INTERNATIONAL STANDARD

ISO 13686

First edition
1998-05-01

Natural gas — Quality designation

Gaz naturel — Désignation de la qualité

Reference number
ISO 13686:1998(E)

Contents

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X.400 c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 13686 was prepared by Technical Committee ISO/TC 193, *Natural gas*.

Annexes A to H of this International Standard are for information only.

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. Standardisation of the designation of quality is specifically stated in the scope of the TC. 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) required 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 percentage of the natural gas that is sold in international trade and transmitted for custody transfer to local distribution systems.

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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 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 clause A.2.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6326-1:1989,	*Natural gas - Determination of sulfur compounds - Part 1: General introduction.*
ISO 6326-2:1981,	*Gas analysis - Determination of sulphur compounds in natural gas - Part 2: Gas chromatographic method using an electrochemical detector for the determination of odoriferous sulphur compounds.*
ISO 6326-3:1989,	*Natural gas - Determination of sulfur compounds - Part 3: Determination of hydrogen sulfide, mercaptan sulfur and carbonyl sulfide sulfur by potentiometry.*
ISO 6326-4:1994,	*Natural gas - Determination of sulfur compounds - Part 4: Gas chromatographic method using a flame photometric detector for the determination of hydrogen sulfide, carbonyl sulfide and other sulfur-containing odorants.*

ISO 6326-5:1989, *Natural gas - Determination of sulfur compounds - Part 5: Lingener combustion method.*

ISO 6327:1981, *Gas analysis - Determination of the water dew point of natural gas - Cooled surface condensation hygrometers.*

ISO 6568:1981, *Natural gas - Simple analysis by gas chromatography.*

ISO 6570-1:1983, *Natural gas - Determination of potential hydrocarbon liquid content - Part 1: Principles and general requirements.*

ISO 6570-2:1984, *Natural gas - Determination of potential hydrocarbon liquid content - Part 2: Weighing method.*

ISO 6570-3:1984, *Natural gas - Determination of potential hydrocarbon liquid content - Part 3: Volumetric method.*

ISO 6974:1984, *Natural gas - Determination of hydrogen, inert gases and hydrocarbons up to C_8 - Gas chromatographic method*

ISO 6975:1997, *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 10101-1:1993, *Natural gas - Determination of water by the Karl Fischer method - Part 1: Introduction.*

ISO 10101-2:1993, *Natural gas - Determination of water by the Karl Fischer method - Part 2: Titration procedure.*

ISO 10101-3:1993, *Natural gas - Determination of water by the Karl Fischer method - Part 3: Coulometric procedure.*

ISO 10715:1997, *Natural gas - Sampling.*

ISO 11541:1997, *Natural gas - Determination of water content at high pressure.*

ISO 12213-1:1997, *Natural gas - Calculation of compression factor - Part 1: Introduction and guidelines.*

ISO 13443:1996, *Natural gas - Standard reference conditions.*

3 Definitions

For the purposes of this International Standard, the following definitions and explanations apply.

3.1 natural gas

A 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. It generally also includes some inert gases, such as nitrogen and carbon dioxide, plus minor amounts of trace constituents.

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 may 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 annex A, clause A.1).

3.2 liquefied natural gas

Natural gas which, after processing, has been liquefied for storage or transportation purposes. Liquefied natural gas is revapourized 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. Substitute natural gas is sometimes called synthetic natural gas.

3.4 raw gas

Unprocessed gas taken from well heads through gathering lines to processing facilities.

3.5 local distribution system

The gas mains and services which supply natural gas directly to consumers.

3.6 gas quality

The quality of a natural gas is defined by its composition and the following physical properties:

Major components:	calorific value, Wobbe index
Minor components:	density, compression factor
Trace constituents:	relative density, dew points

3.7 reference conditions

The preferred reference conditions are referred to as standard reference conditions and denoted by the subscript "s" (see ISO 13443):

p_s = **101,325 kPa**

T_s = **288,15 K**

3.8 calorific values

Divided into two types: superior calorific value and inferior calorific value, defined as follows (see ISO 6976).

3.8.1 superior calorific value

The 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, all of these products being in the gaseous state except for water formed by combustion, which is condensed to the liquid state at the above mentioned temperature. The above mentioned pressure and temperature must be specified.

3.8.2 Inferior calorific value

The 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, all of these products being in the gaseous state. The above mentioned pressure and temperature must be specified.

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.

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

The effect of water vapour on the calorific values, either directly measured or calculated, is described in annex F of ISO 6976.
Normally, the calorific value is expressed as the superior, dry value specified on a volumetric basis under standard reference conditions.

3.9 density

The mass of a gas divided by its volume at specified pressure and temperature.

3.10 relative density

Often called specific gravity, it is the mass of natural gas, dry or wet, per unit volume divided by the mass of an equal volume of dry air, both at the same specified pressure and temperature (see ISO 6976).

