# Wastewater treatment plants —

## Part 9: Odour control and ventilation

The European Standard EN 12255-9:2002 has the status of a British Standard

ICS 13.060.30

# National foreword

This British Standard is the official English language version of EN 12255-9:2002.

The UK participation in its preparation was entrusted to Technical Committee B/505, Wastewater engineering, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

**Cross-references**

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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EUROPEAN STANDARD
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# EN 12255-9

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English version

## Wastewater treatment plants - Part 9: Odour control and ventilation

Stations d'épuration - Partie 9: Maîtrise des odeurs et ventilation

Kläranlagen - Teil 9: Geruchsminderung und Belüftung

This European Standard was approved by CEN on 20 December 2001.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 12255-9:2002 E

# Contents

# Foreword

This European Standard has been prepared by Technical Committee CEN/TC 165, "Wastewater engineering", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2002, and conflicting national standards shall be withdrawn at the latest by December 2002.

It is the ninth part prepared by the Working Groups CEN/TC 165/WG 42 and 43 relating to the general requirements and processes for treatment plants for a total number of inhabitants and population equivalents (PT) over 50. The parts of the series are as follows:

— Part 1: General construction principles

— Part 3: Preliminary treatment

— Part 4: Primary settlement

— Part 5: Lagooning processes

— Part 6: Activated sludge processes

— Part 7: Biological fixed-film reactors

— Part 8: Sludge treatment and storage

— Part 9: Odour control and ventilation

— Part 10: Safety principles

— Part 11: General data required

— Part 12: Control and automation

— Part 13: Chemical treatment – Treatment of wastewater by precipitation/flocculation

— Part 14: Disinfection

— Part 15: Measurement of the oxygen transfer in clean water in aeration tanks of activated sludge plants

— Part 16: Physical (mechanical) filtration[1)]

NOTE For requirements on pumping installations at wastewater treatment plants, provided initially as part 2 "Pumping installations for wastewater treatment plants", see EN 752-6 "Drain and sewer systems outside buildings — Part 6: Pumping installations”.

The parts EN 12255-1, EN 12255-3 to EN 12255-8 and EN 12255-10 and EN 12255-11 were implemented together as a European package (Resolution BT 152/1998).

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1) In preparation.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

# 1 Scope

This European Standard specifies design principles and performance requirements for odour control and associated ventilation for wastewater treatment plants.

The primary application is for wastewater treatment plants designed for the treatment of domestic and municipal wastewater for over 50 PT.

Differences in wastewater treatment throughout Europe have led to a variety of systems being developed. This standard gives fundamental information about the systems; this standard has not attempted to specify all available systems.

Detailed information additional to that contained in this standard may be obtained by referring to the Bibliography.

# 2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 752-4, *Drain and sewer systems outside buildings — Part 4: Hydraulic design and environmental considerations.*

EN 1085, *Wastewater treatment — Vocabulary*.

prEN 13725, *Air quality — Determination of the odour concentration by dynamic olfactometry.*

ISO 5492:1997, *Sensory analysis — Vocabulary*.

# 3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1085 and the following apply.

**3.1**
**olfactometry**
measurement of the response of assessors to olfactory stimuli (see ISO 5492). Definition according to prEN 13725

**3.2**
**odour concentration**
the number of European Odour Units in a cubic metre of gas at standard conditions. The odour concentration has the symbol $c_{od}$ and the unit $ou_E/m^3$ (see prEN 13725)

NOTE The value of the odour concentration is the dilution factor that is necessary to reach the detection threshold. At the detection threshold, the odour concentration of the mixture is 1 $ou_E/m^3$ by definition.

EXAMPLE If a sample has to be diluted by a factor of 300 to reach the detection threshold, the odour concentration of the sample is $c_{OD}$ = 300 $ou_E/m^3$.

**3.3**
**odorant flow rate; odour emission rate**
the odorant flow rate $q_{od}$ is the quantity of odorous substances passing through a defined area per unit time. It is the product of the odour concentration $c_{od}$, the outlet velocity $v$ and the outlet area $A$ or the product of the odour concentration $c_{od}$ and the pertinent volume flow rate $\dot{V}$ . Its unit is $ou_E$/h, $ou_E$/min or $ou_E$/s (see prEN 13725)

NOTE Diffuse sources such as unaerated wastewater or sludge surfaces, do not have a defined waste air flow, although they can emit odorants. In these cases, a special sampling procedure is necessary which is discussed in prEN 13725 (see annex A).

