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Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network

Part 1: Specifications for biomethane for injection in the natural gas network

bsi.

National foreword

This British Standard is the UK implementation of EN 16723-1:2016.

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Erdgas und Biomethan zur Verwendung im Transportwesen und Biomethan zur Einspeisung ins Erdgasnetz - Teil 1: Festlegungen für Biomethan zur Einspeisung ins Erdgasnetz

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European foreword

This document (EN 16723-1:2016) has been prepared by Technical Committee CEN/TC 408 “Natural gas and biomethane for use in transport and biomethane foe injection in the natural gas network”, 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of an identical text or by endorsement, at the latest by May 2017, and conflicting national standards shall be withdrawn at the latest by May 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

EN 16723 consists of the following parts, under the general title “Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network”:

— *Part 1: Specifications for biomethane for injection in the natural gas network*

— *Part 2: Automotive fuel specifications*

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard was prepared by CEN/TC 408 in response to the European Commission standardization mandate M/475.

The Mandate asks for the development of a set of quality specifications for biomethane to be used as a fuel for vehicle engines and to be injected in natural gas pipelines (network).

However, the scope of the standard was widened according to BT decision C109/2012 that redefined the scope of CEN/TC 408: “Standardization of specifications for natural gas and biomethane as vehicle fuel and of biomethane for injection in the natural gas grid, including any necessary related methods of analysis and testing. Production process, source and the origin of the source are excluded”.

NOTE The CEN Technical Board (CEN/BT) is responsible to coordinate the work between technical bodies in order to achieve a coherent set of standards and to avoid overlaps.

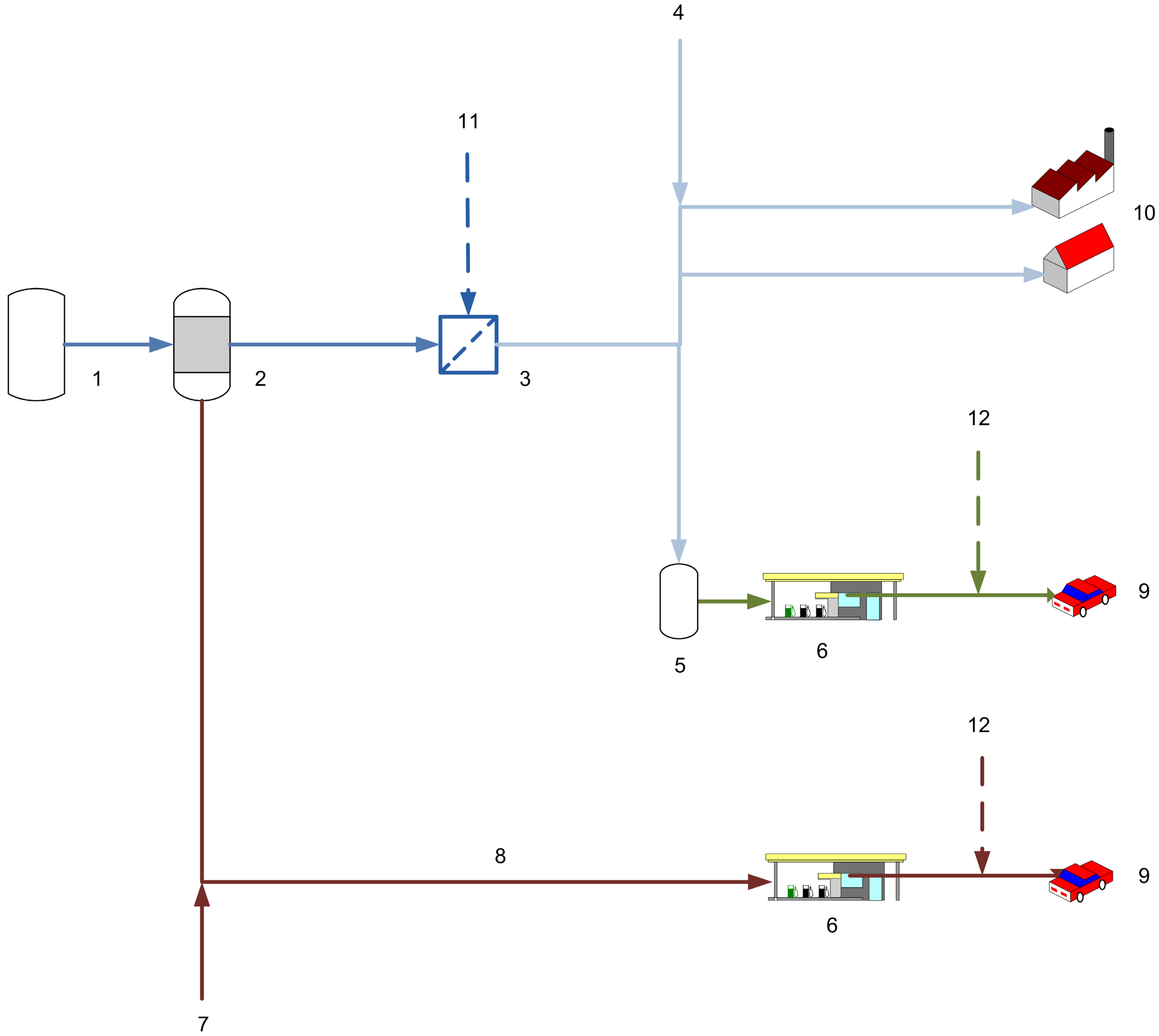
One of the aims of European policy in the field of energy is to increase the security of energy supply in the EU as well as to contribute to reduce the emission of greenhouse gases accepted by the EU at Kyoto. In this context, a special focus is given to the development and use of energy from renewable sources.

Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC stipulates clear aims regarding the percentage of renewables in EU energy consumption and states the related need to support the integration of energy from renewable sources into the energy networks including the establishment of appropriate technical rules in line with Directive 2003/55/EC (Article 6) replaced by 2009/73/EC (Article 8) for the realization of the competitive single European Gas Market and the technical interoperability of gas networks, (network connection, gas quality, gas odorization and gas pressure requirements).

Supporting the EU policy and therefore the maximization of the production and use of biomethane and considering the absence of standards the European Commission DG ENER has included the injection of biomethane in natural gas pipelines in Mandate M/475. Biomethane in this context can be produced from biological (fermentation, digestion …) and thermochemical processing of biomass and is appropriate to be used as a blending component to natural gas. A special focus is given to the development and use of energy from renewable sources of biological and non-biological origin. Other gases complying with this standard can be injected.

Figure 1 provides a visual representation of some applications of biomethane.

Mandate M/475 indicates that the requirements for natural gas quality for injection in the natural gas network are developed by CEN/TC 234 in answer to Mandate M/400 on natural gas quality. CEN/TC 408 should consider the work of the pending mandate M/400 on gas quality, and should refer to the parameters as defined and specified in EN 16726. This standard should exclude the definition of any parameters or substances that are addressed in EN 16726. However, it may specify more strict limits for parameters or substances unique to biomethane if deemed technically necessary. If needed, additional parameters or substances should be defined.



Key

1	biogas from digestion or thermos chemical process	7	non-grid sourced natural gas
2	upgrading	8	local dedicated infrastructure
3	injection into the gas grid	9	automotive use
4	natural gas grid	10	domestic and industrial use
5	conditioning	11	Part 1: grid specification
6	refuelling station	12	Part 2: automotive specification

Figure 1 — Representation of some flows and uses of biomethane and natural gas

1 Scope

This European Standard specifies the requirements and test methods for biomethane at the point of entry into natural gas networks.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 16726:2015, *Gas infrastructure - Quality of gas - Group H*

EN ISO 10715:2000, *Natural gas - Sampling guidelines (ISO 10715:1997)*

EN ISO 13443:2005, *Natural gas - Standard reference conditions (ISO 13443:1996 including Corrigendum 1:1997)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16726:2015 and the following apply.

3.1
biogas
gas, comprising principally methane and carbon dioxide, obtained from the anaerobic digestion of biomass

3.2
biomass
biological material from living, or recently living organisms, typically this may be plants or plant-derived materials

3.3
biomethane
gas comprising principally methane, obtained from either upgrading of biogas or methanation of bio-syngas

3.4
bio-syngas
gas, comprising principally carbon monoxide and hydrogen, obtained from gasification of biomass

3.5
gas infrastructure
pipeline systems including pipework, underground gas storages and their associated stations or plants for the transmission and distribution of gas

3.6
hydrocarbon dew point temperature
temperature above which no condensation of hydrocarbons occurs at a specified pressure

3.7
lower heating value
amount of heat that would be released by the complete combustion with oxygen of a specified quantity of gas, in such a way that the pressure at which the reaction takes place remains constant, and all the products of combustion are returned to the same specified temperature as that of the reactants, all of these products being in the gaseous state

3.8
methane number
MN
rating indicating the knocking characteristics of a gaseous fuel

Note 1 to entry: MN has a similar use as the octane number for petrol.

