SLOVENSKI STANDARD
kSIST-TP FprCEN/TR 17797:2021

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Infrastruktura za plin - Posledice zaradi vodika v infrastrukturi za plin in opredelitev s tem povezanih potreb po standardizaciji na področju CEN/TC 234

Gas infrastructure - Consequences of hydrogen in the gas infrastructure and identification of related standardisation need in the scope of CEN/TC 234

Gasinfrastruktur - Auswirkungen von Wasserstoff in der Gasinfrastruktur und Identifikation des zugehörigen Normungsbedarfs im Zuständigkeitsbereich des CEN/TC 234

Infrastructure gazière - Consequences d'hydrogen dans l'infrastructure gazière et l'identification des besoins relatifs à la normalisation dans le domaine d'application de CEN/TC 234

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TECHNICAL REPORT

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ICS

English Version

Gas infrastructure - Consequences of hydrogen in the gas infrastructure and identification of related standardisation need in the scope of CEN/TC 234

Infrastructure gazière - Consequences d'hydrogen dans l'infrastructure gazière et l'identification des besoins relatifs à la normalisation dans le domaine d'application de CEN/TC 234

Gasinfrastruktur - Auswirkungen von Wasserstoff in der Gasinfrastruktur und Identifikation des zugehörigen Normungsbedarfs im Zuständigkeitsbereich des CEN/TC 234

This draft Technical Report is submitted to CEN members for Vote. It has been drawn up by the Technical Committee CEN/TC 234.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (FprCEN/TR 17797:2021) has been prepared by Technical Committee CEN/TC 234 "Gas infrastructure", the secretariat of which is held by DIN.

This document is currently submitted to Vote on TR.

Introduction

The injection of hydrogen in natural gas infrastructures demands considerations with regard to the integrity, safety and performance of the systems facing increasing hydrogen levels, its fluctuation and variation.

There is extensive research on the use of hydrogen as an admixture with natural gas in various percentages or as pure hydrogen. Impact studies already completed or in progress are focusing on the use of existing gas networks but also of dedicated gas networks for hydrogen. They also include the impact of the introduction of hydrogen in various percentages into the gas infrastructure on all the existing technologies within the gas supply chain.

Accepting hydrogen into the natural gas network requires input from many gas TCs at CEN, i.e. CEN/TC 234 and particularly from the manufacturers of essential components, e.g. valves, gas pressure regulators, gas meters, safety control devices, leak detection devices, and many more (see Annex A). Many of these manufacturers are assessing the potential impact of hydrogen on existing components in natural gas service.

Co-operation with these other CEN and ISO/TCs for various essential components and applications will be necessary to ensure that projects to introduce hydrogen have all the essential elements of the gas chain fully co-ordinated into the plan. The positive co-operation of the component manufacturers will be particularly important.

In the transition scheme to hydrogen, there is a large body of knowledge and experience available from the hydrogen industry for gas production and use. The long-established safety requirements in this sector will aid the amendment of natural gas standards and codes of practice and the development of any new standards

This report is written for

— CEN/TC 234 as basis for definition of a TC roadmap for standardisation

— CEN/TC 234 WGs as a guideline for the standardisation work

— interested parties to get an insight in the decision process of CEN/TC 234's hydrogen standardisation.

NOTE This document has been elaborated in co-operation between the Working Group convenors, secretaries and experts, TC chair and secretariat of CEN/TC 234. Respecting different working group contributions, the way in which the content is presented and the level of details differs for the different topics. This is acceptable as the real technical work will take place in the dedicated working groups with co-ordination of the TC 234 Convenors/Secretaries group to ensure the final coherence of the resulting standardisation deliverables.

1 Scope

This document is written in preparation of future standardization and provides guidance on how injection of H_2 into the gas infrastructure can impact processes from the input of gas into the on-shore transmission network up to the inlet connection of gas appliances.

NOTE 1 Gas infrastructure includes gas installation pipework between the delivery point of the gas and the inlet connection to the gas appliance in buildings and on industrial sites.

The assessments refer to the concentrations of 2, 5, 10, 20 and up to 100 Vol.- % hydrogen in natural gas.

Furthermore, it identifies the expected revision need of the existing CEN/TC 234 standards as well as the need of further new standardisation deliverables.

It examines the effects on each part of the gas infrastructure in the scope of the CEN/TC 234 Working Groups 1 to 12 inclusive, based on available studies, reports and research. Due to several limitations at different hydrogen concentrations, the impacts are specified.

For some specific impact, pre-standardization research is needed.

By convention, for this technical report, the injection of pure hydrogen, i. e. without trace and/or minor components is considered. Awareness is given that there is the need to consider trace and/or minor components and limits set on the gas quality on European and national level, too.

The information from this report is intended to define the CEN/TC 234 work program for the coverage of H_2NG in relation to the scope of the CEN/TC 234 and its WGs.

