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Natural gas — Gas sampling

Gaz naturel — Échantillonnage de gaz

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Contents

Page

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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 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 193, *Natural Gas*, Subcommittee SC 1, *Natural gas analysis*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 238, *Test gases, test pressures and categories of appliances*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 10715:1997), which has been technically revised.

The main changes are as follows:

— This new edition has placed a significant relevance on regular service, maintenance and validation of installed sample systems which previously have not been given proper attention. Sample systems, or at least the fixed/installed portion of them, have all too often been installed and forgotten without realization that through use they become more and more contaminated leading to distortions of the composition of the gas being sampled.

— Introduction of new sampling devices.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The composition, quality, and properties of natural gas vary according to amongst others its source, level of processing, natural mixing at interconnection points, storage facilities, blending stations, fluctuating demand for some of its derivatives such as LPG (Liquefied Petroleum Gases), and increasingly the need to transport unconventional and renewable gases in the same network etc.

The variations that occur are closely monitored and controlled to ensure safety of the general public as well as operational staff, plant, equipment and the gas infrastructures in general. Additionally and commercially critical the energy content of the gas differs with these variations and is very accurately monitored for billing and fiscal purposes because of the very large sums of money involved.

The variations that occur can be best collectively grouped under the generic term “Gas Quality” which is subsequently referred to as GQ in this document.

For monitoring and controlling GQ, samples are taken at many and various stages along the way and analysed. Such samples are taken under many different process parameters with a need to always ensure that any gas that is subsequently analysed for such monitoring purposes is truly representative of the bulk.

Methods of measuring GQ are well specified in numerous ISO standards as are the means of calibrating such measuring instruments, however all those measurements and calibrations are all but futile if the samples used for making such measurements are not representative.

This document provides means to ensure sampling systems and sampling processes are designed, located, installed, operated, and maintained such that samples obtained are representative of the bulk to which they are attributed. It also specifies comprehensive information on the way that samples can be contaminated, altered, modified or degraded and methods, means and procedures for ensuring that the sample remains representative from the start of the sampling process to the point where the sample is presented to the analytical device.

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Natural gas — Gas sampling

WARNING — General quality aspects of natural gas are detailed in ISO 13686[1]. However, it is possible that the standard does not cover all the trace constituents that are increasingly necessary to monitor for various reasons.

1 Scope

This document gives means for ensuring that samples of natural gas and natural gas substitutes that are conveyed into transmission and distribution grids are representative of the mass to which they are allocated.

NOTE To ensure that a particular gas is taken into account in the standard, please see Annex A.

This document is applicable for sampling at sites and locations where interchangeability criteria, energy content and network entry conditions are measured and monitored and is particularly relevant at cross border and fiscal measurement stations. It serves as an important source for control applications in natural gas processing and the measurement of trace components.

This document is applicable to natural dry gas (single phase - typically gas transiting through natural gas pipelines) sampling only. On occasion a natural gas flow can have entrained liquid hydrocarbons. Attempting to sample a wet natural gas flow introduces the possibility of extra unspecified uncertainties in the resulting flow composition analysis. Sampling a wet gas (two or three phases) flow is outside the scope of this document.

This document does not apply to the safety issues associated with gas sampling.

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2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14532, *Natural gas — Vocabulary*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
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.

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[SOURCE: ISO 14532:2014, 2.2.2.6]

3.2
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.

[SOURCE: ISO 14532:2014, 2.2.2.7]

3.3
contaminant
constituent in very low levels, such as particulates, glycol, compressor oil, etc., that are assumed to be intrusive and not part of the gas to be sampled

Note 1 to entry: Such contaminants are generally harmful to the analytical equipment and if they enter the sampling process they need to be removed from the sample before it enters the analyser. However, once the contaminants enter the sampling process they continue to influence any following sample that come into contact with them. Over a period of time the accumulation of contamination in the sampling system can have a profound effect on the sample such that it is no longer representative of the mass.