Note 2 to entry: MN expresses the volume percentage of methane in a methane/hydrogen mixture which, in a test engine under standard conditions, has the same tendency to knock as the gaseous fuel to be examined.

3.9
natural gas
complex gaseous mixture of hydrocarbons, primarily methane, but generally includes ethane, propane and higher hydrocarbons, and some non-combustible gases such as nitrogen and carbon dioxide

Note 1 to entry: Natural gas can also contain components or contaminants such as sulfur compounds and/or other chemical species.

3.10
natural gas network
either transmission network or local distribution system

3.11
non-grid sourced natural gas
natural gas non coming from the natural gas network

3.12
odorization
addition of odorants to gas (normally odourless) to allow gas leaks to be recognized by smell at trace levels (before accumulating to dangerous concentrations in air)

3.13
syngas
gas, comprising principally of carbon monoxide and hydrogen, obtained from gasification of fossil fuel

3.14
upgrading of biogas
removal of carbon dioxide and contaminants from biogas

3.15
water dew point temperature
temperature above which no condensation of water occurs at a specified pressure

3.16
Wobbe index
volumetric-basis heating value, at specified reference conditions, divided by the square root of the relative density at the same specified metering reference conditions

4 Parameters and test methods

4.1 General

This section deals with the various parameters for which requirements are given.

Natural gas, biomethane and blends of those intended for injection into natural gas networks shall be free from any constituents or impurities other than the ones described in this standard, to the extent that it cannot be transported, stored or utilized without quality adjustment or treatment. In the case of such other constituents and/or impurities, it may be necessary to obtain an approval from the competent and legitimate authority to define the acceptable risk in the territory of the injection point.

4.2 Standard reference conditions

Unless stated otherwise, all volumes are for the real dry gas at ISO Standard Reference conditions of 15 °C and 101,325 kPa.

Unless stated otherwise, all calorific values and Wobbe index are for the real dry gas at ISO Standard Reference conditions of:

— 15 °C (combustion);

— and 15 °C and 101,325 kPa (metering).

In assessing compliance with this European Standard, parameters should be determined directly at ISO standard reference conditions. If the properties are only available at other reference conditions and the actual gas composition is not known then conversion to ISO standard reference conditions shall be carried out using the procedure described in EN ISO 13443.

4.3 Applicable requirements and test methods for biomethane for injection in the natural gas network

Biomethane shall meet the requirements of EN 16726 for common parameters and Table 1 only for parameters specific to biomethane. Health criteria assessment for biomethanes is complex and dependent upon the biogas feedstock and upgrading and purification process. As a result, it is recommended that contaminants to be specified and limits to be applied are assessed at national level using an appropriate methodology. An example of such a methodology is provided in CEN/TR, *Proposed limit values for contaminants in biomethane based on health assessment criteria* (WI 00408007)[1].

Table 1 provides common requirements for injection into H and L gas systems.

For injection into L gas systems, national requirements for Wobbe index, relative density, and CO_2 shall be applied when appropriate.

1) This CEN/TR is currently in development.

Table 1 — Applicable common requirements and test methods for biomethane at the point of entry into H gas and L gas networks

Parameter	Unit	Limit values[a]		Test method (Informative)
		Min	Max	
Total volatile silicon (as Si)	mgSi/m³		0,3 to 1[b]	EN ISO 16017-1:2000 TDS-GC-MS
Compressor oil		[c]		ISO 8573-2:2007
Dust impurities		[c]		ISO 8573-4:2001
Chlorinated compounds		-	[d, e]	EN 1911:2010
Fluorinated compounds			[d]	NF X43–304:2007 ISO 15713:2006
CO	% mol	_	0,1[f]	EN ISO 6974- series
NH3	mg/m³		10	NEN 2826:1999 or VDI 3496 Blatt 1:1982–04 NF X43–303:2011
Amine	mg/m³		10	VDI 2467 Blatt 2:1991–08

[a] Limit values are absolute, the number of the decimal places shall not imply the accuracy of the test methods.

