INTERNATIONAL STANDARD

ISO 13686

Second edition
2013-06-15

Natural gas — Quality designation

Gaz naturel — Désignation de la qualité

Reference number
ISO 13686:2013(E)

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Published in Switzerland

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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 documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 193, *Natural gas*.

This second edition cancels and replaces the first edition (ISO 13686:1998), which has been technically revised.

Introduction

The need for an International Standard concerning the designation of natural gas quality was a basic reason for the establishment of ISO/TC 193 in 1989. Standardization of the designation of quality is specifically stated in the scope of ISO/TC 193. Natural gas, supplying 20 % of the world's primary energy, is likely to increase its market share greatly. Yet there is currently no generally accepted definition of natural gas quality.

To meet this need, it was decided that a general statement of the parameters (i.e. components and properties) recommended should be established and that the resulting International Standard would not specify values of, or limits for, these parameters.

Furthermore, it was decided that general-purpose natural gas transmitted to local distribution systems (LDS), referred to as "natural gas", should be the first consideration. Thus, this International Standard was developed. Informative annexes are attached as examples of actual natural gas quality specifications that already exist.

This International Standard does not impose any quality restrictions on raw gas transported via pipelines or gathering systems to processing or treating facilities.

It should be understood that this International Standard covers natural gas at the pipeline level prior to any treatment by LDS for peakshaving purposes. This covers the vast majority of the natural gas that is sold in international trade and transmitted for custody transfer to local distribution systems.

Natural gas — Quality designation

1 Scope

This International Standard specifies the parameters required to describe finally processed and, where required, blended natural gas. Such gas is referred to subsequently in this text simply as "natural gas".

The main text of this International Standard contains a list of these parameters, their units and references to measurement standards. Informative annexes give examples of typical values for these parameters, with the main emphasis on health and safety.

In defining the parameters governing composition, physical properties and trace constituents, consideration has also been given to existing natural gases to ensure their continuing viability.

The question of interchangeability is dealt with in Annex A (see Clause A.2).

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.

ISO 6326-1, *Natural gas — Determination of sulfur compounds — Part 1: General introduction*

ISO 6326-3, *Natural gas — Determination of sulfur compounds — Part 3: Determination of hydrogen sulfide, mercaptan sulfur and carbonyl sulfide sulfur by potentiometry*

ISO 6326-5, *Natural gas — Determination of sulfur compounds — Part 5: Lingener combustion method*

ISO 6327, *Gas analysis — Determination of the water dew point of natural gas — Cooled surface condensation hygrometers*

ISO 6570, *Natural gas — Determination of potential hydrocarbon liquid content — Gravimetric methods*

ISO 6974-1, *Natural gas — Determination of composition and associated uncertainty by gas chromatography — Part 1: General guidelines and calculation of composition*

ISO 6974-2, *Natural gas — Determination of composition and associated uncertainty by gas chromatography — Part 2: Uncertainty calculations*

ISO 6974-3, *Natural gas — Determination of composition with defined uncertainty by gas chromatography — Part 3: Determination of hydrogen, helium, oxygen, nitrogen, carbon dioxide and hydrocarbons up to C8 using two packed columns*

ISO 6974-4, *Natural gas — Determination of composition with defined uncertainty by gas chromatography — Part 4: Determination of nitrogen, carbon dioxide and C1 to C5 and C6+ hydrocarbons for a laboratory and on-line measuring system using two columns*

ISO 6974-5, *Natural gas — Determination of composition and associated uncertainty by gas chromatography — Part 5: Isothermal method for nitrogen, carbon dioxide, C1 to C5 hydrocarbons and C6+ hydrocarbons*

ISO 6974-6, *Natural gas — Determination of composition and associated uncertainty by gas chromatography — Part 6: Determination of helium, oxygen, nitrogen, carbon dioxide and C1 to C10 hydrocarbons using capillary columns*

ISO 6975, *Natural gas — Extended analysis — Gas-chromatographic method*

ISO 6976:1995, *Natural gas — Calculation of calorific values, density, relative density and Wobbe index from composition*

ISO 6978-1, *Natural gas — Determination of mercury — Part 1: Sampling of mercury by chemisorption on iodine*

ISO 6978-2, *Natural gas — Determination of mercury — Part 2: Sampling of mercury by amalgamation on gold/platinum alloy*

ISO 10101-1, *Natural gas — Determination of water by the Karl Fischer method — Part 1: Introduction*

