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Natural gas — Odorization

Gaz naturel — Odorisation

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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*.

This first edition ISO/TS 16922 cancels and replaces the first edition (ISO/TR 16922:2013), which has been technically revised.

The main changes are as follows:

— modification of the structure of the Technical Report, new clauses: 4.1, 4.2, 4.3, 5.1, Clause 7, 7.1, 7.1.1, 7.1.2, 7.1.3, 7.3, 7.3.1, 7.3.2, 7.3.3, 7.3.4, 7.3.5;

— modification of 7.2.

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.

Introduction

Processed natural gas normally has little or no odour. For safety reasons distributed natural gas is therefore be odorized, to permit the detection of the gas by smell.

The odorization is predominantly a safety measure for the user of natural gas. Odorized natural gas needs to be recognized by the characteristic smell.

This document may also be applied to other gases used in gas supply as e.g. biomethane, blends containing hydrogen, regasified LNG or LBG, LPG for conditioning in gas supply, etc.

Natural gas — Odorization

1 Scope

This document gives the specifications and guidelines for the methods to be used in the odorization of natural gas and other methane rich gases delivered through natural gas networks to gas applications under a safety point of view.

This document also specifies the principles for the odorization technique (including handling and storage of odorants) and the control of odorization of natural gas and other methane rich gases.

NOTE The general requirements for odorants, and the physical and chemical properties of commonly used odorants are specified in ISO 13734.

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 5492, *Sensory analysis — Vocabulary*

ISO 14532, *Natural gas — Vocabulary*

3 Terms and definitions

For the purposes of this Technical Specification, the terms and definitions given in ISO 5492 and ISO 14532 and the following apply:

3.1.1
odorant content
content of the odorant either in the gas or in air expressed as its mass concentration, volume fraction or mole fraction

3.1.2
odour perception
awareness of the effect of volatile substances by the olfactory organ

3.1.3
odour character
distinctive and identifiable feature of an odour or flavour

3.1.4
odour intensity
magnitude of the perceived odour

3.1.5
masking
phenomenon by which one or more constituents in the gas stream can change or reduce the *odour intensity* (3.1.4) and/or the *odour character* (3.1.3) of the odorized gas

3.1.6
fading of odorant
phenomenon where adsorption, absorption or chemical reactivity of the odorant result in loss of odorant across the network

4 General requirements

4.1 Necessary odorant addition

Because safety is paramount in the gas industry, it could be assumed that the stronger the odour of gas, the better. However, an upper limit is usually set to avoid unjustified leakage complaints already caused by the small volume of unburnt gas escaping during ignition of the burner. An excessive odorization level can also lead to a slight and permanent gas smell related to micro leaks that cannot be localized and sealed. This could lead to habituation of the customer with the eventuality of a late reaction when actual leaks occur. Gas odorization is in most countries a legal or regulation requirement that specifies that natural gas in air be readily detectable by odour at a concentration of 20 % (safety factor of 5) of the lower flammability limit (LFL). The LFL of natural gas is normally taken as a volume fraction of natural gas in air of 4 % to 5 %. However, local regulations may specify other odorization rules.

NOTE Consider potential masking issues when blending natural gas with other gases (e.g. biomethane, LPG), the odour being either naturally present or artificially added.

4.2 Requirements and parameters for consideration when selecting an odorant

Information about different odorants is given in ISO 13734:2013, Annex A.

Various parameters are considered when selecting an odorant:

— Typical odour character that is intense, unpleasant and universally associated with gas

— Physical properties: Freezing point, boiling point, vapour pressure

— Stability:

  — Stability with respect to oxidation in network:

  Mercaptans being more reactive than sulfides, they tend to form less odorous disulfides in presence of rust, thus lowering odorization efficiency.

  — Stability in storage:

  Some chemicals developed for odorization displaying reactive function can undergo hazardous polymerization reaction if not stabilized adequately. Such reaction could occur in storage tank or within injection system.

— Toxicity

— Environmental issues

— Gas quality: wet gas, presence of other sulphur compounds or network displaying condensates will generate odorant scrubbing or cross contamination that may affect odorant efficiency

— Odorization practice in the region:

  — Centralized / decentralized

  — Odorization technique: (some odorants may not be compatible with Bypass odorizers, etc.)

