BS EN ISO 14532:2017

BSI Standards Publication

Natural gas — Vocabulary (ISO 14532:2014)

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National foreword

This British Standard is the UK implementation of EN ISO 14532:2017. It is identical to ISO 14532:2014. It supersedes BS EN ISO 14532:2005 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PTI/15, Natural Gas and Gas Analysis.

A list of organizations represented on this committee can be obtained on request to its secretary.

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European foreword

The text of ISO 14532:2014 has been prepared by Technical Committee ISO/TC 193 "Natural gas" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 14532:2017 by Technical Committee CEN/TC 238 "Test gases, test pressures, appliance categories and gas appliance types" the secretariat of which is held by AFNOR.

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Foreword

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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 14532:2001/Cor. 1:2002).

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Introduction

ISO/TC 193 Natural Gas was established in May, 1989, with the task of creating new standards and updating existing standards relevant to natural gas. This includes gas analysis, direct measurement of properties, quality designation, and traceability.

In these activities, a comprehensive and uniform review of the definitions, symbols, and abbreviations used in the standards was not previously systematically pursued. The development of standards with terminology created to suit specific purposes often resulted in the detriment of uniformity and cohesiveness between standards.

Thus, there is the need for a work of harmonization of the terminology used in the standards pertaining to natural gas. The intention of this International Standard is to incorporate the reviewed definitions into the ISO/TC 193 source International Standard.

As the aim is to create a coherent body of standards which support each other with regard to their definitions, common and unambiguous terms and definitions used throughout all International Standards is the starting point for the understanding and application of every International Standard.

The presentation of this International Standard has been arranged to facilitate its use as follows:

— Major headings pertain to specific fields of the natural gas industry. All definitions that fall under these headings, as gleaned from ISO International Standards issued through ISO/TC 193, are listed under that heading. A review of the contents will serve to facilitate finding specific terms.

— Notes are given under numerous definitions where it was deemed important to give informative guidance for a given definition. The Notes are not considered a part of the definition.

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INTERNATIONAL STANDARD ISO 14532:2014(E/F)

Natural gas — Vocabulary

1 Scope

This International Standard establishes the terms, definitions, symbols, and abbreviations used in the field of natural gas.

The terms and definitions have been reviewed and studied in order to cover all aspects of any particular term with input from other sources such as European Standards from CEN (The European Committee for Standardization), national standards, and existing definitions in the IGU Dictionary of the Gas Industry.

The definitive intention of this document is to incorporate the reviewed definitions into the ISO/TC 193 source standards.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1 General conditions

2.1.1 Natural gas

2.1.1.1
natural gas
NG
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 containments such as sulfur compounds and/or other chemical species.

2.1.1.2
raw gas
unprocessed gas taken from well heads, through gathering lines, to processing or treating facilities

Note 1 to entry: Raw gas can also be partially processed well-head gas, taken from basic upstream processing facilities.

2.1.1.3
substitute natural gas
SNG
gas from non-fossil origin which is interchangeable in its properties with natural gas

2.1.1.4
manufactured gas
synthetic gas
gas which has been treated and can contain components that are not typical of natural gas

Note 1 to entry: Manufactured (synthetic) gases can contain substantial amounts of chemical species that are not typical of natural gases or common species found in atypical proportions as in the case of wet and sour gases.

Note 2 to entry: Manufactured gases fall into two distinct categories, as follows:

a) those that are intended as synthetic or substitute natural gases, and that closely match true natural gases in both composition and properties;

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b) those that, whether or not intended to replace or enhance natural gas in service, do not closely match natural gases in composition.

Case b) includes gases such as town gas, coke oven gas (undiluted), and LPG/air mixtures. None of which is compositionally similar to a true natural gas (even though, in the latter case, it can be operationally interchangeable with natural gas).

2.1.1.5
lean gas
natural gas having a relatively low energy content, close to or lower than that of pure methane

Note 1 to entry: Lean gas typically contains high amounts of nitrogen and carbon dioxide.

2.1.1.6
rich gas
natural gas having a relatively high energy content, higher than that of pure methane

Note 1 to entry: Rich gas typically contains high amounts of ethane or propane or higher.

2.1.1.7
wet gas
gas which falls short of qualifying as pipeline quality natural gas by the inclusion of undesirable components such as free water, water vapour and/or high hydrocarbons in such amounts that they can condense at pipeline conditions

2.1.1.8
sour gas
gas containing significant amount of acid gases such as carbon dioxide and sulphur compounds

Note 1 to entry: The presence of acid compounds is more detrimental in wet gases.

Note 2 to entry: Typically, wet and sour gases can be unprocessed (well head) or partially-processed natural gases and can also contain condensed hydrocarbons, traces of carbonyl sulphide, and process fluid vapours such as methanol or glycols.

Note 3 to entry: Carbon dioxide in the presence of free water can be an important cause of corrosion damage to pipelines.

2.1.1.9
dry natural gas
natural gas containing a mole fraction of water of no more than 0,005 % [50 ppm (molar)] in the vapour phase

Note 1 to entry: Water vapour content in natural gas can also be expressed in terms of water concentration (mg/m^3).

Note 2 to entry: The correlation between water content and water dew point is given in ISO 18453.[17]

2.1.1.10
saturated gas
natural gas that at the specified conditions of temperature and pressure is at its water dew-point

2.1.1.11
compressed natural gas
CNG
natural gas that has been compressed after processing for storage and transportation purposes

Note 1 to entry: CNG is mainly used as a fuel for vehicles, typically compressed up to 20 000 kPa in the gaseous state.