NOTE 2 Progress on hydrogen will develop over time. In principle this will be reflected in the standardisation process in CEN/TC 234.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviations

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

The International Gas Union glossary on Underground Gas Storage [1] can be useful too:

3.1 Terms and definitions

3.1.1

hydrogen embrittlement

HE

interaction of hydrogen atoms and steel can have a negative effect on the mechanical behaviour of steel.

Note 1 to entry: The general term for this degrading effect is called hydrogen embrittlement

3.2.2

explosive atmosphere

mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture

[SOURCE: EN 13723:2013, 3.28]

3.2.3

hazardous explosive atmosphere

explosive atmosphere present in such quantities that precautions against ignition are required

[SOURCE: IEC 61340-4-4:2018, 3.6]

3.2.4

hazardous area

area in which an explosive atmosphere is present, or can be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment

[SOURCE: IEC 60079-0:2013]

3.2.5

explosion group

ranking of flammable gas-air mixtures with respect to the Maximum Experimental Safe Gap (MESG)

[SOURCE: EN ISO 16852:2016, 3.12.2]

3.2.6

temperature class

temperature range used for:

— classification of equipment, protective system for explosive atmospheres based on its maximum surface temperature; or

— classification of flammable gases and vapours based on their auto ignition

[SOURCE: EN 13237:2012, 3.63]

3.2.7

explosion pressure

highest pressure occurring in a closed vessel during the explosion of a specific mixture of flammable substances with air or air and inert gases determined under specified test conditions

[SOURCE: EN 15967:2011]

3.2.8

ignition temperature

lowest temperature (of a hot surface) at which under specified test conditions an ignition of a flammable gas or flammable vapour in mixture with air or air/inert gas occurs

[SOURCE: EN 14522:2005]

3.2.9

limiting oxygen concentration

LOC

maximum oxygen concentration in a mixture of a flammable substance and air and an inert gas, in which an explosion will not occur, determined under specified test conditions

[SOURCE: EN 13237:2012, 3.49]

3.2.10

lower explosion limit

LEL

lowest concentration of the explosion range at which an explosion can occur

[SOURCE: EN 13237:2012, 3.19.1]

3.2.11

maximum experimental safe gap

MESG

maximum gap of the joint between the two parts of the interior chamber of a test apparatus which, when the internal gas mixture is ignited and under specified conditions, prevents ignition of the external gas mixture through a 25 mm long joint, for all concentrations of the tested gas or vapour in air

[SOURCE: EN 13237:2012, 3.51]

3.2.12

maximum explosion pressure

maximum value of explosion pressure measured in the tests for explosion pressure when the content of the flammable substances in the mixture is varied

[SOURCE: EN 13237:2012, 3.2]

3.2.13

minimum ignition energy

MIE

lowest electrical energy stored in a capacitor, which upon discharge is sufficient to effect ignition of the most ignitable atmosphere under specified test conditions

[SOURCE: EN 13237:2012, 3.54]

3.2.14

upper explosion limit

UEL

highest concentration of the explosion range at which an explosion can occur

[SOURCE: EN 13237:2012, 3.19.2]

3.2.15

ventilation

movement of air and its replacement with fresh air due to the effects of wind, temperature gradients, or artificial means (for example, fans or extractors)

[SOURCE: IEC 60079-10-0:2015]

3.2 Symbols and abbreviations

Symbols and abbreviations should be selected from those already established in relevant ISO and/or CEN standards. New symbols and abbreviations should be defined only where there is no suitable alternative and recorded in CEN/TC 234 Doc N 776 (so called N 215).

The symbols and abbreviations used in this document are listed in Annex J.

4 Executive summary

Intention of the European gas industry is to enable the use of natural gas infrastructure for hydrogen.

For the use of hydrogen in the natural gas infrastructure it is reasonable to identify

— the similarities (what is equal) and differences (what is different) between methane (natural gas) and hydrogen and – based on these

— the consequences or the impact of hydrogen on the gas system (e.g. materials, safety, maintenance).

NOTE 1 Acknowledging the impact of the similarities on applications, in this document only the impact on gas infrastructure is considered as in the scope of CEN/TC 234.

NOTE 2 Natural gas is a mixture of hydrocarbon gases and other gases (e.g. nitrogen). Its main component is methane.

The following similarities and differences of the properties of methane and hydrogen need consideration:

Table 1 gives common properties of hydrogen and natural gas whereas Table 2 shows differences in the nominal values of the common properties of hydrogen and methane.

Table 1 — Common properties of hydrogen and natural gas

Characteristic	Methane (natural gas)	Hydrogen
gaseous	yes	yes
colourless	yes	yes
odourless	yes	yes
toxic	no	no
flammable	yes	yes
explosive	yes	yes
corrosive	no	no

Table 2 — Properties of hydrogen and methane — differences

Parameter	Methane	Hydrogen
Relative density (air = 1)	0,55	0,07
Flammability limits [Mol.- %]	4,4–17	4,0–77
Ignition energy [mJ]	0,26	0,017
Combustion energy up/low) [MJ/m³]	40/36	13/11
Wobbe number [MJ/m³]	upper: 54 lower: 48	48–41
Gross calorific value [kJ/mol, at 20 °C]	891	286
Flame colour	blue	colourless
Molecular mass [g/mol]	16	2
Molecule size [pm]	220	75
Diffusion coefficient in air [10^{-4} m²/s]	0,61	0,20
Infrared absorption	yes	no
Joule-Thomson coefficient [K/bar]	0,4	−0,03
Sound velocity [m/s]	388[a]	1 203

NOTE 1 This Table is meant as indication of general differences between methane (CH_4) and hydrogen (H_2) without referring to the specific conditions.