ISO 10101-2, *Natural gas — Determination of water by the Karl Fischer method — Part 2: Titration procedure*

ISO 10101-3, *Natural gas — Determination of water by the Karl Fischer method — Part 3: Coulometric procedure*

ISO 11541, *Natural gas — Determination of water content at high pressure*

ISO 13443, *Natural gas — Standard reference conditions*

ISO 14532, *Natural gas — Vocabulary*

ISO 15970:2008, *Natural gas — Measurement of properties — Volumetric properties: density, pressure, temperature and compression factor*

ISO 15971:2008, *Natural gas — Measurement of properties — Calorific value and Wobbe index*

ISO 18453, *Natural gas — Correlation between water content and water dew point*

ISO 19739, *Natural gas — Determination of sulfur compounds using gas chromatography*

ISO 23874, *Natural gas — Gas chromatographic requirements for hydrocarbon dewpoint calculation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14532 and the following apply.

3.1
natural gas
gaseous fuel obtained from underground sources and consisting of a complex mixture of hydrocarbons, primarily methane, but generally also including ethane, propane and higher hydrocarbons in much smaller amounts

Note 1 to entry: It also includes some inert gases, such as nitrogen and carbon dioxide, plus minor amounts of trace constituents.

Note 2 to entry: Natural gas remains in the gaseous state under the temperature and pressure conditions normally found in service. It is produced by processing raw gas or from liquefied natural gas and, if required, blended to give a gas suitable for direct use. As pipeline quality natural gas, it can then be transmitted within a local distribution system, within a country, or across national borders. It is subject to contractual requirements between buyer and seller, and in some cases to national or state requirements as to quality (see Clause A.1).

3.2
liquefied natural gas
natural gas which, after processing, has been liquefied for storage or transportation purposes

Note 1 to entry: Liquefied natural gas is revaporized and introduced into pipelines for transmission and distribution as natural gas.

3.3
substitute natural gas
manufactured or blended gas with properties which make it interchangeable with natural gas

Note 1 to entry: Substitute natural gas is sometimes called synthetic natural gas.

Note 2 to entry: This also includes gases manufactured by thermal process from biomass.

3.4
raw gas
unprocessed gas taken from well heads through gathering lines to processing facilities

3.5
local distribution system
gas mains and services which supply natural gas directly to consumers

3.6
gas quality
attribute of natural gas by its composition (major components, minor components and trace components) and its physical properties (calorific value, Wobbe index, compression factor, relative density and dew points)

3.7
reference conditions
standard reference conditions of temperature, pressure and humidity (state of saturation) to be used for measurements and calculations carried out on natural gases, natural gas substitutes and similar fluids in the gaseous state

Note 1 to entry: Standard reference conditions are denoted by the subscript "s": p_s = 101,325 kPa; T_s = 288,15 K.

Note 2 to entry: Adapted from ISO 13443.

3.8
calorific value

amount of heat which would be released by the complete combustion in air 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

Note 1 to entry: It is divided into two types: superior calorific value and inferior calorific value.

Note 2 to entry: Both superior and inferior calorific values, which differ by the heat of condensation of water formed by combustion, can be specified on a molar, mass or volumetric basis. For the volumetric basis the pressure and temperature shall be stated at standard reference conditions.

Note 3 to entry: Calorific values can also be stated as dry or wet, depending on the water vapour content of the gas prior to combustion.

Note 4 to entry: The effect of water vapour on the calorific values, either directly measured or calculated, is described in Annex F of ISO 6976:1995.

Note 5 to entry: Normally, the calorific value is expressed as the superior, dry value specified as a volumetric basis under standard reference conditions.

Note 6 to entry: Adapted from ISO 6976.

3.8.1
superior calorific 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 p_1 at which the reaction takes place remains constant, and all the products of combustion are returned to the same specified temperature t_1 as that of the reactants, all of these products being in the gaseous state except for water, which is condensed to the liquid state at t_1

Note 1 to entry: Adapted from ISO 6976.

3.8.2
inferior calorific 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 p_1 at which the reaction takes place remains constant, and all the products of combustion are returned to the same specified temperature t_1 as that of the reactants, all of these products being in the gaseous state

Note 1 to entry: Adapted from ISO 6976.