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2.1.1.12
liquefied natural gas
LNG
natural gas that has been liquefied after processing for storage or transportation purposes

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

2.1.1.13
gas quality
attribute of natural gas defined by its composition and its physical properties

2.1.1.14
biogas
generic term used to refer to gases produced by anaerobic fermentation or digestion of organic matter, and without further upgrading nor purification

Note 1 to entry: This can take place in a landfill site to produce landfill gas or in an anaerobic digester to produce biogas. Sewage gas is biogas produced by the digestion of sewage sludge. Biogases comprise mainly methane and carbon dioxide.

2.1.1.15
biomethane
methane rich gas derived from biogas or from gasification of biomass by upgrading with the properties similar to natural gas

2.1.1.16
biomass
mass defined from a scientific and technical point of view as material of biological origin excluding material embedded in geological formations and/or transformed to fossil

Note 1 to entry: Biomass is organic material that is plant-based or animal-based, including but not limited to dedicated energy crops, agricultural crops and trees, food, feed and fibre crop residues, aquatic plants, alga, forestry and wood residues, agricultural wastes, processing by-products and other non-fossil organic matter.

Note 2 to entry: See also herbaceous biomass, fruit biomass, and woody biomass.

2.1.2 Pipeline network

2.1.2.1
pipeline grid
system of interconnected pipelines, both national and international that serve to transmit and distribute natural gas

2.1.2.2
local distribution system
LDS
gas mains and services that supply natural gas directly to consumers

2.1.2.3
custody transfer point
location between two pipeline systems where the quantity of energy of the natural gas has to be accounted for

Note 1 to entry: At such location a change of pressure regime can also occur.

2.1.2.4
transfer station
system of pipelines, measurement and regulation (pressure control), and ancillary devices at a custody transfer point necessary to account for the quantity of gases transferred and the adaptation to the possible different pressure regimes of the networks

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2.2 Measurement methods

2.2.1 General definitions

2.2.1.1
absolute measurement
measurement of a property from fundamental metrological quantities

Note 1 to entry: For example, fundamental metrological quantities are length, mass, and time.

Note 2 to entry: For example, the determination of the mass of a gas using certified masses.

2.2.1.2
direct measurement
measurement of a property from quantities that, in principle, define the property

Note 1 to entry: For example, the determination of the calorific value of a gas using the thermometric measurement of the energy released in the form of heat during the combustion of a known amount of gas.

2.2.1.3
indirect measurement
measurement of a property from quantities that, in principle, do not define the property, but have a known relationship with the property

Note 1 to entry: For example, the determination of the calorific value from measurements of the air-to-gas ratio required to achieve stoichiometric combustion that is related linearly to the calorific value.

2.2.1.4
lower range value
lowest value of a quantity to be measured (measurand) that a measuring system or transmitter is adjusted to measure

2.2.1.5
upper range value
highest value of a quantity to be measured(measurand) that a measuring system or transmitter is adjusted to measure

2.2.1.6
span
algebraic difference between the upper and lower range values

2.2.1.7
relative measurement
measurement of a property by means of comparison with a value of the property taken from an accepted standard, for example, reference material

Note 1 to entry: For example, determining gas density from the quotient of the mass of gas contained in a given volume to that of air contained in the same volume at the same temperature and pressure, and multiplying by the density of air at that temperature and pressure.

2.2.2 Specific methods

2.2.2.1
gas chromatographic method
method of analysis by which the components of a gas mixture are separated using gas chromatography

Note 1 to entry: The sample is passed in a stream of carrier gas through a column that has different retention properties relative to the components of interest. Different components pass through the column at different rates and are detected as they elute from the column at different times.

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2.2.2.2
potentiometric method
method of analysis by which a known quantity of gas is first passed through a solution, where a specific gas component or a group of components is (are) selectively absorbed, then the absorbed analyte(s) in the solution is (are) evaluated by potentiometric titration

Note 1 to entry: The result is a titration curve showing the potentiometric end points for the components being sought versus the titration solutions required. From this data, the concentrations of the various components can be calculated.

2.2.2.3
potentiometric titration
method where the amount of titrant consumed for reaction of the gas component with the titrant is proportional to the gas component concentration, and the endpoint of reaction is determined by the variation of potential inside the cell

Note 1 to entry: The volume increments of titrant (titration solution) added determine the difference in potential to be measured. Different volume increments of titrant, specifically smaller volume increments close to end points, can permit a better evaluation of the end points.

2.2.2.4
turbidimetric titration
method to determine the content of sulfate ions whereby a barium salt solution is added to an absorption solution and the turbidity caused by the formation of any insoluble barium sulfate detected

Note 1 to entry: This method is valid for solutions having a total sulfur content below 0,1 mg.

Note 2 to entry: A photometer with galvanometer readout is employed with the titration procedure to determine the inflection point. From these data, the total sulfur content in mg/m^3 can be calculated.

2.2.2.5
combustion method
method by which a gas sample undergoes total combustion and the specific combustion products are measured to determine the total concentration of an element in the sample, e.g. sulfur

Note 1 to entry: Wickbold method: the Wickbold combustion method uses the combustion and complete thermal decomposition of compounds at a high temperature in a hydrogen/oxygen flame. It is performed with a special instrument (see ISO 4260[2]).

Note 2 to entry: Lingener method: the Lingener combustion method uses air, and it is performed using a special instrument (see ISO 6326-5[8]).

2.2.2.6
absorption
extraction of one or more components from a mixture of gases when brought into contact with a liquid

Note 1 to entry: The assimilation or extraction process causes (or is accompanied by) a physical or chemical change, or both, in the sorbent material.