Note 2 to entry: Contaminants are not to be confused with trace components that are inherent to the gas to be sampled.

3.4
desorption
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removal of a sorbed substance by the reverse process of adsorption or absorption

Note 1 to entry: From solution in a liquid phase for example.

[SOURCE: ISO 14532:2014, 2.2.2.8, modified — Note 1 to entry added.]

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3.5
direct sampling
sampling in situations where there is a direct connection between the natural gas to be sampled and the analytical unit

3.6
floating-piston cylinder
container which has a moving piston separating the sample from a buffer gas, where the pressures are in balance on both sides of the piston

3.7
gas sorption effect
physical process 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 such as heavy hydrocarbons, water, sulfur compounds, mercury and hydrogen.

[SOURCE: ISO 14532:2014, 2.3.4.6]

3.8
high-pressure natural gas
natural gas with a pressure exceeding 0,2 MPa

3.9
hydrocarbon dew point
temperature, at a given pressure, at which hydrocarbon vapour condensation begins

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3.10
incremental sampler
sampler which accumulates a series of spot samples into one composite sample

3.11
indirect sampling
sampling in situations where there is no direct connection between the natural gas to be sampled and the analytical unit

3.12
liquid separator
unit, in the sample line, used to collect liquid fall-out

3.13
purging time
period of time during which a sample purges a piece of equipment

3.14
representative sample
sample having the same composition as the natural gas it is attributed to, when the latter is considered as a homogeneous whole

[SOURCE: ISO 14532:2014, 2.3.4.2]

3.15
residence time
time it takes for a sample to flow through a piece of equipment

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3.16
retrograde condensation
production of a liquid phase of heavy hydrocarbons at a particular pressure and temperature where, at that same temperature, the gas stays in a single phase at a higher pressure as well as at a lower pressure

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Note 1 to entry: Retrograde behaviour describes the non-ideal phase properties of hydrocarbon gas mixtures, such as natural gas.

3.17
sample container
container for collecting the gas sample when indirect sampling is necessary

3.18
sample line
line provided to transfer a sample of the gas from the *sampling point* (3.21) to the sampling device or the analytical unit

Note 1 to entry: Devices necessary to prepare the sample for transportation and analysis (conditioning unit) can be part of it.

3.19
sample probe
device inserted into the gas source, used to extract a sample and to which a *sample line* (3.18) is connected

3.20
sampling place
whereabouts along the gas pipeline or on the process plant where the *sample probe* (3.19) is located

3.21
sampling point
exact point in space defined by the *sampling place* (3.20), the *sampling position* (3.22) and by the location of the inlet on the *sample probe* (3.19)

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3.22
sampling position
location within the cross-sectional area of the gas pipeline or process plant at the *sampling place* from where a sample is taken

3.23
spot sample
sample of specified volume taken at a specified place at a specified time from a stream of gas

3.24
trace component
component present at very low levels

Note 1 to entry: Trace components generally include hydrocarbons or groups of hydrocarbons above n-pentane and other components listed in ISO 14532.

3.26
wetted surface
surface of the material in contact with the sampled gas

4 Safety considerations

The use of this document can involve working with high pressure flammable gases and other hazardous materials which can be located in areas designated as hazardous (potentially explosive and or toxic atmospheres). This document does not address the safety issues associated with such situations. It is the user's responsibility to establish appropriate design rules, installation, operating, testing and maintenance procedures for pressurized equipment, equipment located in potentially hazardous areas, the control, handling and transportation of substances potentially hazardous to health, etc.

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International and national regulations on safety requirements should be followed closely and carry more weight than this document.

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5 Principles of sampling

Natural gas sampling is the process of acquiring a sample from a source of interest, conditioning the sample (where necessary) and delivering the sample to an analytical instrument, either directly or indirectly via a vessel or other transport medium.

The methods and equipment for each of these steps are described within this document.