3.9
density
mass of a gas divided by its volume at specified pressure and temperature

3.10
relative density
density of a gas divided by the density of dry air of standard composition at the same specified conditions of pressure and temperature

Note 1 to entry: The term "ideal relative density" applies when both gas and air are considered as fluids which obey the ideal gas law; the term "real relative density" applies when both gas and air are considered as real fluids. For the standard composition of dry air.

Note 2 to entry: Adapted from ISO 6976.

3.11
Wobbe index
volumetric-basis superior (inferior) calorific value, at specified reference conditions, divided by the square root of the relative density at the same specified metering reference conditions

Note 1 to entry: The heat input for different natural gas compositions is the same if they have the same Wobbe index and are used under the same gas pressure.

Note 2 to entry: Adapted from ISO 6976.

3.12
compression factor
compression factor Z is the quotient of the volume of an arbitrary mass of gas, at a specified pressure and temperature, and that of the same gas under the same conditions as calculated from the ideal gas law

Note 1 to entry: The terms "compressibility factor" and "Z-factor" are synonymous with compression factor.

Note 2 to entry: Adapted from ISO 12213-1.

3.13
water dew point
temperature above which no condensation of water occurs at a specified pressure

Note 1 to entry: For any pressure lower than the specified pressure there is no condensation at this temperature.

Note 2 to entry: Adapted from ISO 6327.

3.14
hydrocarbon dew point
temperature above which no condensation of hydrocarbons occurs at a specified pressure

Note 1 to entry: At a given dew point, there is a pressure range within which condensation occurs except at one point, the cricondentherm (see A.3.2).

3.15
gas composition
concentrations of the major and minor components and trace components in natural gas as analysed

3.16
molar composition
gas composition expressed as a molar (or mole) fraction, or molar (mole) percentage

Note 1 to entry: The mole fraction, *x*, of component *i* is the quotient of amount of substance of this component and amount of substance of the whole mixture. The unit of amount of substance is mole. The mass of one mole of any chemical species, in grams, is numerically equal to its relative molecular mass. A table of recommended values of molar masses is given in ISO 6976. For an ideal gas, the mole fraction is identical to the volume fraction, but this relationship cannot in general be assumed to apply to real gas behaviour.

3.17
gas analysis
use of test methods and other techniques for determining the gas composition, as stated in this International Standard

3.18
interchangeability
measure of the degree to which the combustion characteristics of one gas resemble those of another gas

Note 1 to entry: Two gases are said to be interchangeable when one gas may be substituted for the other without affecting the operation of gas burning appliances or equipment.

3.19
odorization
addition of odorants, in most cases intensively smelling organic sulfur compounds, to natural gas to allow the recognition of gas leaks by smell at very low concentration (before a build up to a dangerous gas in air concentration can occur)

Note 1 to entry: Natural gas is normally odourless. It is necessary to add an odorant to the gas for safety reasons. It permits the detection of the gas by smell at very low concentrations.

Note 2 to entry: Odorants in use for gas odorization are specified in ISO 13734.

3.20
methane number
rating indicating the knocking characteristics of a fuel gas

Note 1 to entry: It is comparable to the octane number for petrol.

Note 2 to entry: The methane number 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 fuel gas to be examined.

4 Symbols, abbreviations and units

4.1 Symbols

Symbol	Meaning and units
d	Relative density
$\bar{H}$	Molar basis calorific value (kJ/mol)
$\hat{H}$	Mass basis calorific value (MJ/kg)
$\tilde{H}$	Volumetric basis calorific value (MJ/m^3)
M	Mass per mole (kg/kmol)
p	(Absolute) pressure (kPa)
t	Celsius temperature (°C)
T	Thermodynamic (absolute) temperature (K)
V	(Gas) volume (m^3)
W	Wobbe index (number) (MJ/m^3)
Z	Compression factor
D	Density (kg/m^3)

4.2 Abbreviations

Abbreviation	Meaning
LDS	Local distribution system
NG	Natural gas
SNG	Substitute (synthetic) natural gas

4.3 Subscripts

d	(Gas volume) dry
l	Inferior (calorific value)
s	(Gas volume) saturated
S	Superior (calorific value)
w	(Gas volume) wet

Superior calorific value is denoted by *Hs;* inferior calorific value is denoted by H_I. The calorific value shall be specified under the combustion conditions. The volumetric calorific value shall be specified under standard reference conditions. The calorific value is normally stated as “dry”.