Note 2 to entry: The gaseous components are retained by capillary, osmotic, chemical, or solvent action.

EXAMPLE Removal of water from natural gas using glycol.

2.2.2.7
adsorption
retention, by physical or chemical forces of gas molecules, dissolved substances, or liquids by the surfaces of solids or liquids with which they are in contact

Note 1 to entry: For example, retention of methane by carbon.

2.2.2.8
desorption
removal of a sorbed substance by the reverse process of adsorption or absorption

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2.3 Sampling

2.3.1 Sampling methods

2.3.1.1
direct sampling
sampling in situations where there is a direct connection between the natural gas to be sampled and the analytical unit

2.3.1.2
indirect sampling
sampling in situations where there is no direct connection between the natural gas to be sampled and the analytical unit

2.3.1.3
in-line instrument
instrument whose active element is installed inside the pipeline and makes measurements under pipeline conditions

2.3.1.4
on-line instrument
instrument that samples gas directly from the pipeline, but is installed externally to the pipeline

2.3.1.5
off-line instrument
instrument that has no direct connection to the pipeline

2.3.1.6
spot sample
sample of specified volume taken at a specified place at a specified time from a stream of gas

2.3.2 Sampling devices

2.3.2.1
floating piston cylinder
container that has a moving piston separating the sample from a buffer gas. The pressures are in balance on both sides of the piston

2.3.2.2
incremental sampler
sampler that accumulates a series of spot samples into one composite sample

2.3.2.3
flow-proportional incremental sampler
sampler that collects a series of spot samples over a period of time with the spot samples taken in such a manner as to ensure the incremental sample is proportional to the incremental totalised flow

Note 1 to entry: This is normally achieved by varying the frequency of extraction of a constant volume spot sample (grab).

2.3.2.4
sample container
container that is used to collect a representative sample and maintain the sample in a representative condition

Note 1 to entry: The sample container should not alter the gas composition in any way or affect the proper collection of the gas sample. The materials, valves, seals, and other components of the sample container shall be specified to maintain this principle.

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2.3.2.5
sample line
conduit to transfer a sample of gas from the sample place to the analytical unit or sample container

Note 1 to entry: Another word used for sample line is transfer line.

2.3.2.6
sample probe
device inserted into the gas pipeline so that a representative sample of the flowing gas can be taken. The sample probe will have a conduit to convey the sample from the flowing gas to a point external to the pipeline

2.3.2.7
hot loop
sampling configuration that returns the sample to the pipeline

Note 1 to entry: The loop requires a pressure differential from collection point to discharge so as to ensure a constant and steady flowrate through the sampling equipment located in the loop.

2.3.2.8
vent line
section of the sampling system that diverts a portion of the sampled gas away from the analyser/instrument or sample container

Note 1 to entry: The flowrate and pressure loss in the open-ended line need to be controlled so as to ensure that sample accuracy cannot be affected from any cooling and condensation.

2.3.2.9
fast loop
sampling system that takes more sample from the process than is needed to make the measurement so as to reduce the residence time

2.3.3 Conditioning device

2.3.3.1
condenser
apparatus used to transform the condensable fraction (consisting of water vapour and/or of the higher hydrocarbons) of the vapour phase present in natural gas into a liquid phase by cooling

2.3.3.2
liquid separator
unit, in the sample line, used to collect liquid fall-out

2.3.3.3
pressure reducer
device used to reduce gas pressure immediately downstream of its installed position

Note 1 to entry: It has the ability to maintain a near constant outlet pressure within its design parameters regardless of changes in pressure or flow in other parts of the system.

2.3.3.4
back-pressure regulator
device used to control/maintain gas pressure immediately upstream of its installed position

Note 1 to entry: It has the ability to maintain a near constant inlet pressure within design parameters, regardless of pressure or flow fluctuations in other parts of the system.

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2.3.3.5
heating device
device to ensure that the sample gas remains at a temperature sufficient to avoid a change of its composition due to condensation of some compounds

Note 1 to entry: Heating elements can be installed on the sample probe and sample lines. In some cases, heating the sample cylinder is also required. It is particularly important where Joule-Thomson cooling occurs as a result of pressure reduction.

Note 2 to entry: Heating devices are also used to maintain "wetted surface areas" at near constant temperatures to avoid changes in gas sorption coefficients when measuring components that are prone to strong sorption effects.

2.3.4 Other definitions

2.3.4.1
purging time
residence time plus the time to insure that the sample in the sampling system is representative of the gas stream

Note 1 to entry: The purging time can be much longer than the residence time and will be multiples of the residence time in poorly designed sampling systems.

2.3.4.2
representative sample
sample having the same composition as the natural gas sample when the latter is considered as a homogeneous whole

2.3.4.3
residence time
time it takes for a sample to flow through a piece of equipment

2.3.4.4
sampling point
point in the gas stream or vessel where a representative sample can be taken

2.3.4.5
sampling place
location of a sampling point along a stream, or the location of the vessel

2.3.4.6
gas sorption effects
physical processes whereby some gases are adsorbed onto or desorbed from the surfaces of a solid without transformation of the molecules

Note 1 to entry: The force of attraction between some gases and solids is purely physical and depends on the nature of the participating material. Natural gas can contain several components that exhibit strong sorption effects. Special care should be taken when determining trace concentrations of heavy hydrocarbons, water, sulfur compounds, and hydrogen.

