
**Natural gas — Guidelines for odorizing
gases**

Gaz naturel — Lignes directrices pour odoriser les gaz

STANDARDSISO.COM : Click to view the full PDF of ISO/TS 16922:2002



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

STANDARDSISO.COM : Click to view the full PDF of ISO/TS 16922:2002

© ISO 2002

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword.....	iv
Introduction.....	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 General recommendations for natural gas odorants.....	3
5 Typical odorants	3
6 Safety precautions.....	6
7 Odorization technique.....	7
8 Necessary odorant addition	9
9 Control of odorization	9
Bibliography.....	11

STANDARDSISO.COM : Click to view the full PDF of ISO/TS 16922:2002

Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years with a view to deciding whether it should be confirmed for a further three years, revised to become an International Standard, or withdrawn. In the case of a confirmed ISO/PAS or ISO/TS, it is reviewed again after six years at which time it has to be either transposed into an International Standard or withdrawn.

Attention is drawn to the possibility that some of the elements of this Technical Specification may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 16922 was prepared by Technical Committee ISO/TC 193, *Natural gas*.

Annex A of this Technical Specification is for information only.

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.

STANDARDSISO.COM : Click to view the full PDF of ISO/TS 16922:2002

Natural gas — Guidelines for odorizing gases

1 Scope

This Technical Specification gives the guidelines for the methods and odorants to be used in the odorization of natural gas.

This Technical Specification also specifies the general requirements for odorants, the physical and chemical properties of commonly used sulfur-containing odorants, the principles for the determination of odour intensity, the odorization technique (including handling and storage of odorants) and the control of odorization of natural gas.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Technical Specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this Technical Specification are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards:

ISO 5492, *Sensory analysis — Vocabulary*

ISO 10715, *Natural gas — Sampling guidelines*

ISO 13734, *Natural gas — Organic sulfur compounds 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 Technical Specification, 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

type of sensation of an odour

NOTE Odour character is a qualitative parameter.

3.1.3

odour intensity

strength of odour perception

3.1.4

terminal threshold

saturation

minimum value of an intense sensory stimulus above which no difference in intensity can be perceived

[ISO 5492]

3.1.5

sensory fatigue

form of sensory adaptation in which a decrease in sensitivity occurs

[ISO 5492]

3.1.6

addition of odours

masking of odours

result of the odour intensity of a mixture of odoriferous compounds being higher or lower than the odour intensity of each odorant present at the same concentration as in the mixture

NOTE The odour character may be changed by the addition or masking of odours.

3.2 Specific definitions for the gas odorants

3.2.1

olfactory degree

unit of measure of the odour intensity in accordance with the general law established by Weber, Fechner and Stevens and is proportional to the logarithm of the odorant concentration

NOTE Various scales have been proposed for expressing the odour intensity of substances. The gas industry refers frequently to the scale proposed by Sales (see Table 1). It refers to trained persons.

Table 1 — Odour intensity and corresponding sensation

Odour intensity olfactory degrees	Sensation
0	No odour
0,5	Very feeble odour (limit of odour perception)
1	Feeble odour
2	Medium odour (alert level)
3	Strong odour
4	Very strong odour
5	Maximum odour (upper limit of perception)

3.2.2

detection threshold

odorant concentration which has a probability of 0,5 of being detected by a person or by 50 % of the population

NOTE To detect an odour does not imply that this odour may be identified.

3.2.3**identification threshold**

odorant concentration which has a probability of 0,5 of being identified under test condition by a person or by 50 % of the population

3.2.4**alert level**

by convention a medium odour of olfactory intensity degree 2 on the Sales scale

3.2.5**odour intensity curve**

gives the correlation of odour intensity versus odorant concentration in air

NOTE The odour intensity of an odorant for natural gas or a gas can only be determined by human olfactory organ.

4 General recommendations for natural gas odorants

Gas odorants should meet the following general recommendations:

- a) The gas odorant should have a strong odour at very low concentration.
- b) The odour character of the odorant needs to be unpleasant, distinctive and not confusable with other frequently occurring odours so that it is unmistakably associated with a gas leak.
- c) The odour character should be the same at different dilutions of natural gas with air.
- d) The odorant should be sufficiently stable during storage and when mixed with natural gas.
- e) The volatility of the odorant should be high enough so that the odorant does not appreciably condense under the conditions (temperature and pressure) existing in the pipeline system.
- f) Evaporation of the gas odorant should not appreciably leave residues.
- g) The odorant should be useable at low temperatures, when required.
- h) The combustion of the odorant should not leave significant solid deposits.
- i) The addition of the odorant to natural gas should not make the resulting gas harmful.

These general recommendations should be assessed against the specific conditions of use of the odorant (condition of the natural gas transportation grid, odorization installation, type of odorant, composition of the gas).

Requirements for organic sulfur compounds used as natural gas odorants are specified in ISO 13734.