— Network material (Carbon steel, plastics)

The level of the odorant added, that determines the odour intensity, is based on different factors whereof not all are based on measurement, as e.g. local experience. The typical objective is that the population with a functional sense of smell will be able to smell odorized gas before its concentration reaches the specified limit (typically 20 % LFL) and thus takes the appropriate measures to protect itself. Different approaches are applied to define and estimate the concentration of odorant required to achieve this effect.

The odour intensity of an odorant for natural gas or a gas is best determined by the human olfactory organ.

4.3 Public awareness

In some countries, local regulations require the operators to follow a public awareness program, which may include specific information about the risk of gas and guidance for leak recognition. The use of scratch-and-sniff cards containing the encapsulated odorant or other carriers is also frequently used in a number of countries, but other kind of smell samples are also encountered.

In the case of changing the odour character of the gas odorant, the need to provide adequate information to the members of the public and gas users should be considered.

5 General remarks on odorant behaviour

5.1 Masking and fading of odorants

Temporary fading in a new gas distribution system or after changing the odorant requires specific monitoring and can need temporary supplemental odorization or other measures (e.g. preconditioning).

Some components, e.g. present in some natural gases or biogases may react on or with the odorant applied, resulting in a major loss of smell of the odorant either by masking effects or by chemical reaction.

5.2 Seals and membranes

Liquid odorants may cause severe swelling or even dissolution of organic materials such as plastics, elastomeric seals and lubricants. Therefore, in odorization equipment and for joints close to the points where the liquid odorant is injected into the line, only sealing materials should be used which are compatible with liquid odorants. This information is normally supplied by the manufacturer of the odorant (see ISO 13734).

5.3 Pipelines

The low odorant concentrations used for odorization of natural gas do not compromise the integrity of plastic pipes, seals or diaphragms in gas transportation, distribution and utilization.

When starting gas distribution through new gas lines or when changing the odorant it may take some time to reach the required odorant concentration at the end of the line. This may result from the odorant being sorbed on the pipe wall, by pipe dust, rust and incrustations or by gas condensates (odour fading). The degree of sorption depends on several factors, for example the condition of the pipe grid, the pressure, the temperature, the flow velocity and the physicochemical properties of odorants.

5.4 Buried pipeline

Odorized gases leaking from gas lines in the ground may lose odorants by sorption in the soil. Sorption and oxidation of odorants may vary with moisture content and the type of soil. Degradation of odorants by microorganisms may also occur.

6 Safety precautions

6.1 Handling of odorants

WARNING — Odorants should be handled according to their actual characteristics and prevailing regulations.

IMPORTANT — All relevant safety precautions being observed when handling odorants, employees should be instructed periodically. Odorants are irritating, harmful and flammable. Therefore, the specific material safety data sheet should be read prior to handling liquid odorants. All safety precautions should be strictly observed and followed.

A minimum level of safety may be achieved by the following recommendations:

— Concentrated vapours of odorants may cause short-term acute health problems, such as dizziness, headache, nausea and irritation of throat, nose and eyes. Therefore protection, for example with a filter containing activated charcoal or a respirator, is common use. Any extended exposure without respiration protection need to be avoided.

— When handling odorants, suitable personal protective equipment (eye-, face-, body-protection, gloves) and safe-handling procedures of the odorant are recommended. If, in spite of the use of personal protection equipment, liquid odorant contacts the skin or the eyes, wash the affected spot as first aid, immediately with plenty of water. If an eye comes in contact with liquid odorant, consult a physician immediately.

6.2 Spill management and remediation

WARNING — Undiluted oxidants should never be brought into contact with odorants: RISK OF EXPLOSION!

There are several possibilities to eliminate the nuisance caused by the strong odour of spilled odorants.

— For odour mitigation, deodorants may be used, which normally do not change the chemical properties of the odorant. Therefore, health risks will not be eliminated. For larger amounts of spilled odorants these masking compounds are not suitable.