2.4 Analytical systems

2.4.1
measuring system
complete set of measuring instruments and other equipment assembled to carry out specified measurements

Note 1 to entry: System comprising, in general, a sample transfer and introduction unit, a separation unit, a detector and an integrator or a data processing system.

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2.4.2
introduction unit
unit for introducing a constant, or a measured amount of material to be analysed into the analyser

Note 1 to entry: Gas chromatographic analysers are comparative rather than absolute. Therefore, the introduction of equal quantities of a calibration mixture and of sample allows quantitative measurement of sample components.

Note 2 to entry: In gas analysis, the introduction device is frequently a multi-port valve, in which a fixed volume of a calibration mixture or sample is isolated, and by operation of the valve, passed into the analyser.

Note 3 to entry: Equimolar quantities can be obtained by controlling the pressure and temperature of the introduction device.

2.4.3
gas chromatograph
device that physically separates components of a mixture in the gaseous phase and measures them individually with a detector whose signal is processed

Note 1 to entry: A chromatograph consists of the following main parts: an introduction unit, a separation unit, and a detector. The separation unit consists of one or more chromatographic columns through which carrier gas flows and into which samples are introduced. Under defined and controlled operating conditions, components can be qualitatively identified by their retention time, and quantitatively measured by comparing their detector response to that of the same or a similar component in a calibration mixture.

Note 2 to entry: In gas analysis, the range of components and their properties frequently cause more than one separation mechanism to be required. These can be and often are combined in a single separation unit or chromatograph.

Note 3 to entry: A gas chromatograph capable of temperature programming is a chromatograph whose columns are placed in an oven whose temperature is programmable in a defined and repeatable manner over the period of analysis.

2.4.4
carrier gas
pure gas introduced so as to transport a sample through the separation unit of a gas chromatograph for analytical purposes

Note 1 to entry: Typical carrier gases are hydrogen, nitrogen, helium, and argon.

2.4.5
auxiliary gases
gases required for detector operation, e.g. hydrogen and air for flame detectors

2.4.6
chemiluminescence detector
CD
detector that uses a reducing reaction in which molecules give rise to characteristic luminous emissions that are measured by a photomultiplier and the associated electronic devices

Note 1 to entry: A chemiluminescence detector is used in gas chromatography mainly to detect components that contain particular elements, e.g. nitrogen (N) and sulfur (S).

2.4.7
electrochemical detector
ED
detector consisting of an electrochemical cell that responds to certain substances contained in the carrier gas eluting from the column

Note 1 to entry: The electrochemical process can be an oxidation, reduction, or a change in conductivity. The detection can be very specific depending on the electrochemical process involved.

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2.4.8
flame ionization detector
FID
detector in which hydrocarbons are burned in a hydrogen-air flame and the electrical current caused by the resulting ions is measured between two electrodes

Note 1 to entry: The flame ionization detector is used in gas chromatography mainly to detect hydrocarbon compounds.

2.4.9
thermal conductivity detector (TCD)
hot wire detector (HWD)
detector that measures the difference in thermal conductivity between two gas streams when a sample (gas mixture) passes through the sample channel

Note 1 to entry: The HWD is a dual channel detector, requiring a reference flow of pure carrier gas through the reference channel.

Note 2 to entry: The use of helium or hydrogen is recommended as carrier gas except when the sample contains either of these two substances to be measured.

Note 3 to entry: The detector consists of a bridge circuit; the change in resistance in the sample channel during the passage of the sample produces an out-of-balance signal that is the basis of the detection. The detector responds to all components except the carrier gas and it is non-destructive.

2.4.10
flame photometric detector
FPD
detector that uses a reducing flame in which individual elements give rise to characteristic colours that are measured by a photomultiplier

Note 1 to entry: The detector is used in gas chromatography mainly to detect components that contain particular elements, e.g. phosphorous (P) and sulfur (S).

2.4.11
integrator
device that quantitatively measures the response signal of a detector to a component in a mixture

Note 1 to entry: By comparing the integrator output to the same component in a calibration mixture and in a sample, the concentration in the sample can be calculated. If the detector response has a temporal dimension, as in chromatography, then the instantaneous response is integrated with respect to time.

2.4.12
photometry
determination of the concentration of a dissolved substance in a solution by using the absorption of light by this substance

2.4.13
absorption cell
device put into the light path of the photometer

Note 1 to entry: The lower the concentration of the dissolved substance, the greater path length of the absorption cell has to be.

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2.5 Analysis

2.5.1 Calibration and quality control

2.5.1.1
calibration
operation, that under specified conditions in a first step establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step uses this information to establish a relation for obtaining a measurement result from an indication

Note 1 to entry: A calibration can be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it consists of an additive or multiplicative correction of the indication with associated measurement uncertainty.

Note 2 to entry: Calibration should not be confused with adjustment of a measuring system, often mistakenly called "self-calibration", nor with verification of calibration.

Note 3 to entry: Often, the first step alone in the above definition is perceived as being calibration.

2.5.1.2
adjustment of a measuring instrument
operation of bringing a measuring instrument into a state of performance suitable for its use

Note 1 to entry: Adjustment can be automatic, semi-automatic, or manual.

2.5.1.3
volumetric conversion
determination of the volume at reference conditions from the volume at operating conditions

2.5.1.4
correction
value added algebraically to the uncorrected result of a measurement to compensate for systematic error

Note 1 to entry: The correction is equal to the negative of the estimated systematic error.

Note 2 to entry: Since the systematic error cannot be known perfectly, the correction cannot be complete.

2.5.1.5
correction factor
numerical factor by which the uncorrected result of a measurement is multiplied to compensate for systematic error

Note 1 to entry: Since the systematic error cannot be known perfectly, the correction cannot be complete.