The purpose of the sampling system is to ensure that the sample acquired is representative of the source gas desired and that in the process of delivering the sample to the analytical instrument the chemical and physical state remain unchanged, even on a molecular level.

Considering the equipment is relied on to fulfil this purpose for many years of operation, careful consideration should be applied to the design (considering application-specific conditions and measurement objectives), manufacturing, operation, maintenance and performance evaluation of the system.

6 The concept of representative sample

In order to show that any information gained from a sample of natural gas is truly representative of the whole quantity to which the information is to be attributed we use the term "representative sample"

A representative sample is established by two main criteria:

a) The sample is not altered in any way, or more realistically in any avoidable way, during the process of collecting, handling, containing or preparing the sample for analysis or measurement. The condition of the sample being the same in composition and phase -absolute or essential sameness

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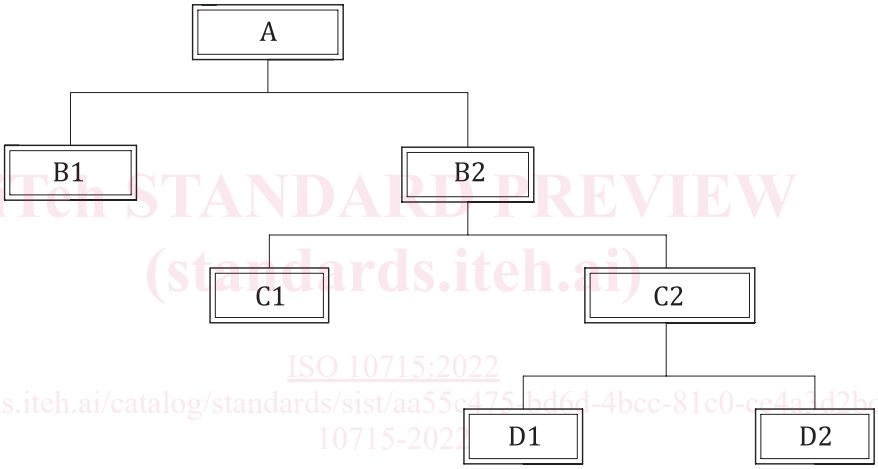
as the mass from which it was taken for the quality/analyte under consideration - is considered as being identical.

b) The sample is taken at a sample point where we can be sure that it is actually from the bulk to which the information is to be applied at a known time or time period. This requires a matching in time or a synchronization of analytical results to the mass. This is considered as being pertinent.

7 Types of sampling

7.1 Sampling method considerations

The main function of sampling is to take an adequate sample that is representative of the gas. The main distinction in sampling is between direct and indirect sampling methods. In the direct sampling method, the sample is drawn from a stream and directly transferred to the analytical unit. In the indirect sampling method, the sample is stored in a sample container before it is transferred to the analytical unit. The main classifications of the indirect sampling method are spot sampling or incremental sampling. Incremental sampling regarding regasified LNG is described in ISO 8943[17].



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ISO 10715:2022
https://standards.iteh.ai/catalog/standards/sist/aa55c475-bd6d-4bcc-81c0-ce4a4d2bdfc7/iso-10715-2022

Key

A sampling
B1 direct
B2 indirect
C1 spot
C2 incremental
D1 time
D2 flow

Figure 1 — Survey of direct and indirect sampling methods

The information needed from the analysis of natural gas falls into two basic categories: averaged and limit values.

— Averaged values:

A typical example is the calorific value. Custody transfer requires the time- or flow-averaged calorific value. Commercial agreements determine the period and method of averaging.

— Limit values:

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Most gas custody transfer contracts contain specification limits on composition or on gas properties. Direct sampling can be applied, but often the requirements are such that also indirect sampling has to be applied.

7.2 Spot sampling

7.2.1 General

This clause specifies a method of indirect sampling in which a suitable container is filled with the sample. The sample is subsequently transported to the place of analysis.