[b] A range of limit values for siloxanes is proposed for this standard. Studies have demonstrated that continuous exposure to 100 % biomethane for 15 years should require a specification as low as 0,1 mg Si/m3. However, a limit set at this level would present difficulty in terms of analytical measurement (current quantification limits are at best 0,10 mg Si/m3, which would imply setting a limit of 0,30 mg Si/m3). Moreover, this would not recognize the mitigating effects of dilution of injected biomethane by natural gas. It is therefore suggested that the limit value to be applied [in a Network Entry Agreement] should be agreed between biomethane producer and gas transporter [grid operator] taking into account both performance of current analytical methods and dilution opportunities through, e.g. capacity studies. See Annex C for further guidance on monitoring regimes.

[c] The biomethane shall be free from impurities other than “de minimis” levels of compressor oil and dust impurities. In the context of this European Standard, “de minimis” means an amount that does not render the biomethane unacceptable for conveyance and use in end user applications.

[d] See CEN/TR, *Proposed limit values for contaminants in biomethane based on health assessment criteria* (WI 00408007).

[e] Alkyl halides are a leading substances in the sense that the given limit value to halides provides automatically a satisfactory limit value of fluorine, chlorine containing compounds – the measure is made on halides.

[f] The 0,1 % limit was taken from the CLP-Regulation (EC) No 1272/2008.

Test methods other than those listed in the relevant standards column in Table 1 may be applied, provided their fitness for purpose can be demonstrated and validated.

Some test methods have not been validated for biomethane or mixtures with natural gas, however further work is undertaken towards validation.

Additional information on the components listed in Table 1 can be found in Annex A and Annex B for sulfur. Additional information on compliance schemes can be found in Annex C.

5 Sampling

Components shall be sampled according to EN ISO 10715 as those of EN 16726. This sampling method has not been validated for biomethane or mixtures with natural gas, however further work is undertaken towards validation.

Other parameters as total volatile silicon need special attention for the sampling method.

Measures shall be taken to avoid any contamination of the sample from the moment of sampling until the analysis can be performed.

Annex A
(informative)

Parameters

A.1 Total silicon

It is reported that the use of siloxanes (organic silicon) is increasing in household industrial cleaning products and personal care products. Most siloxanes are very volatile and decompose in the atmosphere into silanols, which are eventually oxidized into silica (silicon dioxide). Some siloxanes end up in effluents (including from agricultural anaerobic digestion) and waste water and are adsorbed onto the extracellular polymeric substances of sludge flocks. Siloxanes are volatilized from the sludge during anaerobic digestion and end up in biogas.

Silicones are also sometimes added in digesters as anti-foaming agents, where they can biodegrade into siloxanes. Organic silicon compounds end up in landfills from sources such as shampoo bottles and other containers in which some of the product remains, through landfilling of waste water treatment sludge and from packaging and construction material.

It is reported that organic silicon compounds present in biogas are oxidized during biogas combustion into microcrystalline silicon oxide, a residue with chemical and physical properties similar to glass. Silicon dioxide collects in deposits on valves, cylinder walls and liners causing abrasion and blockage of pistons, cylinder heads and valves.

Gas combustion turbines are vulnerable to silica because hard particles cause erosion by the high velocity of the gas streams or build up deposits. Seizure is reported, when larger chunks of silica break off. Some turbine manufacturers request silicon contents below 0,1 mg silicon/m^3 biomethane.

Higher silicon contents misalign and reduce durability of oxygen sensors in stationary gas engines, e.g. for CHP generation. Deposition of silica on sensor elements impedes oxygen diffusion. Silicon levels above 0,1 mg/m3 can severely harm oxygen sensors of some engines as shown by oxygen sensors producers.

Within the EDGaR programme the impact of siloxanes on domestic boilers was investigated. This study* has shown that levels above 0,077 mg Si/Nm^3 can reduce the thermal output of boilers by silica deposition inside heat exchangers to an inacceptable level (−10 %). The impact of silica deposition on the ionization probe by gas with silicon contamination in the same order of magnitude can result in a failure of the flame-detection safeguard.

Besides siloxanes, biogases may also contain organic silicon compounds other than siloxanes which are also converted to silica upon combustion.

A.2 Hydrogen

See Annex E in EN 16726:2015.

A.3 Compressor oil, dust impurities and biogenic materials

To avoid problems with lubricating oil carryover and dust and other impurities, a minimum of one oil removal filter should be installed downstream of equipment. Dust and impurities can be removed using a dedicated dust filter. The main function of the dedicated dust filter is to retain dust or solid particles. The operation of the filter should not be impaired by water, oil or hydrocarbon droplets. The filter should be of the cartridge type. The cartridge should retain 99 % of the 5 µm dust and 99 %

liquid ≥ 10 µm. Please note that the removal of oil and dust are interdependent unit operations. The first filter will have to take care of both oil and particles, irrespective of filter design.