2.5.1.6
calibration interval
period between routine calibrations over which the performance of the analyser meets specified requirements

2.5.1.7
working range
range of parameters for which the calibration function has been developed and validated

2.5.1.8
extended working range
range of parameters for which the correlation has been developed, but outside the range for which the calibration function has been validated

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2.5.1.9
single-point calibration
establishment of the calibration function using one (only) calibration point

Note 1 to entry: This is a calibration in which the response of the analyser to a measured component maintains an exact proportion to the concentration of the component over the entire working range.

Note 2 to entry: The response can be described as being linear through the origin. A plot of the analyser response against the concentration of the component would show a straight line intercepting the (0,0) point of the plot. In such circumstances, the use of a single calibration mixture containing the component at a concentration within the working range (single-point calibration) is appropriate, as the ratio of response to concentration remains constant at all points.

Note 3 to entry: Where a more complex response function, first order not passing through the origin or second or third order polynomial, has been defined by the use of multiple calibration mixtures, and the different elements of this function, e.g. the coefficient of the polynomial, have been shown to maintain a constant relationship to each other, then a single-point calibration can be used to adjust all the elements of the function on a short-term basis (for example, daily).

2.5.1.10
bracketing
method consisting in principle in reducing the interval over which the linearity of the calibration function is assumed as much as possible

Note 1 to entry: This leads to surrounding the value of the unknown quantity by two values of reference materials (RMs) as tightly as possible (or bracketing).

2.5.1.11
multi-point calibration
establishment of a calibration function using more than two calibration points

Note 1 to entry: In multi-point (also called “multi-level”) calibrations, the response curves of the detector are determined for each component over the ranges to be analysed using a series of certified reference gas mixtures.

Note 2 to entry: To define the response curves, it is necessary to obtain results at a number of different concentration levels for each component. The number of concentration levels needed depends on the order of the polynomial (response curve) that has to be fitted. For first order, the minimum number of concentration levels needed is three, for second order is five, and for third order is seven. In most cases, the order of fit of the response curves is unknown beforehand, in which cases; it is advisable to perform the analysis of at least seven concentration levels so as to detect third order detector behaviour with a high degree of detection sensitivity. Where the order of fit is known, then the corresponding number of concentration levels can be used. For polynomical order one, these concentration levels should be equally spaced across the specified working range of each component. The lowest concentration level should be slightly below the lowest concentration level of the working range, and the highest concentration level should be slightly higher than the highest concentration level of the working range.

2.5.1.12
verification
provision of objective evidence that a given item fulfils specified requirements

EXAMPLE Confirmation that performance properties or legal requirements of a measuring system are achieved.

Note 1 to entry: When applicable, measurement uncertainty should be taken into consideration.

Note 2 to entry: The item can be, e.g. a process, measurement procedure, material, compound, or measuring system.

Note 3 to entry: The specified requirements can be, e.g. that a manufacturer’s specifications are met.

Note 4 to entry: Verification in legal metrology as defined in VIM 2007[20] and in conformity assessment in general, pertains to the examination and marking and/or issuing of a verification certificate for a measuring system.

Note 5 to entry: Verification should not be confused with calibration; not every verification is a validation.

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Note 6 to entry: In chemistry, verification of the identity of the entity involved, or of activity, requires a description of the structure or properties of that entity or activity.

2.5.1.13
analytical quality control
monitoring of the measurement system on a regular basis so as to detect quickly when the method has deteriorated, or the calibration shifted, or both

2.5.1.14
control chart
plot in which component mole fraction values from each analysis of the control gas are compared with the mean value and the lines for ±2 standard deviations and ±3 standard deviations obtained from the results of the initial analyses of the control gas

2.5.2 Gas analysis

2.5.2.1 General definitions

2.5.2.1.1
mass (volume)
(mole) fraction
quotient of the mass [volume (under specified conditions of pressure and temperature)] (amount of substance) of a component A to the sum of the masses [sum of the volumes (intended prior to mixing under specified conditions of pressure and temperature)] (sum of the amounts of substances) of all components of the gas mixture

2.5.2.1.2
mass (molar)(volume)
concentration
quotient of the mass [volume (under specified conditions of pressure and temperature)] (amount of substance) of each component to the volume of the gas mixture under specified conditions of pressure and temperature

Note 1 to entry: The mass, molar, and volume concentrations depend on the pressure and temperature of the gas mixture.

2.5.2.1.3
gas composition
fractions or concentrations of all the components determined from natural gas analysis

2.5.2.1.4
gas analysis
measurement methods and techniques for determining the gas composition

2.5.2.1.5
direct measurement of components
measurement in which individual components or group of components are determined by comparison with identical components in the reference gas mixture

Note 1 to entry: Main and associated components are usually determined using direct measurement.

2.5.2.1.6
indirect measurement of components
measurement in which individual components or groups of components are determined using relative response factors to a reference component in the reference gas mixture

Note 1 to entry: Trace components are mostly determined using indirect measurement.

2.5.2.2 Analysed components

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2.5.2.2.1
main component
major component
component whose content influences physical properties

Note 1 to entry: Main components of natural gases generally include: nitrogen, carbon dioxide, and saturated hydrocarbons from methane through pentane.

2.5.2.2.2
associated component
minor component
component whose content does not significantly influence physical properties

Note 1 to entry: Associated components generally include: helium, hydrogen, argon, and oxygen.

2.5.2.2.3
trace component
trace constituent
component present at very low levels

Note 1 to entry: Trace components generally include hydrocarbons or groups of hydrocarbons above n-pentane and the components listed in 2.5.2.3.