Spot sampling is a form of sampling that is representative of what is in the pipeline at the moment that the sample is being taken. Spot sampling may be used for well or feed assessment, periodic stream assessment, result verification, process verification, trouble shooting and auditing purposes.

Spot sampling is a form of sampling that is taken from a single location and a single point in time and provides a sample of what was in the pipeline when the technician extracted the sample.

The interval between samples should be specified by the user, based on safety or process criticality of the results and stability of the gas quality (see 7.2.8).

The sample is extracted by utilizing one of several approved methods for taking spot samples, such as: the fill and empty method, the Helium pop method, the continuous purge, constant pressure method or another proven and tested method of extraction. Most samples are gathered in a standard, single cavity sample cylinder or a constant pressure piston style sample cylinder.

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While valuable information can be gathered by this method, it shall always be noted that the sample represents what was present at the time of sampling. It is not representative of the sample location for the next week or month, unless it is from a single gas well that has a long history of producing the same gas and gas content. It is worthy to note that an older field begins to get richer and richer near the end of its life. The gas quality could stay the same for 10 years and then begin to change near the end of its field production life.

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Annex B on low pressure sampling describes a method of obtaining spot samples from a low pressure natural gas distribution system using a glass vessel. Other specialist vessels such as inert polymeric bags are available for niche applications.

Methods suited for high and low pressure spot sampling are:

— fill and empty;

— controlled rate;

— evacuated container;

— helium pre-fill – (helium pop);

— floating-piston cylinder;

— single cavity sample cylinder.

7.2.2 Fill-and-empty method

This method is applicable when the sample container temperature is equal to or greater than the source temperature. The source pressure shall be above atmospheric pressure. A detailed example procedure is given in B.2.

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7.2.3 Controlled-rate method

In this method, a needle valve is used to control the sample flow rate. This method is applicable when the sample container temperature is equal to or greater than the source temperature. The source pressure shall be above atmospheric pressure. B.3 gives a detailed example of this method.

7.2.4 Evacuated-cylinder method

In this method, a previously evacuated cylinder is used to gather the sample. This method is applicable when the source pressure is above or below atmospheric pressure and the source temperature is greater or less than the sample container temperature. The valves and fittings on the sample cylinder shall be in good condition and there shall be no leaks. B.4 gives an example of a detailed procedure.

7.2.5 Helium pre-fill method

This is similar to the evacuated-cylinder method except that a helium pre-fill is used to keep the container "air free" prior to sampling. It is used in those cases when helium is not to be measured, and preferably can be ignored, for example analysis by gas chromatography with helium carrier gas.

7.2.6 Floating-piston cylinder method

By this method, a sample is drawn into a floating-piston cylinder maintained at pipeline pressure and with heat-traced sample lines.

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7.2.7 Single cavity sample cylinder

A single cavity cylinder used for the collection of a sample for analysis. Typically, the cylinder is stainless steel and formed with spun ends and tapped at each end of the cylinder. Some designs can only have a single tapped end. The most common sizes are 300 ml, 500 ml and 1 000 ml, with other volumes available. The cylinder has a valve and a safety relief at one end and a valve at the other end.

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7.2.8 Sampling frequency

7.2.8.1 General considerations

Information on the properties of the gas stream in the past and about expected (systematic) future changes determines the sampling frequency. Generally, pipeline gas composition can have daily, weekly, monthly, semi-annual and seasonal variations. Compositional variations can also occur because of gas treatment equipment and reservoir changes. All of these environmental and operational considerations shall be taken into account when selecting a sampling interval.

These considerations may be supported by the statistical approach given below.

An appropriate number of samples may be calculated based on the required (target) uncertainty of the averaged quantities. (Strictly speaking, the approach takes into account the precision constituents of the combined measurement uncertainty).

Formula (1) for calculating the appropriate number of samples is as follows (details are described in Annex I):

$$n = \left(t \times \frac{s}{U_{\mathrm{tg}}} \right)^2 \tag{1}$$

Where

U_{tg} is the target expanded uncertainty of the average quantity value;

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