Odorant flow rates can be used in an analogous fashion to mass flow rates when modelling the impact from a source. All odour sources will have an odorant flow rate, even where no air flow rate is easily identifiable.

# 4 Design principles

## 4.1 General

Given the nature of wastewater it is not possible to guarantee that a wastewater treatment plant will be totally odour free. A well-designed plant minimises the potential for odour problems.

The potential for odour generation shall be considered at the earliest stages in the design of wastewater treatment works. The likelihood of odour emission, its impact and ease of treatment shall be considered in all aspects of design, especially:

a) Minimise the septicity of the raw wastewater by considering the sewerage system.

b) Process selection – e.g. if septic wastewater is anticipated, possibilities to minimise odour are for example:

— minimise the retention time of the sludge in the primary settlement tank;

— having no primary settlement (thus avoiding a major source of odour) and applying extended aeration;

— select a covered process.

c) By locating the major sources of odour, wherever possible, away from the most sensitive locations surrounding the plant. For planning the direction and speed of winds local to the installation shall be taken into account.

NOTE Situations with light wind or no wind and stable atmospheric conditions are most unfavourable for the dispersion of odours. Thus, if these situations happen very often, then the local wind direction during these situations is relevant instead of the generally prevailing wind direction.

d) By considering the location of unit processes relative to each other it may be possible to use a single abatement process to treat more than one source of odour or to use the odorous air from one process as process or combustion air in an adjacent process. Any decision to treat odorous air will require a process to be covered and ventilated with the vented air ducted to treatment. Covering, venting and treatment shall be designed as an integrated package.

Where treatment plants are not covered or housed in buildings and the effect of odour is difficult to quantify prior to commissioning designs should allow for covering and/or ventilation at a later date.

When tanks or processes are covered careful consideration is required of:

a) explosion risk;

b) corrosion prevention;

c) health and safety of operators;

d) access for maintenance.

## 4.2 Sources and nature of odours

Odour is generated during the conveyance and treatment of wastewater due to the degradation of organic matter by micro-organisms under anaerobic conditions. Industrial wastewater can also contain characteristic odorous constituents. The onset of septicity can be accelerated by elevated temperatures, high BOD concentration and presence of reducing chemicals. The range of odorous constituents is very wide and includes:

— hydrogen sulphide;

— ammonia;

— organic sulphur compounds;

— thiols (e.g. mercaptans);

— amines;

— indole and skatole;

— volatile fatty acids;

— other organic compounds.

The conditions that give rise to odours occur most typically in:

— unfavourable conditions in the sewage systems (e.g. long retention times, poor maintenance, industrial discharges);

— long pressure mains;

— some high rate treatment processes;

— anaerobic lagoons;

— sludge storage and treatment processes.

Odours can be present or form in the sewer system or in the treatment plant. Once formed, odours tend to travel with the flow through the treatment process to be transferred to the atmosphere at points of turbulence or where there is a large air-water interface. Levels of odour can be increased by the recycling of liquors within a treatment process, particularly when recycling those produced by the thickening or dewatering of sludge.

NOTE EN 752-4 gives guidance on minimising septicity in drain and sewer systems.

Particular problems can however be found at:

a) inlet works: strong odours in the incoming flow lead to high levels of release at inlet works;

b) primary settlement tanks: if they receive a highly odorous flow or if excessive sludge is allowed to accumulate in the tank, generating septicity;

c) secondary treatment if it is highly loaded or receives a highly odorous feed;

d) sites for the transfer, storage and treatment of sludges, especially of non-stabilised sludges;

e) leaks or emissions of biogas from anaerobic digestion and the first point of discharge of digested sludge.

## 4.3 Odour measurement

Quantitative measurements of odour shall be carried out when undertaking investigations into the causes of odour, for identifying sites where odour is formed or emitted, for estimating the impact from an odour source and for specifying the duty of odour abatement equipment.

Quantitative measurements of odour include:

a) Measurement based on olfactometry:

— the odorant detection threshold concentration applicable to single compounds;

— the odour concentration applicable to air samples of unknown composition;

— the odour potential and odour emission capacity (see annex A);

— the odorant flow rate (see annex A).

b) Measurements based on specific compounds:

— the measurement of specific odorous compounds can assist in the choice and dimensions of treatment units;

— levels of hydrogen sulphide are easy to measure and provide valuable information. Reliance solely on $H_2S$ measurements can be misleading in cases where odorants other than $H_2S$ are predominant e.g. ammonia and organic sulphides. Often this can be the case:

  — odours come predominantly from a specific industrial discharge;

  — odours come from secondary treatment;

  — odours come from the incineration or drying of sludge;

  — odours follow abatement measures aimed specifically at reducing $H_2S$.