2.5.2.2.4
group of components
components with similar properties whose mole fractions are so low, that their measurement as individuals would be difficult or require excessive time, and measured as a group

Note 1 to entry: The property of the group, rather than each individual property, is used to evaluate the properties of the mixture.

Note 2 to entry: The group can be physically combined as a result of the analytical procedure, as with backflushing in chromatography, or individually measured and combined by calculation. If they are physically combined, the precision of the measurement of the group is likely to be superior to the precision of measurement of the individual components.

Note 3 to entry: It is important to recognize when it is appropriate to consider groups of components, and when it is not. For calculation of calorific value or relative density, all hydrocarbons of carbon number six (C6) and higher can be considered as a group (C6+) with relatively little resulting error. However, such simplification gives rise to large calculation errors of the hydrocarbon dew point.

Note 4 to entry: When a number of hydrocarbons are identified and quantified as a group or groups, the following options are possible:

— the total is reported as though the group extends from the lowest carbon number of that group (e.g. C6+, which indicates all hydrocarbons of carbon number six and above);

— separate groups are reported as the total of each carbon number (e.g. total C6, total C7, etc.);

— the above groups, reported as total of each carbon number, can be further broken down to component types (e.g. C6 alkanes, as distinct from benzene and C_6 cycloalkanes or naphthenes).

In the above mentioned cases, the response of the group is the sum of the responses of the normal hydrocarbon component(s) and its (their) isomers. The relative response of the group is equal to the relative response of the normal alkane of the group (C_6 for C_{6+}).

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2.5.2.2.5
other component
other constituent
component possibly being present in the gas, which is either measured directly using other analytical methods or its content in the gas is assumed to remain constant and set to a value based on past measurements or valid estimations

2.5.2.2.6
reference component
component present in the WRM, used as a reference to define the relative response factors of sample components that are not present in the WRM

Note 1 to entry: The response function of the reference component and of the sample components measured relative to it should be linear and pass through the origin.

2.5.2.3 Trace components (constituent)

2.5.2.3.1
alkane thiol
alkyl mercaptan
organic sulfur compound with the general formula R-SH (where R is the alkyl group), either naturally present or added as an odorant to natural gas

Note 1 to entry: They are classified as primary, secondary, and tertiary thiols (mercaptans) according to whether the alkyl group attached to the thiol (mercaptan) group is a primary, secondary, or tertiary group, respectively. The number of carbons attached to the carbon atom bearing the thiol group distinguishes primary, secondary, and tertiary thiols.

In a primary alkyl group, one or none carbon is attached to the carbon atom under consideration. [Examples of primary thiols (mercaptans): methane thiol (methyl mercaptan) CH3-SH, ethane thiol (ethyl mercaptan) CH3CH2-SH]. In a secondary alkyl group, two carbons are attached to the carbon atom under consideration. (Example of a secondary thiol (mercaptan): 2-propane-thiol (isopropyl mercaptan) (CH3)2CH-SH). In a tertiary alkyl group, three carbons are attached to the carbon atom under consideration. (Example of a tertiary thiol (mercaptan): 2-methylpropane-2-thiol (tertiary-butyl mercaptan) (CH3)3C-SH).

Note 2 to entry: Thiols (mercaptans) are the sulfur analogues of the alcohols.

2.5.2.3.2
alkyl sulphide
thioether
organic sulfur compound with the general formula R-S-R¢ (where R and R¢ are alkyl groups), either naturally present or added as an odorant to natural gas

Note 1 to entry: The alkyl groups are identical (R = R¢) in symmetrical sulfides (e.g. diethyl sulfurs: C2H5-S-C2H5) or different (R [1] R¢), in asymmetrical sulfides (e.g. methyl ethyl sulfur: CH3-S-C2H5).

Note 2 to entry: Sulfides are the sulfur analogues of the ethers and are also known as thioethers.

2.5.2.3.3
alkyl disulfide
organic sulfur compound with the general formula R-S-S-R¢ (where R and R¢ are alkyl groups)

Note 1 to entry: The alkyl groups are identical (R = R¢) in symmetrical disulfides (e.g. dimethyl disulfide:

CH3-S-S-CH3) or different (R [1] R¢) in asymmetrical disulfides (e.g. methyl ethyl disulfide: CH3-S-S-C2H5).

Note 2 to entry: Disulfides are formed by oxidation of thiols (mercaptans). Their odour intensity is insufficient to be used as gas odorants.

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2.5.2.3.4
carbonyl sulphide
COS
sulfur compound found in natural gas, which contributes to the total sulfur content

Note 1 to entry: Under particular conditions, it can be formed from, or be converted to H_2S.

2.5.2.3.5
cyclic sulfide (thioether)
cyclic organic sulfur compound with one sulfur atom incorporated into a saturated hydrocarbon ring

EXAMPLE Tetrahydrothiophene (thiophane or thiacyclopentane), i.e. C_4H_8S, which is added as an odorant to natural gas.

