carbon monoxide (CO) as the mass spectrometer used for GC/MS does not have resolution to distinguish the mass of CO (28 amu) from nitrogen gas (N2) which also has a mass of 28 amu. A much better mass spectrometer is required. Given that CO is a "severe catalyst contaminant" this is particularly worrying.	Footnote h shall read as follows – "Appropriate ASTM methods will be developed to measure the contaminants, and more than one method may be required to measure all of the contaminants"	
US	5.2	Table 1	TE	Most of the cited test methods are not proven for trace contamination analysis of hydrogen. Therefore the table is misleading and not suitable. There are individual, custom laboratories that have developed test methods. ASTM Subcommittee DO3 and other international groups are developing consensus analytical standards	Change column four in Table 1 and footnotes as shown on pages 6-7.	
CA	5.2 Table 1	NOTE 1	te	It is recognized that the margin between the lower detectable limit and the acceptable limit for several potential non-hydrogen constituents is based on the limited state of development **of PEM fuel cell technology** as of the date of this technical specification. This statement is inaccurate and should be corrected.	It is recognized that the margin between the lower detectable limit and the acceptable limit for several potential non-hydrogen constituents is based on the limited state of development of **the published test methods** as of the date of this technical specification	

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US	5.2 Table 1	Maximum particulates concentration	te	at 20 ºC and 101,325 kPa The temperature value is inconsistent with other ISO hydrogen documents. If this is a standard, the temperatures need to be consistent.	Use the accepted normal temperature for hydrogen 15 ºC (59 ºF)	
CA	A.1		ed	Water ($H2O$) generally does not affect the function of fuel cell, however, it provides a transport mechanism for water-soluble contaminants such as K+ and Na+ when present as an aerosol. Both K+ and Na+ are recommended not to exceed 0,05 µmol/mol. In addition, it may pose a concern for onboard vehicle fuel system. At the maximum allowable concentration, water will remain gaseous throughout the operating conditions of fuel cell system. Ice formation in regulators, control valves, etc is of concern	Include the ice concern	
US	A.1		ed	Water ($H2O$) generally does not affect the function of fuel cell, however, it provides a transport mechanism for water-soluble contaminants such as K+ and Na+ when present as an aerosol. Both K+ and Na+ are recommended not to exceed 0,05 µmol/mol. In addition, it may pose a concern for onboard vehicle fuel system. At the maximum allowable concentration, water will remain gaseous throughout the operating conditions of fuel cell system. Ice formation in regulators, control valves, etc is of concern	Include the ice concern	
US	A.4		te	Inerts (e.g., Nitrogen) cross-over from air side can have a significant impact on fuel side dilution. That amount could potentially be significantly larger than 100 ppm, making this limit irrelevant. A proper limit shall include this impact, which depends on several fuel cell parameters, notably membrane thickness.	Addition of a line – Operation….For example, the nitrogen crossover from the air side may require these limits to be further modified.	

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US	A.7		TE	The term "irreversible" is used to describe sulfur poisoning. This term implies that the performance can never be recovered; however, there can be some recovery following the impurity removal. There are also some published techniques that if employed can recover the performance.	Change wording in first sentence of A.7 to Sulfur containing compounds are considered as severe contaminants that cause performance degradation that is not easily recovered	
US	A.9	Table 1	TE	The term "irreversible" is used to describe ammonia poisoning. This term implies that the performance can never be recovered; however, the performance can be partially recovered following the removal of the impurity	Change wording in first sentence of A.9 Ammonia (NH_3) causes fuel cell performance degradation ….	
CA	A.11		ed	A maximum particulate size diameter is specified because of concerns of gasket erosion in tanks. A maximum particulate concentration is specified to ensure that filters are not clogged and/or particulates do not enter the fuel system and affect operation of valves. Potassium and sodium ions present in aerosols cause irreversible performance degradation by contaminating the proton exchange membrane/ionomer.	Change **maximum particulate** to **maximum and particulate**	
US	A.11		ed	A maximum particulate size diameter is specified because of concerns of gasket erosion in tanks. A maximumparticulate concentration is specified to ensure that filters are not clogged and/or particulates do not enter the fuel system and affect operation of valves. Potassium and sodium ions present in aerosols cause irreversible performance degradation by contaminating the proton exchange membrane/ionomer.	Change **maximumparticulate** to **maximum and particulate**	
AR	Bibliography		Te	*ASTM D 1946:1990 (Reapproved 2000), Standard Practice for Analysis of Reformed Gas by Gas Chromatography* This standard was reapproved in 2006 as: *ASTM D 1946-90 (2006), Standard Practice for Analysis of Reformed Gas by Gas Chromatography*	Rename the cited standard as: *ASTM D 1946-90 (2006), Standard Practice for Analysis of Reformed Gas by Gas Chromatography*	