EXAMPLE Superior calorific value, specified on a volumetric basis, at standard reference conditions and stated as wet. For simplicity, the combustion conditions are not specified.

$$\tilde{H}_{S,w}(p_s, T_s)$$

The Wobbe index, denoted by W, is expressed on a volumetric basis and given in MJ/m3, where the volume is stated at standard reference conditions. The Wobbe index can be specified as superior or inferior, depending on the calorific value and as dry or wet, depending on the calorific value and the corresponding density.

EXAMPLE Wobbe index, superior, specified an a volumetric basis, at standard reference conditions and stated as "wet".

$$W_{S,w}(p_s, T_s) = \frac{\tilde{H}_{S,w}(p_s, T_s)}{\sqrt{d_w(p_s, T_s)}}$$

5 Quality designation parameters

5.1 General

This clause deals with the various parameters which may be referred to in a designation of the quality of natural gas. The parameters actually selected will depend upon the purpose for which the designation is required and it is unlikely that all the parameters listed in this International Standard will be used.

5.2 Gas composition

5.2.1 General

Natural gas is composed primarily of methane with smaller amounts of higher hydrocarbons and of non combustible gases. Major and minor components and trace constituents may be determined as given in Tables 1, 2 and 3.

Limits are not given in this International Standard, but analysis to determine the natural-gas properties may be specified in contracts and state and federal codes in some countries (see informative annexes).

5.2.2 Major components

Table 1 — Major components of natural gas

Constituent	Units	Relevant standard
Methane	mol %	ISO 6974 (parts 1 to 6)
Ethane	mol %	ISO 6974 (parts 1 to 6)
Propane	mol %	ISO 6974 (parts 1 to 6)
Butanes	mol %	ISO 6974 (parts 1 to 6)
Pentanes	mol %	ISO 6974 (parts 1 to 6)
Hexanes plus	mol %	ISO 6974 (parts 1 to 6), ISO 6975
Nitrogen	mol %	ISO 6974 (parts 1 to 6)
Carbon dioxide	mol %	ISO 6974 (parts 1 to 6), ISO 6975

5.2.3 Minor components

Table 2 — Minor components of natural gas

Constituent	Units	Relevant standard
Hydrogen	mol %	ISO 6974-3 and ISO 6974–6, ISO 6975
Oxygen	mol %	ISO 6974-3 and ISO 6974–6, ISO 6975
Carbon monoxide	mol %	ISO 6974-3
Helium	mol %	ISO 6974-3 and ISO 6974–6, ISO 6975

5.2.4 Trace constituents

Table 3 — Trace constituents of natural gas

Constituent	Units	Relevant standard
Hydrogen sulfide	mg/m^3	ISO 6326-1and ISO 6326–3, ISO 19739
Mercaptan sulfur	mg/m^3	ISO 6326-3, ISO 19739
Dialkyl (di) sulfide	mg/m^3	ISO 19739
Carbonyl sulfide	mg/m^3	ISO 6326-3, ISO 19739
Total sulfur	mg/m^3	ISO 6326-5, ISO 19739
Mercury	$\mu g/m^3$	ISO 6978-1 and ISO 6978–2

5.3 Gas properties

5.3.1 General

Physical properties may be determined as specified in Table 4.

5.3.2 Physical properties

Table 4 — Physical properties of natural gas

Constituent	Units	Relevant standard
Molar calorific value, $\bar{H}$	MJ/mol	ISO 6976, ISO 15971
Mass-basis calorific value, $\hat{H}$	MJ/kg	ISO 6976, ISO 15971
Volumetric-basis calorific value $\tilde{H}$	MJ/m^3	ISO 6976, ISO 15971
Relative density, d	-	ISO 6976, ISO 15970
Wobbe index, W	MJ/m^3	ISO 6976, ISO 15971
Water dew point	°C (K)	ISO 6327, ISO 18453
Water content	mg/m^3	ISO 10101-1, ISO 18453 ISO 10101-2 ISO 10101-3 ISO 11541
Hydrocarbon dew point	°C (K)	ISO 23874
Hydrocarbon liquid content	mg/m^3	ISO 6570

5.3.3 Other parameters

Content of:

— water and hydrocarbons in liquid form;

— solid particulate substances;

— other gases.

NOTE Usually, the above substances are not present in the natural gas in an amount that could adversely affect the transportation, distribution or utilization of the gas.

6 Sampling

For the control of natural gas quality, sampling is necessary. Natural gas is generally sampled at agreed upon points, using routines representing established good practice, applying the relevant standards. See ISO 10715 for guidance on sampling.