2.5.2.3.6
glycol
liquid binary alcohol ($CH_2OH\text{-}CH_2\text{-}O\text{-}(CH_2\text{-}CH_2\text{-}O\text{-})_XH$, where x=0,1,2…n) used as an anti-freeze and in some processing operations as a dehydrating agent

2.5.2.3.7
hydrogen sulphide
H_2S
colourless, toxic gas with an odour similar to rotten eggs

2.5.2.3.8
mercaptan
see alkane thiol (2.5.2.3.1)

[SOURCE: (alkyl mercaptan) (2.5.2.3.1)]

2.5.2.3.9
mercaptan sulfur
see thiol sulfur (2.5.2.3.12)

2.5.2.3.10
methanol
light, volatile, flammable, poisonous, liquid alcohol (CH_3OH) used to prevent hydrate formation in wet, high-pressure gas lines

2.5.2.3.11
organic sulfur
term commonly used to designate all of the sulfur compounds in natural gas with the exception of hydrogen sulfide and carbon disulfide (CS_2), and carbonyl sulfide(COS)

EXAMPLE These sulfur compounds consist of thiophene (C_4H_4S) and its homologues, alkane thiols (alkyl mercaptans) such as methane thiol (methyl mercaptan) ($CH_3\text{-}SH$) and ethane thiol (ethyl mercaptan) ($C_2H_5\text{-}SH$), and various other sulfur compounds present in very small traces, such as the thioethers and the alkyl disulfides.

2.5.2.3.12
thiol (mercaptan) sulfur
amount of sulfur bonded in the form of a thiol [mercaptan] in natural gas

2.5.2.3.13
thiol
see alkane thiol (2.5.2.3.1)

[SOURCE: (alkyl mercaptan) (2.5.2.3.1)]

2.5.2.3.14
total sulfur
total amount of sulfur found in natural gas

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2.5.2.4 Analyser response

2.5.2.4.1
response
output signal of the measuring system

Note 1 to entry: Chromatographic response is peak area or peak height for a certain component.

2.5.2.4.2
response factor
ratio of the mole fraction of a component in a reference gas mixture to the response of this component

2.5.2.4.3
relative response factor
ratio of the mole fraction of component *j* to the mole fraction of reference component which gives an equal detector response

2.5.2.4.4
response function
function describing the response of the detector and obtained by a multi-point calibration performed for a certain component over the range to be analysed

Note 1 to entry: See the note in the definition of the multi-point calibration in 2.5.1.11.

2.5.2.4.5
normalization

2.5.2.4.5.1
conventional normalization (or normalization)
correction to unity of the sum of raw (unprocessed) mole fractions in a complete analysis of natural gas by applying the same proportional adjustment to all measured components

Note 1 to entry: If in an analysis some components are not measured but instead are given a fixed mole fraction, then the normalization will be to unity less the total for the undetermined components.

Note 2 to entry: The specific case of the independent application of conventional normalization to each of a series of repeat analyses of a natural gas, with the normalized mole fractions being used to calculate the means for the components, is known as “run-by-run normalization”.

2.5.2.4.5.2
mean normalization
method of normalization whereby the repeat analyses for each component are averaged to form a series mean, and these mean values are then normalized

2.5.2.4.6
chromatographic resolution
column efficiency characteristic describing the degree of separation of two adjacent peaks

Note 1 to entry: The resolution is measured as twice the distance between the maximum of the named peaks, divided by the sum of the intercepts on the baseline made by tangents drawn to the peaks at half the height.

2.5.2.5 Calibration gas mixtures

2.5.2.5.1 General definitions from metrology

Note 1 to entry The definitions in this section are taken from various documents that are quoted. In case of evolution of the reference documents, the definitions in this standard will be considered as the correct ones for the purpose of ISO/TC193 standard development.

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2.5.2.5.1.1
reference material
RM
material or substance, one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials [ISO Guide 30[21]]

Note 1 to entry: A reference material can be in the form of a pure or mixed gas, liquid, or solid.

Note 2 to entry: In the field of gas analysis, a reference material is gas mixture of known composition and/or properties which is traceable by one or more steps to national or International Standards.

EXAMPLE Several kinds of reference materials exist. An internal reference material is an RM developed by a user for its own internal use. An external reference material is an RM provided by someone other than the user. A certified reference material (CRM) is an RM issued and certified by an organization recognized as competent to do so.

2.5.2.5.1.2
certified reference material
CRM
reference material, accompanied by a certificate where one or more of whose property values are certified by a procedure that establishes traceability to an accurate realization of the unit in which the property values are expressed, and for which each certified value is accompanied by an uncertainty at a stated level of confidence [ISO Guide 30 [[21]]]

2.5.2.5.1.3
reference measuring system
represents not only a measuring instrument but the set of procedures, operations, and environmental conditions associated with that instrument

2.5.2.5.1.4
traceability
property of the result of a measurement, or the value of a standard whereby it can be related to stated references, usually national or International Standards through an unbroken chain of comparisons, all having stated uncertainties [ISO Guide 30 [[21]]]

Note 1 to entry: The concept is often expressed by the adjective traceable.

Note 2 to entry: It should be noted that traceability only exists when scientifically rigorous evidence is collected on a continuing basis, showing that the measurement is producing documented results for which the total measurement uncertainty is quantified (NIST Technical Note 1297:1994 Edition).

Note 3 to entry: The unbroken chain of comparisons is called a traceability chain.

2.5.2.5.1.5
measurement standard
realization of the definition of a given quantity, with stated quantity value and associated measurement uncertainty used as a reference VIM 2007 [[20]]

2.5.2.5.1.6
group standard
series of standards
set of standards of specially chosen values that individually or in suitable combination reproduce a series of values of a quantity over a given range

Note 1 to entry: Adapted from the VIM 2007 [[20]].

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2.5.2.5.1.7
primary standard
standard that is designated or widely acknowledged as having the highest metrological qualities and whose value is accepted without reference to other standards of the same quantity VIM 2007 [[21]]

Note 1 to entry: The concept of primary standard is equally valid for base quantities and derived quantities.