— Minor quantities of spilled odorants (surface cleaning) can be treated with different options:

  — oxidized to less smelling compounds utilizing a procedure incorporating the spraying of diluted solutions of an oxidant such as 5 % by mass of sodium hypochlorite or 5 % by mass of hydrogen peroxide, preferably under the addition of detergents. This procedure should account for the corrosive and reactive nature of these oxidants.

  — neutralized with enzymatic solutions, only effective for some odorants (e.g. mercaptans)

— Larger quantities of spilled or leaked odorants should be sorbed by sorbents (activated charcoal) and disposed of in tightly shut containers. Small remainders should be treated as minor quantities.

These sorbents or soil contaminated by odorants should be treated according to prevailing regulations.

Commercial products are also available to mask and/or mitigate odorant spillage. These products are generally available through the odorant manufacturer.

For the cleaning of pipework, containers and parts of the odorizing equipment the use of alcohols (isopropanol, technical ethanol) is an option. The used cleaning solution are to be disposed according to prevailing regulations.

6.3 Transportation and storage

Odorants are delivered in corrosion-resistant containers suitable for transport and/or storage according to prevailing regulations. Odorant containers need to be accompanied by a safety data sheet conforming to the requirements of all prevailing regulations.

The use of the proper sealing materials is according to the type of odorant, sulfurous or acrylic.

To avoid nuisance when stationary odorant tanks are refilled, vapour equalization lines for gas phase transfer between storage and transportation tanks are recommended. Lines for transfer equipped with

automatic shutoff valves are recommended, where possible. Connections and valves preferably have minimum dead volume.

Storage rooms for odorant containers are best cool, dry and well ventilated. Extended impact of the sun increase of the internal pressure of odorant containers during transport and/or storage.

Storage containers and the odorizing plant may be in the same room. Odorants jointly with any easily inflammable substance is best to be avoided.

7 Odorization technique

7.1 Odorization of pipeline networks

7.1.1 Odorization of transmission pipelines

Centralized odorization is performed at the entry point of gas into the transmission network (i.e. LNG terminal, interconnection points, etc.). Its advantages are:

— the installation, operation and maintenance of sophisticated equipment to automate and monitor each odorizer is simpler and results in better uniformity of the odorant concentration in the gases;

— it allows a uniform gas odour throughout a region.

Its disadvantages are

— the odorants may have to be removed from the gas supplied to some industrial consumers, and

— odorized gas is delivered to industrial consumers that may not need it because other safety measures may be provided to recognize gas leaks (e.g. gas sensors for these industrial processes).

7.1.2 Odorization of distribution pipelines

Decentralised odorization is performed typically at the entry points of the distribution networks, including biomethane injection points. Advantages for decentralized odorization are:

— odorant concentrations can be adjusted to the specific conditions of the local distribution grid (new pipes or old pipes with deposits),

— the sulfur content of gas for industrial use or the environmental effects of odorants on some types of underground storage are not increased by odorization by avoiding unnecessary odorization.

Disadvantages of decentralized odorization are

— the multiplicity of odorization stations, generally close to populated areas,

— generation of transportation of odorant on road or rail, and

— handling of odorant by a multitude of personnel,

— low gas flow is more difficult to follow up in odorant dosage.

7.1.3 Combined odorization of transmission and distribution pipelines

In some countries, classification of transmission pipelines is enforced according to the human occupancy on either side of the pipelines, defining which pipelines have to be odorized. In a number of countries, odorization is mandatory when the human occupancy is high.

In some cases, minimum odorization levels in transmission and distribution are different. In other cases, where different odorants are in use and the possibility exists to transfer odorized gas from distribution to transmission grids (in case of biomethane overproduction) it may be required to deodorize the gas.

7.2 Odorizer

7.2.1 General

Odorization is usually performed using one of the following techniques:

— liquid odorant injection;

— evaporation odorizer.

7.2.2 Liquid injection odorizers

To allow for a constant odorization, the necessary amount of odorant is added to the gas stream continuously or quasi continuously. This is best accomplished by flow proportional odorization by injection odorizers. Flow proportioning refers to adjusting the odorant injection rate to the flowrate of the gas flowing in the pipeline. These odorizers are typically the most commonly used nowadays, and can be sized to fit most flowrates.