NOTE 2 More details related to mixtures of methane with hydrogen are given in Table B.1.

[a] High caloric natural gas

In Clause 6, a detailed evaluation of technical safety and integrity and performance aspects is given per part of the natural gas infrastructure.

In Clause 7, the suitability of the different parts of the gas infrastructure for hydrogen and hydrogen admixtures are summarised in form of tables.

As a conclusion, the following aspects need specific attention:

1) materials

- embrittlement of steel (5.2.2)
- diffusion and/or permeation of the gas through materials
- deterioration of elastomers
- suitability of sealing materials
- …

NOTE 3 Consideration should be given also to historic materials remaining in networks such as grey cast iron and ductile cast iron.

2) safety aspects of hydrogen/, explosion prevention and protection
   - ATEX requirements
   - purging
   - venting
   - proof of gas tightness
   - detection of hydrogen and admixtures
   - odorization
   - fire detection
3) technical system
   - compression
   - biochemical reactions in reservoirs and caverns
   - metering
   - gas preheating
   - Joule-Thomson-Dehydration
   - ...

4) Other aspects
   - Volume in relation to energy content (5.3)
   - Gas quality

The existing standards of CEN/TC 234 can be amended to cover natural gas infrastructure used for hydrogen services. For some aspects new CEN deliverables are needed.

The revision needs of the CEN/TC 234 standards respectively the need to elaborate additional standards is documented in Clause 8. The extent and timeframe of revision differs for the single aspects and for some aspects rely on further research results.

The involvement of the competent experts will be ensured by calls to the NSB, with the new work item proposals and beyond. Strong involvement of the sector is required.

NOTE 4 CEN/TC 234 intends to elaborate the related revisions in cooperation with the relevant TCs (e.g. CEN-CLC/JTC 6) and stakeholders. Preparations and first work items are already in process in the dedicated working groups.

5 General considerations for the entire gas infrastructure

5.1 Explosion protection and prevention

5.1.1 General principles

The general principles for the prevention of and protection against explosions are laid down in the European Directive 1999/92/EC (ATEX II). It addresses employers in order to protect workers and other persons from explosion hazards. The provisions given in this European Directive are detailed in national regulations. However, operators of plants and equipment also apply the general principles given of Directive 1999/92/EC with regard to third party protection.

With a view to preventing and providing protection against explosions, technical and/or organizational measures need to be taken, in order of priority and in accordance with the following basic principles:

— prevention of the formation of explosive atmospheres, or where the nature of the activity does not allow that,

— avoidance of the ignition of explosive atmospheres, and

— mitigation of the detrimental effects of an explosion to ensure the health and safety of workers.

Safety measures of the gas industry include safe gas infrastructure as well as safe gas utilisation and does focus on the prevention of unsafe situations, as explosions, by preventing the formation of explosive atmosphere and avoidance of the ignition where the formation of hazardous explosive atmospheres cannot be safely excluded. For pipework in buildings, also prevention measures in case of external fire are required. These basic principles are applying equally to natural gas, hydrogen and any admixtures of these. Public and workers safety is the prime consideration.

5.1.2 Safety characteristics of natural gas-hydrogen mixtures and their impact on explosion prevention

5.1.2.1 General

The safety characteristics of natural gas and hydrogen are well known. In a detailed study the safety characteristics of natural gas – hydrogen mixtures were examined in order to determine possible risks relating to occupational safety and health for hydrogen concentrations of up to 10 Vol.-%. The results of the measurements are given in Annex B.

A safety design for hydrogen can fully be used for natural gas application. Gas detecting equipment needs special consideration as detailed in Annex C.

5.1.2.2 Prevention of the formation of explosive atmospheres

Basic requirement for the prevention of the formation of explosive atmospheres is the gas tightness of the gas system. Wherever possible, the gas bearing part of the gas infrastructure is designed and operated to be permanently technically gastight. The gas tightness of the gas system is proven by tightness tests.

On components of the system for natural gas tightness test are carried out with air. If components of the gas system are specified for higher contents of hydrogen the test gases for the tightness tests need to be specified to verify the gas tightness against hydrogen leakage. For existing systems, the gas tightness can be verified with operating gas after the overall gas tightness test with inert gas, e.g. nitrogen.

Gas releases from the gas system can occur e.g. from:

— shaft sealing systems of valves or rotating equipment

— joints (e.g. pipe joints)

— venting of block and bleed systems

— depressurization and opening of equipment for maintenance activities

— emergency shut down with depressurization

— equipment failure