Note 2 to entry: A primary standard is never used directly for measurements other than for comparison with duplicate or reference standards. In general the National Standards Laboratory is responsible for the conservation of a primary standard in a country.

2.5.2.5.1.8
secondary standard
standard established through calibration with respect to a primary standard for a quantity of the same kind VIM 2007[[20]]

2.5.2.5.1.9
international measurement standard
standard recognized by an international agreement to serve internationally as the basis for assigning values to other standards of the quantity concerned

2.5.2.5.1.10
national measurement standard
standard recognized by a national decision to serve in a country as the basis for assigning values to other standards of the quantity concerned

Note 1 to entry: A National Standards Laboratory ensures that the national standards are primary standards.

2.5.2.5.1.11
reference standard
standard designated for the calibration of other measurement standard for quantities of a given kind in a given organization or at a given location. VIM 2007 [[20]]

2.5.2.5.1.12
working standard
standard that is used routinely to calibrate or verify measuring instruments or measuring systems

Note 1 to entry: A working standard is usually calibrated with respect to a reference standard. VIM 2007[20]

2.5.2.5.1.13
transfer standard
standard used as an intermediary to compare standards

2.5.2.5.2 Definitions relevant to gas mixtures

2.5.2.5.2.1
primary standard gas mixture
PSM
gas mixture whose component quantity levels have been determined with the utmost accuracy and can be used as a reference gas for determining the component quantity levels of other gas mixtures

2.5.2.5.2.2
secondary standard gas mixture
gas mixture whose component quantity levels have been validated by direct comparison with a PSM

Note 1 to entry: A secondary standard gas mixture is a CRM. It is used for the determination of the response curves of the measuring system and can also be used for its regular calibration. It can be a binary or multi-component mixture and can be prepared gravimetrically in accordance with ISO 6142[4] and verified in accordance with ISO 6143[5]. The quantity levels of the components can be determined by comparison with a PSM of closely related composition in accordance with ISO 6143[5].

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2.5.2.5.2.3
working reference gas mixture
WRM
gas mixture whose component quantity levels have been validated by direct comparison with a secondary standard gas mixture

Note 1 to entry: A WRM is used regularly to calibrate the measuring system. A WRM can be a binary or a multi-component mixture and can be prepared gravimetrically in accordance with ISO 6142[4] and verified in accordance with ISO 6143[4]. The quantity levels of the components can be determined by comparison with a CRM of closely related composition in accordance with ISO 6143[5] .

2.5.2.5.2.4
control gas
gas mixture of known composition containing all the components present in the working reference gas mixture

Note 1 to entry: A control gas can be either a sample gas with a composition determined in accordance with ISO 6143[5] or a multi-component mixture prepared in accordance with ISO 6142[4]. A control gas is used to calculate the mean (m) and standard deviation (s) of the quantity levels of the components detected so as to prepare the relevant control charts.

2.6 Physical and chemical properties

2.6.1 Reference conditions

2.6.1.1
combustion reference conditions
specified temperature T and pressure p at which a fuel is notionally burned

2.6.1.2
metering reference conditions
specified temperature T and pressure p at which an amount of fuel to be burned is notionally determined

Note 1 to entry: There is no a priori reason for the metering reference conditions to be the same as the combustion reference conditions.

2.6.1.3
normal reference conditions
reference conditions of pressure, temperature, and humidity (state of saturation) equal to 101,325 kPa and 273,15 K for a gas in the dry state

2.6.1.4
ISO standard reference conditions
reference conditions of pressure, temperature, and humidity (state of saturation) equal to 101,325 kPa and 288,15 K for a real gas in the dry state

Note 1 to entry: The conditions 273,15 K, 101,325 kPa, 288,15 K, and 101,325 kPa are commonly referred to as “normal” and “(metric) standard” conditions respectively in gas measurement practice. This usage should not be confused with “NTP” (normal temperature and pressure) and “STP” (standard temperature and pressure), both of which refer conventionally to the former conditions. For NTP and STP there is no restriction on the state of saturation.

2.6.2 Behaviour of ideal and real gas

2.6.2.1
ideal gas
an ideal gas is one that obeys the ideal gas law:

$$p \cdot V_m = R \cdot T$$

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where

p is the absolute pressure;

T is the thermodynamic temperature;

V_m is the molar volume;

R is the molar gas constant, in coherent units.

(R = 8,3144621 J/ mol.K)

No real gas obeys this law. For real gases, this equation shall be rewritten as

$$p \,.V_m = Z\,(p,T,x_i)\,.\,R\,.T$$

where

$Z\,(p,T,x_i)$ is a variable, often close to unity, for gases and is known as the compression factor.

2.6.2.2
compression factor
Z
ratio of the volume of an arbitrary mass of gas at a specified pressure and temperature to the volume of the same mass of gas under the same conditions as calculated from the ideal-gas law, as follow:

$$Z = V_m(\text{real})/V_m(\text{ideal})$$

where

$V_m(\text{ideal}) = RT/p$

Thus

$$Z(p,\,T,x_i) = pV_m/(RT)$$

where

p is the absolute pressure;

T is the thermodynamic temperature;

V_m is the molar volume of the gas;

R is the molar gas constant, in coherent units.

Note 1 to entry: The compression factor is a dimensionless quantity, which is normally close to unity for a gas near standard or normal reference conditions.

Note 2 to entry: Within the range of pressures and temperatures encountered in gas transmission, the compression factor can significantly differ from unity.

Note 3 to entry: The terms “compressibility factor” and “*Z*-factor” are synonymous with compression factor.

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