Odorant is injected from a storage tank, generally maintained at low pressure, directly into the flowing gas. In principle, two systems are commonly in use:

a) Systems with injection pumps: the injection rate is related to the volumetric pump displacement and the stroke frequency. This frequency is adjusted by accounting for the gas flow as measured by a measurement device. The pump protected by an upstream filter against clogging.

b) Valve-controlled systems: Gas-flow proportional injection from a pressurized storage tank may be achieved by means of mass-flow or volume-flow controllers.

The injection of odorant may also be regulated by taking into account the actual odorant concentration present in the gas. The injection system also can produce information regarding the total odorant injected, injection rate, and alarms regarding the performance of the system.

The liquid odorant can be injected into an injection probe. Designs of these probes vary but are intended to maximize vaporization of the odorant into the natural gas. Filters are normally installed upstream to the injection system in order to decrease the required maintenance of the system. A check valve and isolation valve should be installed in the connection line between the injection system and the injection point.

All material in contact with liquid odorants should be assessed for compatibility with the specific odorant in accordance with the odorant manufacturer's information. Such assessment is therefore also performed when the type of odorant is changed.

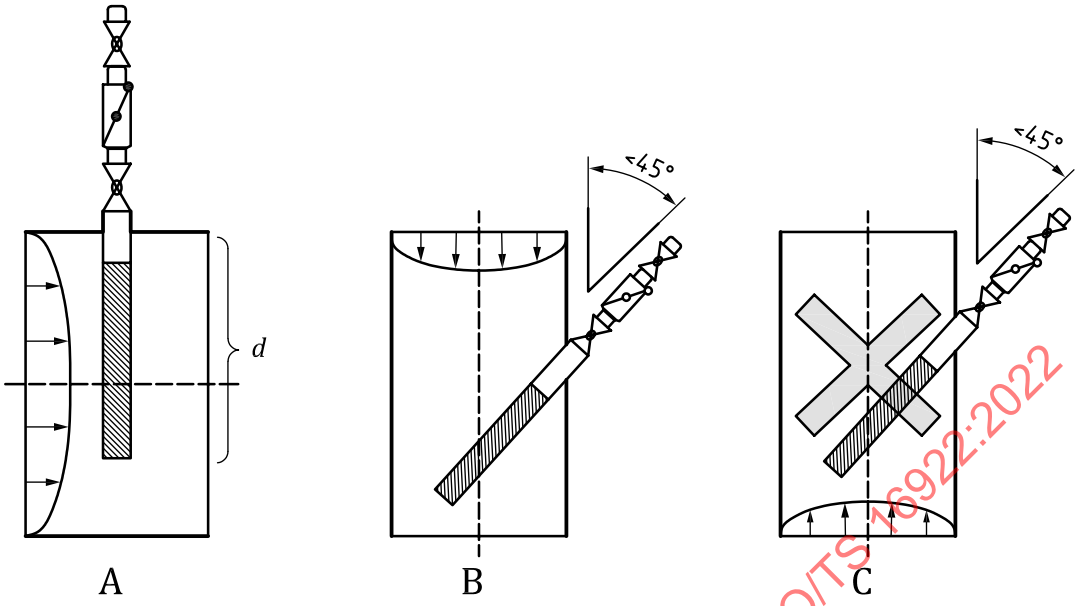
To inhibit the possibility of leakage, lines carrying liquid odorant are made of seamless precision stainless steel pipe, but for the connection line to the injection point suitable flexible tubing reinforced by steel fabric may be used. All pipes carrying liquid odorants are indelibly signed.

NOTE To avoid extreme nuisance due to smell, odorizers are equipped for flushing in case of maintenance.

7.2.3 Positioning of odorant injectors

When installing injectors to horizontal gas pipes, it is recommended to install the injector radially (see Figure 1). When installing to vertical gas pipes, an installation angle of 45° has proven most adequate (see Figure 1). It is not recommended, however, that the gas flow towards the injector is opposing gravity (see Figure 1).

