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Natural gas — Odorization

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National foreword

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TECHNICAL REPORT

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Natural gas — Odorization

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Foreword

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

ISO/TR 16922 cancels and replaces ISO/TS 16922:2002.

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Introduction

Processed natural gas normally has little or no odour. For safety reasons, distributed natural gas should 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 is recognized by the characteristic smell.

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TECHNICAL REPORT **ISO/TR 16922:2013(E)**

Natural gas — Odorization

1 Scope

This Technical Report gives the specifications and guidelines for the methods to be used in the odorization of natural gas under a safety point of view.

This Technical Report also specifies the principles for the odorization technique (including handling and storage of odorants) and the control of odorization of natural gas.

This Technical Report does not cover odorization of gas supply with gases other than natural gas.

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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5492:2008, *Sensory analysis — Vocabulary*

ISO 10715, *Natural gas — Sampling guidelines*

ISO 13734, *Natural gas — Organic components used as odorants — Requirements and test methods*

ISO 14532, *Natural gas — Vocabulary*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5492 and ISO 14532 and the following apply.

3.1 General

The following general definitions apply to the human ability for sensation, awareness and intensity of odour perception.

3.1.1
odour perception
awareness of the effect of volatile substances by the olfactory organ

3.1.2
odour character
distinctive and identifiable feature of an odour or flavour

3.1.3
odour intensity
magnitude of the perceived odour

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3.1.4
sensory fatigue
form of sensory adaptation in which a decrease in sensitivity occurs

[SOURCE: ISO 5492:2008]

3.1.5
masking of odours
phenomenon where one quality within a mixture obscures one or several other qualities present

Note 1 to entry: The qualities may be odour intensity or character.

3.2 Specific definitions for the gas odorants

3.2.1
olfactory degree
measure of the odour intensity in accordance with a general law established by Weber, Fechner and Stevens, which is proportional to the logarithm of the odorant concentration

3.2.2
odorant content
content of the odorant either in the gas or in air, expressed as its mass concentration, volume fraction or mole fraction

3.2.3
odour intensity curve
correlation curve of odour intensity versus odorant concentration in air

Note 1 to entry: The odour intensity of an odorant for natural gas or a gas can only be determined by the human olfactory organ.

4 General requirements for natural gas odorants

Requirements for compounds used as natural gas odorants are given in ISO 13734.

Information about different odorants is given in informative Annex A of ISO 13734.

5 General remarks on odorant behaviour

5.1 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. According to ISO 13734 this information should be supplied by the manufacturer of the odorant.

5.2 Pipelines

The low odorant concentrations used for odorization of natural gas and thus their low partial pressures 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 physico-chemical properties of odorants.

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5.3 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 — Special care should be taken when handling odorants according to their actual characteristics and prevailing regulations.

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, should be used. Any extended exposure without respiration protection should 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 Masking and remediation

WARNING — Do not bring undiluted oxidants into contact with odorants: RISK OF EXPLOSION!

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

— For masking of odours, 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 can be 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 take into account the corrosive and reactive nature of these oxidants, which can lead to heat and pressure built-up.

— Larger quantities of spilled or leaked odorants should be sorbed by sorbents (e.g. sand, non-flammable chemical sorbent) 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 should be disposed according to prevailing regulations.

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6.3 Transportation and storage

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

NOTE It should be considered to use the proper sealing materials 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 should have minimum dead volume.

Storage rooms for odorant containers should be cool, dry and well ventilated. Odorant containers for transport and/or storage should not be subjected to extended impact of the sun to avoid an increase of the internal pressure. Storage containers and the odorizing plant may be in the same room. Odorants should not be stored jointly with any easily inflammable substance. For storage, prevailing regulations and the instructions of the odorant manufacturer should be followed.

7 Odorization technique

7.1 Centralized or decentralized odorization

Centralized odorization is done at a few terminals. 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 for a uniform odour throughout the gas distribution of a region.

Its disadvantages are that:

— temporary fading in a recently converted or new distribution system has to be corrected by temporarily adding supplemental odorization.

— A disadvantage is that the odorants may have to be removed from the gas supplied to some industrial consumers.

— It also means that 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).

Decentralised odorization is done typically at the entry points of the distribution networks. 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 is not increased by odorization, and the detrimental effects of odorants on some types of underground storage are avoided.

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.

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7.2 Odorizer

7.2.1 Injection odorizers

To allow for a constant odorization, the necessary amount of odorant are 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 should be 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 should be 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 should therefore also be performed when the type of odorant is changed.

To inhibit the possibility of leakage, lines carrying liquid odorant should be 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 should be indelibly signed.

NOTE Odorizers should be equipped for flushing in case of maintenance to avoid extreme nuisance due to smell.

7.2.2 Evaporation odorizers

7.2.2.1 General

Evaporation odorizers are used for low flow odorization. Their main advantages are roughness, 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 (approximately 10 °C) of the components, for example a mixture of MES and TBM, should be used. High vapour pressures at ambient temperature are beneficial as the evaporation rates do not change dramatically when temperatures changes. With these odorizers, the odorant tanks are required to withstand the gas pressure. Procedures for the filling of evaporation odorizer tanks should include proper flaring or scrubbing of the vapours contained in the empty tank. Examples of evaporation odorizers are bypass odorizers and wick-type odorizers.

7.2.2.2 By-pass 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 (7.2.2.3). 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

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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.

7.2.2.3 Wick-type odorizers

The wick-type odorizers are inexpensive and convenient for 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 Constructional measures

7.3.1 Odorizer 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 odorizer rooms should comply with all prevailing regulations.

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

Beneath the odorizer, a containment should be 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.

Hazards associated with the installation should be posted on entrances and other appropriate locations in accordance to prevailing regulations.

7.3.2 Ventilation

Odorizer rooms and storage rooms for odorants should be sufficiently ventilated. To avoid annoyance by odour it may be necessary to install 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 should ensure the even distribution of the odorant in the gas. Beyond a distance of about 100 pipe diameters from the injection a uniform mixture should 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.

7.4 Pressure resistance

The parts of the odorizer equipment in injection systems, which are not pressure resistant, should be protected by check and safety valves, according to the prevailing regulations.

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

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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 should be 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 should be adjusted to achieve the required odorant concentration.

7.5.2 Monitoring and control devices

The amount of odorant injected to the gas stream should be controllable at the odorizer. As control devices are, for example, in use:

— a system of graduated glass tubes;

— liquid level control of the odorant container;

— automated dosing volume control;

— injection impulse control.

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 should be subjected at the place of final installation to a test for leaks and proper function. The recommendations of the manufacturer(s) should be regarded. This test at the place of final installation should be documented.

8 Necessary odorant addition

8.1 General remarks

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 may be 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 may 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.

The level of the odorant added is based on different factors whereof not all are based on measurement, as, for example. 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.

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9 Control of odorization

9.1 General

The control of odorization is necessary to check the correct function of the odorization equipment. Furthermore, as gas odorization 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 on the jurisdiction related to gas accident investigation. If no local regulations are in existence, the following recommendations should be followed.

All inspections, maintenance and measurement results should be recorded in a suitable manner and the documentation be kept for the time specified by local regulations for gas safety equipment.

9.2 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.

9.3 Control of odorization of the gas

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

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

The control of the odorant content in the gas may be continuous using permanently installed measuring devices or discontinuous.

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

For the control period, local regulations prevail. The number of control points and the frequency of sampling should be 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 specified in ISO 19739 using sulfur-specific detectors or chromatographs with high resolution columns should be taken as reference method. 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.

9.4 Odour complaints

The response to the 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.

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