## 4.4 Planning

### 4.4.1 Preliminary considerations

#### 4.4.1.1 General

Discussions should be held with the appropriate authorities to ascertain what standards need to be met by the proposed plant or proposed abatement measures at an existing plant. Most wastewater treatment processes may require odour abatement in particularly sensitive locations.

An atmospheric dispersion model using a historical record of wind-speed and direction and atmospheric stability class can be used to estimate the odour emission rate that will comply with such a standard. This odour emission rate can be used as a target for design or as a specification for the performance of abatement technology.

At existing sites with known odour emission rates, the results from a model of atmospheric dispersion can be compared against the locations of received complaints to estimate a suitable quality standard.

New installations shall be designed where possible to minimise the problem of odour generation.

#### 4.4.1.2 Sewer system

A sewer system designed according to the principles contained in EN 752-4 should minimise the development of septicity.

For more information see Bibliography [19].

#### 4.4.1.3 Wastewater treatment plants

The following points shall be considered during the design:

a) the control of the discharge of particularly odorous industrial wastewater;

b) the location of the plant;

c) the minimising of the exposure of non-stabilised or pseudo-stabilised sludges during storage and treatment;

d) avoiding the development of septicity in settlement tanks by minimising the retention time of the accumulating sludge layer;

e) choosing processes which minimise emissions where a highly odorous feed-stream is unavoidable (see 4.1);

f) minimising turbulence e.g. by minimising the drop over weirs (unless used for stripping);

g) the addition of odorous return flows as close to aerobic secondary treatment processes as possible;

h) choosing compact designs where process covering is unavoidable;

i) locating the major sources of odour as far as possible from the most sensitive receptors in the vicinity;

j) grouping the main odour sources to allow the use of common abatement measures;

k) the use of odorous air from one process as the process or combustion air for another process. In this case air quality shall be considered.

#### 4.4.1.4 Remedial measures

When designing remedial measures to overcome an unacceptable odour impact in the vicinity, thorough investigations should be undertaken to identify how odour is generated, where it is emitted and, if possible, to estimate the odour emission rates of the major sources. Specific compound analysis and the measurement of odour potentials in the liquid streams will show where odours are being formed. Analysis for specific compounds in air samples can help to locate the significant points of odour emission. Preparation of a map of hydrogen sulphide concentrations within and around a treatment works can be very valuable. For techniques for measuring odour emission rates see annex A.

### 4.4.2 Detailed planning

#### 4.4.2.1 Odour abatement

Methods for odour abatement from a number of basic categories include:

a) process design and layout;

b) process operation;

c) industrial wastewater limits and controls;

d) chemical addition to prevent septicity, to ameliorate its effects or otherwise reduce odour;

e) cover odour sources, provide ventilation and treat the collected air;

f) the use of atmospheric sprays to act as a barrier or to add chemical odour counteractants or modifiers.

Methods a), b) and c) are described in 4.4.1.1 and 4.4.1.2.

When using chemicals great care shall be taken to ensure that no detrimental by-product is produced as a consequence.

#### 4.4.2.2 Chemical additives

Chemical additives can be divided into:

a) strong oxidising agents such as hydrogen peroxide and sodium hypochlorite which will oxidise many odorous compounds after they have been formed;

When using sodium hypochlorite the formation of AOX compounds shall be considered.

b) sources of oxygen: air, liquid oxygen and nitrate salts; these act primarily as sources of oxygen to prevent the development of septicity. In a secondary range some treatment of pre-formed odours can occur.

c) metal salts, typically of iron; these are used to fix sulphide as insoluble metal sulphides, preventing any transfer to the atmosphere;

d) a miscellaneous range of odour modifiers reduce odour.

#### 4.4.2.3 Treating odorous air

Methods of treating odorous air that may be considered include:

a) biological oxidation.

b) wet chemical scrubbing;

c) fixed bed adsorption e.g. active carbon adsorption;

d) thermal oxidation;

Most wastewater derived odours can be destroyed by bio-oxidation. This can be carried out in:

1) odour biofilters;

2) bioscrubbers;

3) existing secondary treatment plant. Odorous air can be used as the process air in most secondary wastewater treatment processes of a suitable configuration such as:

— the diffused air activated sludge process;

— the aerated granular fixed bed reactor;

Secondary treatment processes used in this way should be lightly loaded and not themselves generators of significant odour.