The installation depth of the injector best covers at least 60 % of the internal diameter of the gas pipe in order to position the evaporation zone centrally in the pipe.



Key

d injection depth, minimum 60 %

A position of the injector radially

B position of the injector: installation angle of 45°

C position not recommended: the gas flow towards the injector is opposing gravity

Figure 1 — Positioning of the injector

7.2.4 Evaporation odorizers

7.2.4.1 General

Evaporation odorizers are used for low flow odorization. Their main advantages are robustness, low cost and the fact that they do not require any power supply. Only single component odorants, such as THT, or odorant mixtures with low boiling point differences (~10 °C) of the components, for example a mixture of MES and TBM, are used. With these odorizers, the odorant tanks are required to withstand the maximum operating pressure of the pipe. Procedures for the filling of evaporation odorizer tanks include proper flaring or scrubbing of the vapours contained in the empty tank. Examples of evaporation odorizers are bypass odorizers and wick type odorizers.

7.2.4.2 Bypass odorizers

In bypass odorizers a partial stream of gas is saturated with odorant and afterwards mixed with the main gas stream. These odorizers are used for higher gas flow than the wick type odorizers (see 7.2.4.3). Typically a bypass is installed on the main pipe, a pressure drop being created between the junctions of the bypass and the main pipe by inserting for example an orifice plate. Thus a part of the gas flow is passed through the bypass. A valve allows the adjustment of the ratio between the main and bypass gas flow. The bypassed flow goes through the odorant tank, or may bubble through the odorant and will be partially or fully saturated with odorant. The mixing of this odorant-saturated flow of gas in the main stream will odorize the gas.

Temperature variations of the odorant tank may lead to a different vapour pressure and thus a different odorization rate. This can be minimized by insulating the tank or storing it inside a building. Under low flow conditions, the pressure drop on the main stream may be too small to induce a significant bypass flow leading to insufficient odorization. Contamination is a problem as deposition of dirt or oil on the surface of the odorant in the tank will, by reducing the evaporation surface, reduce the odorization rate.

7.2.4.3 Wick type odorizers

The wick type odorizers are inexpensive and convenient for low flow applications, such as odorizing an isolated farm or several houses. The wick is partially immersed in the odorant tank, which is attached to the pipe. The odorant travels up the wick by capillarity and evaporates in the gas flow. The disadvantage of the wick type odorizer is that it will give varying odorant concentrations rates according to the temperature and the gas flow rate. As is with bypass odorizers, contamination is a problem as deposition of dirt and oil on the wick impedes the evaporation by coating the wick.

7.3 Design of installation

7.3.1 Odorization rooms

Odorants are volatile flammable liquids and, in case of a spill, may lead to the formation of an explosive atmosphere. Therefore, the installation and materials used in odorization rooms or cabinets shall comply with all prevailing regulations.

The electrical installation in odorization rooms or storage rooms for odorant containers check all prevailing regulation with respect to the flammability of odorants and their low flash point.

Beneath the odorizer a containment is installed, sufficient to collect the total volume of odorant contained in the odorizer. No part of the odorizer containing odorant should extend beyond the containment except the line to the injection point.

7.3.2 Ventilation

Sufficient ventilation is important for odorizer and storage rooms for odorants. To avoid annoyance by odour it may be necessary to install a forced ventilation with the purification of the exhaust by a filter with activated charcoal or other technically adequate means.

7.3.3 Installation of injection point and injection pipe

The design of the injection point ensures the even distribution of the odorant in the gas. Beyond a distance of about 100 pipe diameters from the injection a uniform mixture is best to be reached. Maintenance can be simplified by a special construction also used for sampling probes without depressurization of the pipe.

Installation of operational equipment in close proximity downstream of the injection point should be avoided.

7.3.4 Tank design and operations

The tank design the national regulations for flammable products apply.

A dry and clean blanket gas avoids condensation of water or heavy hydrocarbon impurities into the odorant. The solubility of blanket gas in the odorant is to avoid vapour lock issues in injection systems. In some countries, recommendations are in place to avoid overfill of the odorant container, e.g. by filling to 80 % of its maximum volume, and keep a gaseous phase in the container.