5 Typical odorants**5.1 Odorant components**

The components of commonly used odorants are almost exclusively sulfur containing organic compounds which comply with the basic recommendations listed in clause 4. They belong to the following classes of substances:

- a) alkyl sulfides (alkyl thioethers):
 - symmetrical sulfides, e.g. $C_2H_5-S-C_2H_5$;
 - asymmetrical sulfides, e.g. $CH_3-S-C_2H_5$;
- b) cyclic sulfides (cyclic thioethers), e.g. C_4H_8S ;

- c) alkyl mercaptans (alkane thiols):
- primary mercaptans, e.g. C_2H_5-SH ;
 - secondary mercaptans, e.g. $(CH_3)_2CH-SH$;
 - tertiary mercaptans, e.g. $(CH_3)_3C-SH$.

5.2 Properties of sulfurous odorants

5.2.1 Olfactory properties

Mercaptans and sulfides are used as natural gas odorants because of their strong and characteristic odour. Compared to other compounds of the class of sulfides, for example the simple alkyl sulfides such as dimethylsulfide, methylethylsulfide and diethylsulfide, the cyclic sulfide tetrahydrothiophene (THT) (thiacyclopentane) shows higher odour intensity. Mercaptans possess the highest odour intensity.

5.2.2 Physical and chemical properties

Among the physical properties of odorants, the volatility, closely related to the boiling point, is the most important. To avoid condensation low-boiling components are preferred.

When used as evaporation odorizers, the differences between the boiling points of the odorant components in mixtures should be small.

It is not recommended to use *tert*-butylmercaptan (TBM) as a single component odorant because of its high freezing point. At low temperatures, TBM would not be sufficiently vaporized and thus not be detected.

Sulfides are chemically more stable than mercaptans. Mercaptans may be oxidized by iron oxide (rust) to disulfides. Iron oxide also acts as a catalyst for the oxidation of mercaptans by oxygen [e.g. when LPG¹–air mixtures are used for peak shaving²]. By this reaction mercaptans are transformed into disulfides, which have significantly lower odour intensity and also a different odour character.

Tertiary mercaptans (e.g. TBM) are more resistant to oxidation than secondary mercaptans (e.g. iso-propylmercaptan) and secondary mercaptans are more resistant than primary mercaptans. Mixtures of branched and unbranched mercaptans are more easily or more quickly oxidized than pure branched mercaptans. For the odorization of pipeline gas, it is preferable to use sulfides and branched mercaptans. Mercaptans are normally used as mixtures with sulfides. However, examples of pure products used as odorants are THT and sec-butylmercaptan.

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.

Odorized gases leaking from gas lines in the ground may lose odorants by sorption in the soil. Higher boiling odorants such as THT will more likely be adsorbed than lower boiling odorants such as TBM. Mercaptans may be oxidized by soil containing iron oxide to less odoriferous but more strongly sorbed disulfides. Sorption and oxidation of odorants may vary with moisture content and the type of soil. Degradation of odorants by microorganisms may also occur.

1) LPG = liquefied petroleum gas

2) Peak shaving is a load management tool that reduces energy costs by replacing expensive energy used during peak operating hours with inexpensive energy which is produced on-site.

5.3 Physical and chemical data of pure sulfur compounds

Some data of the most widely used sulfur compounds used as odorants pure or in a mixture are listed in Table 2. Specific requirements for commonly used natural gas odorants and the appropriate test methods are specified in ISO 13734.

Table 2 — List of chemical and physical properties of pure sulfur compounds

Sulfur compound	Formula	Molar mass g/mol	Boiling point °C	Freezing point °C	Density (at 20 °C) g/cm ³
Sulfides (thioether)					
Dimethyl sulfide (DMS)	CH ₃ SCH ₃	62,14	37,3	-98,3	0,848 3
Methyl ethyl sulfide (MES)	CH ₃ SC ₂ H ₅	76,16	66,7	-105,9	0,842 2
Diethyl sulfide (DES)	(C ₂ H ₅) ₂ S	90,19	92,1	-103,9	0,836 2
Tetrahydrothiophene (THT)	C ₄ H ₈ S	88,17	121,0	-96,1	0,998 7
Mercaptans (thiol)					
Methylmercaptan (MM) ^a (methanethiol)	CH ₃ SH	48,11	5,9	-123	0,866 5
Ethylmercaptan (EM) ^a (ethanethiol)	C ₂ H ₅ SH	62,14	35,1	-147,8	0,831 5 ^b
<i>n</i> -Propylmercaptan (NPM) (1-propanethiol)	C ₃ H ₇ SH	76,16	67 to 68	-113,3	0,841 1
<i>iso</i> -Propylmercaptan (IPM) (2-propanethiol)	(CH ₃) ₂ CHSH	76,16	52,6	-130,5	0,814 3
<i>n</i> -Butylmercaptan (NBM) (1-butanethiol)	C ₄ H ₉ SH	90,19	98,5	-115,7	0,841 6
<i>sec</i> -Butylmercaptan (SBM) (2-butanethiol)	CH ₃ CH(SH)C ₂ H ₅	90,19	85	-165	0,829 5
<i>iso</i> -Butylmercaptan (IBM) (2-methylpropane-1-thiol)	(CH ₃) ₂ CHCH ₂ SH	90,19	88,5	< -70	0,835 7
<i>tert</i> -Butylmercaptan (TBM) (2-methylpropane-2-thiol)	(CH ₃) ₃ CSH	90,19	64,3	-0,5	0,794 3 ^b
Values taken from the <i>Handbook of Chemistry and Physics</i> , 80th ed., CRC Press, Boca Raton, Florida, USA.					
^a Not used for natural gas odorization, but may naturally occur in natural gas.					
^b Value at 25 °C.					