### 4.4.3 Criteria for selection

The main criteria for selection of methods of treating odorous air are performance and cost. Performance should be evaluated from trials or by comparison with similar plant operating under similar conditions.

The following restrictions can also be important. Space limitations can restrict the use particularly of odour biofilters, while height limitations can restrict the use of counter-current scrubbers, both chemical and biological. The implications of handling hazardous chemicals for chemical scrubbers shall be considered. Access difficulties can limit the use of solid adsorbers and odour biofilters that require regular replacement. Other considerations include the availability of electricity, water or final effluent and also of a suitable drain for bleed liquors.

When very high performance is required a combination of processes shall be considered, e.g. a combination of chemical and biological processes.

## 4.5 Design requirements

### 4.5.1 General

Because the odour concentration of air does not define its chemical composition, design procedures for odour abatement technology are frequently less rigorous than for related technology used in other fields. Most designs are based on pilot scale trials, modified by experience from full-scale installations. Suppliers of plant should either provide pilot scale plant or sufficient performance details of similar installations already operating.

### 4.5.2 Chemical addition

Chemicals may be added in the sewerage system and wastewater treatment plants to prevent odour generation or to destroy odorous compounds.

Dosing with the following chemicals is possible:

a) oxidising agents e.g.

- air oxygen;
- pure oxygen;
- hydrogen peroxide;
- nitrate;

b) odour binding compounds e.g.

- ferric salts.

Advanced literature in the Bibliography [11].

### 4.5.3 Treatment of odorous air

The required performance of plant to treat odorous air should be specified in terms of the volumetric flow-rate of air to be treated, together with expected inlet parameters and desired outlet parameters. Suitable parameters can be the concentration of hydrogen sulphide and the odour concentration in European Odour Units ($ou_E/m^3$). The desired outlet odour emission rate (the volumetric flow rate multiplied by the odour concentration) can be obtained from a modelling exercise to estimate odour impact. For new installations, the outlet parameters only can be sufficient to design a treatment plant.

If other specific odorous compounds are expected they can be added to the list of parameters in the specification. Care should be taken such that the cost of acceptance tests does not become excessive.

A minimum time between replacement should be specified for dry adsorbers.

### 4.5.4 Design of covers

The following shall be considered when designing covers:

- overpressure or negative pressure under the cover;
- the size and geometry of the process to be covered, particularly the unsupported span required, and the required clearances for mechanical items;

- the loads supported by the covers e.g. snow and wind loads and for man-access. Walkways should be specified where appropriate;
- materials of construction – their suitability to withstand corrosive atmospheres and exposure to sunlight;
- access requirements for routine operation of plant and for mechanical maintenance, repair or replacement.

The volume of air inside the covers should be minimised. The creation of confined spaces that require regular man-entry should also be minimised. A consistent design principle is to enclose an odorous process with covers that fit as closely as possible. As many openings and access hatches should be specified as necessary to allow as much operation and maintenance as possible to be undertaken from outside the covers.

A single large building should not be used as the primary containment for odorous processes. Consideration of the air-quality inside the building increases the requirement to separately cover processes compared to the same processes situated in the open.

#### 4.5.5 Design of ventilation plant

Ventilation should be provided for covered structures to meet a number of requirements. These include:

- the provision of a negative pressure to minimise escape of air from non air-tight covers or from unavoidable openings;
- to maintain a given air-quality inside the covers to prevent the build up of toxic, corrosive or explosive atmospheres;
- to provide and/or collect process air or air displaced by changes in the level of liquid inside the cover.

Ventilation rates should be minimised consistent with the above requirements. This will reduce the costs and increase the efficiency of subsequent treatment. Minimising the enclosed space under covers can allow lower ventilation rates to be used.

Air extracted from lightly contaminated areas may be used in treatment aeration (biofilters, activated sludge process and incineration). In completely covered treatment plants and provided that comprehensive attention is given to health and safety considerations, the air extracted from lightly contaminated areas may be used to ventilate more heavily contaminated areas.

Air containing deleterious or dangerous components should be extracted continuously and as closely as possible to their source.

### 4.6 Process requirements

All schemes, which involve enclosing wastewater treatment plant, shall be evaluated on grounds of health and safety and given an appropriate confined space classification.

Equipment for treating odorous air shall be designed to treat a specified flow rate of air and concentration of relevant determinants, if known, and produce treated air of a suitable quality to reduce impact to an acceptable level.

Equipment shall be provided with points with easy access suitable for measuring flow rate or velocity, pressure and for collecting air samples for analysis.