3.11 Wobbe index

The Wobbe index is a measure of the heat input to gas appliances, derived from the orifice flow equation. It is defined as the specified calorific value, always on a volume basis, divided by the square root of the corresponding relative density. 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 (see ISO 6976).

3.12 compression factor

The 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.

The terms compressibility factor and *Z*-factor are synonymous with compression factor (see ISO 12213-1).

3.13 water dew point

The dew point defines the temperature above which no condensation of water occurs at a specified pressure. For any pressure lower than the specified pressure there is no condensation at this temperature
(see A.4.1 and ISO 6327).

3.14 hydrocarbon dew point

The dew point defines the temperature above which no condensation of hydrocarbons occurs at a specified pressure.
At a given dew point, there is a pressure range within which condensation occurs except at one point, the cricondentherm (see A.4.2).

3.15 molar composition

The molar composition of a gas is the term used when the proportion of each component is expressed as a molar (or mole) fraction, or molar (mole) percentage, of the whole.
Thus the mole fraction, x_i, of component *i* is the quotient of the number of moles of component *i* and the number of moles of the whole mixture present in the same arbitrary volume. One mole of any chemical species is the amount of substance which has the relative molecular mass in grams. A table of recommended values of relative molecular masses is given in ISO 6976.
For an ideal gas, the mole fraction (or percentage) is identical to the volume fraction (percentage), but this relationship cannot in general be assumed to apply to real gas behaviour.

3.16 gas composition
The concentrations of the major and minor components and trace constituents in natural gas as analysed.

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

3.18 interchangeability
A measure of the degree to which the combustion characteristics of one gas resemble those of another gas. 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
Natural gas is normally odourless. It is necessary to add an odorant to the gas fed into the distribution system for safety reasons. It permits the detection of the gas by smell at very low concentrations.

3.20 methane number
The methane number is a rating indicating the knocking characteristics of a fuel gas. It is comparable to the octane number for petrol.
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

Symbol/Abbreviation	Meaning and units
d	Relative density
$\overline{H}$	Molar basis calorific value (kJ/mol)
$\hat{H}$	Mass basis calorific value (MJ/kg)
$\tilde{H}$	Volumetric basis calorific value (MJ/m^3)
LDS	Local distribution system
M	Mass per mole (kg/kmol)
NG	Natural gas
p	(Absolute) pressure (kPa)
SNG	Substitute (synthetic) natural gas
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)
Subscripts	
d	(Gas volume) dry
I	Inferior (calorific value)
s	(Gas volume) saturated
S	Superior (calorific value)
w	(Gas volume) wet

Calorific value

Superior calorific value denoted by H_S, inferior calorific value 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.

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

Wobbe index

The Wobbe index, denoted by W, is expressed on a volumetric basis and given in MJ/m^3, 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 on a volumetric basis, at standard reference conditions and stated as "wet"

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

5 Quality designation parameters

This section 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.

5.1 Gas composition

Natural gas is composed primarily of methane with smaller amounts of higher hydrocarbons and non combustible gases. Major and minor components and trace constituents may be determined as follows.

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

5.1.1 Major components

Constituent	Units	Test methods
Methane		
Ethane		
Propane		
Butanes		ISO 6568
Pentanes	mol %	ISO 6974
Hexanes plus		ISO 6975
Nitrogen		
Carbon dioxide		

5.1.2 Minor components

Constituent	Units	Test methods
Hydrogen		
Oxygen		ISO 6975
Carbon monoxide	mol %	ISO 6974
Helium		

5.1.3 Trace constituents

Constituent	Units	Test methods
Hydrogen sulfide		ISO 6326-1
Mercaptan sulfur		ISO 6326-2
Dialkyl (di) sulfide	mg/m^3	ISO 6326-3
Carbonyl sulfide		ISO 6326-4
Total sulfur		ISO 6326-5

5.2 Gas properties

5.2.1 Physical properties

Property		Units	Test methods
Molar calorific value	$\overline{H}$	MJ/mol	
Mass-basis calorific value	$\hat{H}$	MJ/kg	
Volumetric-basis calorific value	$\tilde{H}$	MJ/m^3	ISO 6976
Density	d	—	
Wobbe index	W	MJ/m^3	
Water dew point		°C (K)	ISO 6327
Water liquid content		mg/m^3	ISO 10101-1 ISO 10101-2 ISO 10101-3 ISO 11541
Hydrocarbon dew point		°C (K)	
Hydrocarbon liquid content		mg/m^3	ISO 6570-1 ISO 6570-2 ISO 6570-3

5.2.2 Other properties

Natural gas shall be technically free of:

- Water and hydrocarbons in liquid form;
- Solid particulate substances in amounts deleterious to the materials normally encountered in transportation and utilisation;
- Other gases that could adversely affect the transportation or utilisation of the gas.

Note:
Technically free means that there are no visible traces of the components mentioned under actual conditions.

6 Sampling

Natural gas shall be sampled at agreed upon points, using routines representing established good practice, for the purpose of applying the test methods required. See ISO 10715 for guidance on sampling.