A.4 Water and hydrocarbon dew point temperature

See Annex C in EN 16726:2015.

Annex B
(informative)

Odorization and sulfur

B.1 CEN/TC 408 approach

With regard to sulfur content on natural gas, CEN/TC 408 takes the decision on an approach how to handle the different opinions about the maximum permitted sulfur content, and agrees that the standard for injection will follow the specification for sulfur in EN 16726.

B.2 General

Gas usually contains a small amount of sulfur as result of the decay of organic substances. This can come as Hydrogen sulfide, Carbonyl sulfide, Mercaptan, and other kinds of sulfides, depending on the origin of the gas and of its treatment. Further, in nearly all distribution grids, but also some transmission grids, artificial odorant whereof the majority is based on sulfur organic compounds, is added to identify the gas for the purpose of leak detection whereof the majority is based on sulfurorganic compounds.

It is generally agreed that high pressure networks preferably contain non-odorized gas. For such gases, a maximum content of 20 mg/m^3 total sulfur will apply. Nothing should prevent existing practices with respect to transmission of odorized gas between high pressure networks to continue.

Biomethane could contain residual elements that can affect the odorizing process.

B.3 Total sulfur from Odorants

In all European countries, distributed gas is odorized for safety reason. As most odorants used are sulfur based molecules, odorization increases the amount of sulfur in the gas. The report Natural Gas odorization practices in Europe from Marcogaz indicates the usual amount of sulfur added in various countries by odorization in terms of total sulfur and mercaptan sulfur.

NOTE In some countries, the addition of odorant may be done upstream of the distribution grid.

Annex C
(informative)

Examples of different compliance schemes

C.1 General

This annex presents a framework and examples of means and methods (analytical or technical) to comply with the standard limit values.

Biomethane production and injection or use as vehicle fuel are depending on local conditions such as:

— Production, distribution and consumption matching: sizing, flowrates, seasonally, customer requirements: domestic, Combined Heat and Power (CHP), etc.;

— Specific equipment and grid design: metallic or plastic piping, etc.

C.2 General prescriptions

C.2.1 Permit conditions

The operating conditions should be agreed between the involved parties and precise all the measures necessary to achieve a high level of protection of the environment, equipment, workers and end users as a whole. The permit should also include compliance rules for limit values, or equivalent parameters or technical measures, appropriate safety and environment requirements and monitoring requirements.

Agreement conditions should be set on the basis of best available techniques.

This permit or agreement may present in a table the different conditions:

— parameter and its unit;

— control means and methods, (EN standards or specific protocol or procedure if any);

— communication: signal to central control room;

— registration: feedstock registration;

— conditions for warnings and alarms;

— conditions for disconnection.

C.2.2 Upgrading plants

Upgrading plants should be designed, equipped, built and operated in such a way that the limit values set out in the standard are not exceeded in the gas injected into the grid during an appropriate duration defined in the local permit.

C.2.3 Control and monitoring

Measurement equipment should be installed and techniques used in order to monitor the parameters, conditions and mass/molar concentrations relevant to the upgrading and injection processes.

The measurement requirements and control methods should be laid down in the agreement or in the conditions attached to the agreement issued by the competent authority.

Relevant parameters are defined in the local permit, based on a feedstock and end-user risks assessment.

The appropriate installation and the functioning of the automated monitoring equipment for injection or use should be subject to control and to an annual surveillance test. Calibration has to be done by means of parallel measurements with the reference methods at least every three years.

C.2.4 Measurement

All measurement results should be recorded, processed and presented in an appropriate fashion in order to enable the competent authorities to verify compliance with the permitted operating conditions and limit values laid down in this standard in accordance with procedures to be decided upon by those national authorities.

The following measurements of parameters should be carried out:

Table C.1 — Measurements of parameters

Phase	Measurements and relevant parameters
Commissioning period	Sampling and lab analysis Continuous measurements of the parameters or process operation parameters near the injection point or at another point.
First year operation	Periodic sampling and measurement
Continuous operation	Continuous measurements of the relevant parameters or process operation parameters near the injection point or at another point. Examples of relevant parameters: temperature, pressure, Wobbe, H2S, O_2
Periodically: 2 times/once a year, every 2 years…	Sampling and lab analysis Examples of relevant parameters: siloxanes, halogenated compounds, heavy metals, toxic organic compounds or any other hazardous substances if suspected in the feedstock

The involved parties fix measurement periods where they have set limit values for such relevant parameters.