Processes and equipment shall be subject to an acceptance test, agreed between client and contractor following a suitable period after installation, based on e.g. olfactometry or the measurement of specified compounds.

## 4.7 Maintenance and Operation

A site log should be kept and all visits recorded. This shall include details of all samples collected for test purposes, either by the regulatory authority or the operator, and the results of the analysis of such samples should be recorded.

NOTE Details on construction principles, health and safety and drawings or operating manual requirements can be found in EN 12255-1 [1], EN 12255-10 [2] and EN 12255-11 [3] respectively.

# Annex A
(informative)

# Odour potential and odour emission capacity, measurement of odour emission rate

## A.1 Odour Potential and Odour Emission Capacity

Reference can be made to two methods for determining the possibility of a given liquid producing odorous emissions and quantifying the potential amount. These give valuable hints on the characteristics of different liquids and can help to determine their behaviour in respect of odour emissions during the steps of wastewater and sludge treatment.

The odour potential of a liquid sample has been defined as the odour concentration of air that has been brought to equilibrium with the liquid sample, and would have the same units as odour concentration, $ou_E/m^3$.

The odour emission capacity has been defined as all of the odour contained in a liquid as determined by stripping the liquid to a low level of odour and summing all of the odour units collected in $ou_E/m^3$ ( [11]).

## A.2 Measurement of Odour Emission Rate

Where identifiable flow rates exist such as in stacks, vents or extracted air covered processes, the odour emission rate may be calculated from separate measurements of the flow rate and odour concentration. Where such a separation is not possible indirect methods can be used to assess odour emission rates. These include:

a) Floating hood or Lindvall-box

The odour emission rate from the water surface in a tank can be estimated from the use of a floating hood or Lindvall-box. A fan is used to blow air at a known flow rate into one end of a floating box, which is open at the bottom. The air travels along the surface of the water inside the box, typically at 0,5 m/s to 1 m/s, and is collected from the other end. This air is sampled for the determination of odour concentration by olfactometry. The product of the odour concentration and the flow rate of air is the odour emission rate from the floating hood respectively the Lindvall-box. The emission rate from the tank surface is then estimated from the odour emission rate from the box times the surface area of the tank divided by the area covered by the Lindvall-box.

Advantages: this is a relatively cheap and easy measurement to obtain. The technique can also be used to estimate emissions from contaminated ground or stock-piles of sludge cake.

Disadvantages: the floating box interferes with the flow patterns in the tank. This is known to influence the odour emission. Such estimates have been considered to be equal to the odour emission rate from settlement tanks, whereas it is known the latter tend to be dominated by emissions from the peripheral weir and flow channel.

b) Micrometeorological approach

This requires the measurement of a parameter, in this case odour concentration in a series of air samples taken from increasing distances either vertically above a large area source or downwind of a source. By combining these values with measurements of the local meteorological parameters, wind-speed (at various heights), temperature profiles and energy input from the sun (or grouping these together in the term stability class) it is possible to use a model of dispersion to effectively back calculate from the observed odour concentrations to the required odour emission rate of the source. In Germany (see [10]) this is referred to as the ”plume measurement”, though instead of samples being collected for olfactometry, this requires a test panel to visit the site and make their observations in situ.

Advantages: This will make an estimate of the overall strength of a compound odour source, such as a primary settlement tank. It can make an estimate for processes such as flumes and peripheral weirs which would be almost impossible to make in the field by any other method.

Disadvantages: cost, interference from adjacent sources; levels of odour rapidly fall below the limit of easy measurement, particularly from large area sources.

c) Extrapolation from wind tunnel studies

Once a process is enclosed it becomes easy to make a direct measurement of its odour emission rate. Studies on enclosed processes can measure the odour emission rates under different conditions of wind-speed, liquid flow and investigate the influence of process dimensions and of the odour potential in the process flow. The results can be extrapolated to full-scale processes. Using the relationships found from the wind tunnel studies, good estimates of odour emission rate can be made from the process dimensions, liquid flow rates, wind-speeds and an estimated or, preferably, measured value of the odour potential of the process flow.

Advantages: cost, once the original studies have been made; applicability, odour emission rates can be estimated for a range of process and weather conditions. The benefit of different classes of abatement measures can be evaluated on a common footing, such as reducing the levels of odour in the process flow, altering process parameters or covering and treating collected air.

Disadvantages: Being an indirect measurement, calibration may be felt necessary at each site.

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The following documents contain details which can be used within the framework of this standard.

This list of documents which are published and used by the members of CEN was correct at the time of publication of this European Standard but should not be considered to be exhaustive.

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