5.4 General remarks on odorant behaviour

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 point where the liquid odorant is injected into the line, only sealing materials should be used which are compatible with liquid odorants (e.g. fluorocarbon elastomers).

However, 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.

6 Safety precautions

6.1 Handling of odorants

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

All relevant safety precautions should be observed when handling odorants. Employees should be instructed periodically.

Odorants are irritating, harmful and flammable. Therefore the specific material 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 shall, 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 in 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. This procedure should account for the corrosive and reactive nature of these oxidants.
- Larger quantities of spilled or leaked odorants should be sorbed by sorbents (sand, activated charcoal) and disposed of in tightly shut containers.

These sorbents or soil contaminated by odorants should be treated according to prevailing regulations to avoid pollution of underground water.

6.3 Transportation and storage

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

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.

7 Odorization technique

7.1 Centralized or decentralized odorization

The advantages of centralized odorization at a few terminals are that 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. Centralized odorization allows for a uniform odour throughout the gas distribution of a region. Temporary fading in recently converted or new distribution system have to be corrected by temporarily adding supplemental odorization. A disadvantage is that the odorants have to be removed from the gas supplied to large industrial consumers (e.g. glass industry, chemical industry or reforming plants), who may prefer sulfur-free gas. Furthermore, gas for power plants may not need to be odorized (to reduce environmental pollution) because other safety measures may be provided to recognize gas leaks (e.g. gas sensors for these industrial processes).

There may be limited advantage in safety for gas transportation at high pressure for odorized gas, since a leak is a very rare event and would rapidly become obvious by other means than odour.

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 underground storage is not increased by odorization.

A disadvantage of decentralized odorization is that the multiplicity of odorization stations, generally close to populated areas, generates a lot of transportation and handling of odorant whose nuisance and risks should be assessed.

7.2 Odorizer

7.2.1 Injection odorizers

To allow for a constant odorization, the necessary amount of odorant should be 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, maintained at low pressure, directly into the flowing gas. 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. Gas-flow proportional injection from a pressurized storage tank may be achieved by means of mass-flow or volume-flow controllers. 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. It is recommended to install filters 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 metal in contact with liquid odorants should be corrosion resistant. Seals should be made of fluorocarbon elastomers (FPM), polytetrafluoroethylene (PTFE), or similar materials, which are compatible with the selected odorant. To inhibit the possibility of leakage, lines carrying liquid odorant should normally be seamless or welded precision-steel pipes, but for the connection line to the injection point flexible tubing made of PTFE, FPM or similar material reinforced by steel fabric may be used. All pipes carrying liquid odorants should be indelibly signed.

7.2.2 Other odorizers

7.2.2.1 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 ($\sim 10\text{ }^{\circ}\text{C}$) 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 evaporative 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 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 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 will, by reducing the evaporation surface, reduce the odorization rate.

7.2.2.3 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 should be in accordance with all prevailing regulations 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 in accordance with prevailing regulations. To avoid annoyance by odour it may be necessary to install a forced ventilation with purification of the exhaust by a filter with activated charcoal or other technically adequate means.

7.3.3 Installation of injection point

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.

7.5 Addition of odorant

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.

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 has to 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. Therefore the medium odour (olfactory degree 2 on the Sales scale, see Table 1) was chosen as reference odour or alert level.

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 gas odorization may have to comply with local regulations and/or standards that will have prevalence over these guidelines.

8.2 Line conditioning (supplement odorization)

If new pipelines are to be put in operation, it may be suitable to raise the odorization level for several days in a defined district to reach the required minimum odorant concentration more rapidly.

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. The following recommendations are general guidelines.

9.2 Check of odorization equipment and systems

9.2.1 Performance checks

The following performance checks are recommended:

- automatic or manual monitoring and recording of equipment performance data to include, if available, odorant flow and/or odorant concentration, gas volume and alarms;
- reading of the odorant flow and the corresponding volume flow of the gas, if possible, for calculating the odorant concentration and comparing it to the required value;
- testing of the integrity of the equipment;
- testing of the filling level of the storage medium;
- control of odorant concentration in the gas either by random sampling or automatic sampling.

9.2.2 Maintenance procedures for odorization equipment

Formal maintenance procedures should be established in accordance with the manufacturer's recommendations with due consideration to operating conditions, operation requirements and experience.

9.3 Control of odorant concentration in the gas

The control can be performed by determination of the odorant content in the gas or by olfactometric tests (for references see the Bibliography).

To determine the odorant concentration in the distributed gas, quantitative analysing methods should be used. The gas chromatographic methods specified in ISO 19739 using sulfur-specific detectors or chromatographs with high resolution columns should be taken as reference method. Care has to be taken for correct sampling (see ISO 10715) and the use of certified calibration gas mixtures.