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AR	Bibliography		Te	*ASTM D 5504:2001, Standard Test Method for Determination of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Chemiluminescence* This standard was reapproved in 2006 as: *ASTM D 5504-01 (2006), Standard Test Method for Determination of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Chemiluminescence*	Rename the cited standard as: *ASTM D 5504-01 (2006), Standard Test Method for Determination of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Chemiluminescence*	
AR	Bibliography		Te	*ASTM D 5454:1993 (Reapproved 1999), Test Method for Water Vapor Content of Gaseous Fuels Using Electronic Moisture Analyzers* The last valid version of this standard is: *ASTM D 5454:2004, Test Method for Water Vapor Content of Gaseous Fuels Using Electronic Moisture Analyzers*	Rename the cited standard as the last version: *ASTM D 5454:2004, Test Method for Water Vapor Content of Gaseous Fuels Using Electronic Moisture Analyzers*	
AR	Bibliography		Te	*JIS K 0123:1995, General rules for analytical methods in gas chromatography mass spectrometry* The last valid version of this standard is: *JIS K 0123:2006, General rules for analytical methods in gas chromatography mass spectrometry*	Rename the cited standard as the valid version: *JIS K 0123:2006, General rules for analytical methods in gas chromatography mass spectrometry*	

Proposed new Table 1 from the USA

Table 1 — Directory of limiting characteristics

Characteristics (assay)	**Type I** **Grade D**	**Type II** **Grade D**	**Laboratory Test Methods** [a]
Hydrogen fuel index (minimum, %) [b, c]	99,99	99,99	
Para-hydrogen (minimum, %)	NS	95,0	
Non-hydrogen constituents (maximum content)			Dimensions in micromoles per mole unless otherwise stated
Total gases, [c]	100	100	
Water (H_2O)	5	5	No standardized test method available ASTM test methods for trace water in hydrogen under development (Work Item 10196) and ASTM D 1946 under revision (Work Item 4548)
Total hydrocarbons [d] (C_1 basis)	2	2	No standardized test method available ASTM D 1946 under revision (Work Item 4548)
Oxygen (O_2)	5	5	No standardized test method available ASTM D 1946 under revision for low level O_2, N_2, Ar, CO_2, and CO (Work Item 4548)
Total Inert Gases as Helium (He), Nitrogen (N_2), Argon (Ar)	100	100	No standardized test method available ASTM D 1946 under revision for low level O_2, N_2, Ar, CO_2, and CO (Work Item 4548)
Carbon dioxide (CO_2)	2	2	No standardized test method available ASTM D 1946 under revision for low level O_2, N_2, Ar, CO_2, and CO (Work Item 4548) ASTM developing new standard (WK10196)
Carbon monoxide (CO)	0,2	0,2	No standardized test method available ASTM D 1946 under revision for low level O_2, N_2, Ar, CO_2, and CO (Work Item 4548) ASTM developing new standard (WK10196)
Total sulfur compounds [e]	0,004[g]	0,004[g]	No standardized test method available ASTM developing a new standard (Work Item 4548) ASTM acquiring data on D5504 demonstrating ultra-low sensitivity to sulfur gases
Formaldehyde (HCHO)	0,01	0,01	No standardized test method available ASTM developing new standards (Work Items 4548 and 6624)
Formic acid (HCOOH)	0,2[g]	0,2[g]	No standardized test method available ASTM developing new standards (Work Items 4548 and 9211)
Ammonia (NH_3)	0,1[g]	0,1[g]	No standardized test method available ASTM developing new standards (Work Items 4548, 6527, 10196)
Total halogenated Compounds	0,05	0,05	No standardized test method available ASTM developing new standard (Work Item 4548)
Max Particulates Size [f]	10 µm	10 µm	No standardized test method available ASTM developing new standard (Work Item 9688)
Max Particulates Concentration [f]	1 µg/L @ NTP	1 µg/L @ NTP	No standardized test method available ASTM developing new standard (Work Item 9688)

Table 2 — Directory of limiting characteristics (continued)

a. Approved, standard test methods are not available for detecting many of the non-hydrogen constituents at the levels cited. There are some independent laboratories that can perform hydrogen analysis at the levels cited using proprietary test methods and procedures. Standard Development Organizations such as ASTM are in the process of developing consensus-based test methods to analyze for non-hydrogen constituents at the levels cited.
b. The hydrogen fuel index is obtained when the value of Total gases (%) is subtracted from 100%.
c. The value of Total gases is summation of the values of impurities listed in this table except Particulates.
d. THC may exceed 2 micromoles per mole due only to the presence of methane, provided that Total gases do not exceed 100 micromole per mole.
e. As a minimum, analysis shall include H_2S, COS, CS_2 and Mercaptans, which are typically found in natural gas.
f. Recommended value for Particulates is subject to sampling under realistic operational conditions and improved standardized analytical procedures.
g. These values are based on detection limits of currently proprietary instrumentation and test methods, and serve as a basis for subsequent improvements in test methods and instrumentation. Recommended values for these constituents are subject to revision from further research and testing under realistic operational conditions and improved consensus-based analytical procedures suitable for standardization.