7.3.5 Spill kit

The consequences of an odorant spillage are not limited to the risks of flammability and toxicity. Any spillage will generate odour nuisances in the extended neighbourhood and false alarms for gas leaks reported by the public. In order to mitigate this risk, it is recommended to store a spill kit close to the odorant tank and/or in the odorization room. The odorant manufacturer's recommendations for the operators as well as training to use the spill kit apply.

7.4 Pressure resistance

Check and safety valves, according to the prevailing regulations, should protect the parts of the odorizer equipment in injection systems, which are not pressure resistant.

For odorizers with a pump, all components downstream of the pump as e.g. the injection pipes is designed for the maximum outlet pressure of the pump.

7.5 Addition of odorant

7.5.1 Control of the addition

The required volume of liquid odorant to be injected into the gas stream is adjusted by stroke mass flow or volume flow control and a steering unit. The gas flow measurement is used to control the frequency of the injection pump or the flow controllers by the control unit.

For bypass odorizers the relationship of the main gas stream and the partial gas stream to be saturated with the odorant shall be appropriately adjusted to achieve the required odorant concentration.

7.5.2 Monitoring and control devices

The amount of odorant injected to the gas stream is controllable at the odorizer in order to identify the need for refilling. As control devices are for example in use:

— a system of graduated glass tubes,

— liquid level or weight control of the odorant container,

— automated dosing volume or weight control,

— injection impulse control.

NOTE For control of the odorization, remote control systems as well as local control systems exist.

7.5.3 Testing and commissioning

Odorizer plants, their components or the entire installation, should be tested by their manufacturer for integrity and tightness in accordance with the prevailing regulations.

The completely installed odorizer plant up to the injector at the place of final installation is subject to a test for leaks and proper function prior to filling the tank with odorant. Usually recommendations of the manufacturer(s) exist.

This test at the place of final installation should be documented.

8 Control of odorization

8.1 General

The control of odorization is necessary to check the correct odorization of the gas which is frequently a requirement from external authorities. This control is generally needed for demonstrating the quality of odorization in relation to prevailing regulations. Thus, close attention should be paid to the required documentation, relevant investigative procedures asked for in the prevailing regulations and/or standards, but also to the regulations related to gas accident investigation. If no local regulations are in existence, the recommendations of 8.2, 8.3 and 8.4 may be followed.

8.2 Check of odorization equipment and systems

The performance checks are recommended either by automated remote control or by regular on-site inspection, in accordance with the recommendations of the odorization plant manufacturer.

8.3 Control of odorization of the gas

It is recommended to check the odorization in the gas grid on a regular basis.

This can be performed by determination of the odorant content in the gas and/or by olfactometric tests.

The check of the odorant content in the gas may be continuous using permanently installed measuring devices or discontinuous. To ensure the representativeness of the gas sample care should be taken in the correct purge of the sampling lines (see ISO 13734).

In particular new grids may require more frequent control because of possible interaction effects of the odorant to the pipeline material.

In the case of introduction of any component that may affect the efficiency of the odorization, control checks should be performed.

For the control period, local regulations prevail. The number of control points and the frequency of sampling are normally fixed by the grid operator.

To determine the odorant content in the distributed gas quantitative analysing methods should be used. For sulfurous odorants the gas chromatographic methods using sulfur-specific detectors or chromatographs with high resolution columns are advised as reference method (see ISO 19739). Also, hand held measuring devices may be used if the influence of components affecting the measurement result can be excluded.

Care has to be taken for correct sampling (see ISO 10715) and the use of certified calibration gas mixtures.

8.4 Odour complaints

The response to the odour perception of a gas smell by the population may be an odour complaint, by which an individual informs the gas utility that a gas leak may occur. Gas companies have generally an obligation to give an emergency response to such call. A significant number of these calls may not lead to the discovery of a gas leak due to various reasons (confusion about the smell, misinterpretation, smell from other sources). Nevertheless, the follow up of such odour complaints may be an asset to evaluate the success of an odorization practice.