C.2.5 Risk assessment

The limit value compliancy should be determined and agreed on the basis of:

— a risk assessment (risk is a matter of hazard and exposure in time);

— local situation (climate, …);

— the grid architecture and operation, (dry networks, PE/steel, gas mix, pressure,…).

C.3 Common practices

The following tables show examples of common practices and risk assessment in European biomethane industry.

Table C.2 — Common practices

Parameters	Risks	Control	Remarks
Calorific value, Wobbe index, density,	Equipment operation disturbances	Continuous monitoring	Hourly, daily average
O_2	Equipment operation disturbance Corrosion if long term and wet systems.	Continuous monitoring Dry networks	Hourly, daily average
CO_2, water dew point	Equipment operation disturb. + Corrosion if long term	Continuous monitoring Dry networks	Hourly, daily, monthly average
Odorizing agent (range)	Safety for end user (leakage)	Depends on the national rules	Depends on the national rules
H2S	Long term corrosion	Continuous monitoring	Daily, monthly or yearly average
	Short-term exposure at high level	Continuous monitoring	Hourly average
	NG quality variation at border point		Daily or monthly or yearly average

Table C.3 — Risk assessments

Parameters	Risks	Control
CO	Short-term exposure	Periodic sampling[a]
Total volatile silicium (as Si)	Mid/Long term damages on stationary equipments	Chemical foaming agents control Feedstock control [a] Polishing filter periodic inspection and maintenance
		Periodic sampling [a]
	Mid-term damages on vehicles components or sensitive industrial equipment (gas turbine)	
		Polishing filter periodic inspection and maintenance
Heavy metals and its compounds	Long term, chronic toxicity Threshold / non threshold	Feedstock control[b] Periodic sampling Health risk assessment
Fluorine and its compounds Chlorine and its compounds	Long term, chronic toxicity Threshold / non threshold Long term, damages due to corrosion	Periodic sampling [a] Feedstock control[b]
Mono aromatic (BTEX) Poly aromatic (PAHs) hydrocarbons	Long term, chronic toxicity Threshold / non threshold	Periodic sampling [a] Feedstock control [b] Health risk assessment
Mercaptans, terpene	Odorizing agent neutralization	Periodic sampling [a]
Biological agents	Biohazard	Filter periodic inspection and maintenance

[a] Periodic sampling maybe used with different conditions and frequency:

-during commissioning;

-periodically;

-if there is a risk depending the feedstock variation;

-when feedstock is changed.

No sampling is required if limit values in feedstock are maintained.

[b] Feedstock control depends on the organic material employed in the digestion processes: Recommended for biomethane from waste, not for biomethane from agriwastes.

Annex D
(informative)

A-deviations

A-deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN-CENELEC national member.

This European Standard does not fall under any Directive of the EU.

In the relevant CEN-CENELEC countries these A-deviations are valid instead of the provisions of the European Standard until they have been removed.

Clause	Deviation
4.3 Table 1 Total volatile silicon (as SI)	Dutch Deviation - Ministerial Regulation Gas Quality - MR Gaskwaliteit; Regeling van de Minister van Economische Zaken van 16 februari 2016, nr. WJZ/15079642, tot wijziging van de Regeling gaskwaliteit Based on the above legislation the value for total volatile silicon (as Si) shall comply with the requirements of the Ministerial Regulation on Gas Quality. Specifically, the following requirement shall need to be fulfilled: The maximum value for total volatile siloxanes shall not exceed < 0,1 mg Si/m3 at the point of entry into gas networks.
4.3 Table 1 Total volatile silicon (as SI)	Danish Deviation - "Gasreglementet", section C12, dealing with requirements on gas quality (Executive order no. 1264 of 14th December 2012). Based on the above legislation the value for total volatile silicon (as Si) shall comply with the requirements of the Danish Regulation on Gas Quality. Specifically, the following requirement shall need to be fulfilled: The maximum value for total volatile siloxanes shall not exceed < 1.0 $mg/m3_n$ at the point of entry into gas networks, which corresponds to approximately 0,4 mg/m^3_n (Si).

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