SLOVENSKI STANDARD
SIST-TS CEN/TS 16115-2:2017

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Zunanji zrak - Meritve bioaerosolov - 2. del: Načrtovanje in vrednotenje meritev industrijskih izpustov

Ambient air - Measurement of bioaerosols - Part 2: Planning and evaluation of plant-related plume measurements

Außenluft - Messen von Bioaerosolen - Teil 2: Planung und Auswertung von anlagenbezogenen Fahnenmessungen

Qualité de l'air ambiant - Mesurage de bioaérosols - Partie 2 : Planification et évaluation des mesurages dans le panache de fumée des installations industrielles

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European foreword

This document (CEN/TS 16115-2:2016) has been prepared by Technical Committee CEN/TC 264 “Air quality”, the secretariat of which is held by DIN.

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

CEN/TS 16115 consists of several parts dealing with the determination of bioaerosols in ambient air:

— *Part 1: Determination of moulds using filter sampling systems and culture-based analyses;*

— *Part 2: Planning and evaluation of plant-related plume measurements.*

The basic requirements of the determination of bioaerosols are first published as Technical Specifications. The precision and the performance characteristics of bioaerosol measurements should be determined in comparison and validation trials in order to validate the method(s). Based on the validation results the Technical Specifications can be transferred to European Standards. For this purpose it is intended to apply for mandated support by the European Commission and the European Free Trade Association using the Technical Specifications as a basis for validation measurements.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Airborne particles of biological origin are called bioaerosols. Natural and anthropogenic sources for bioaerosols are widely distributed in the environment. Anthropogenic sources can for example be agriculture or waste treatment activities.

The purpose the measurement planning here described is to determine the mean plant- and/or source-related impact range of microbial air pollutants. As it has so far not been possible to set limit values based on dose-response relationships, the mean impact range is to be used as a criterion for assessing the environmental impact of a plant.

The scale of work for the plume measurements here described is necessary to obtain statistically representative data about the impact range of the plant and/or source, taking into account the great variety of influencing factors. Whilst a reduced measurement effort is possible in principle, this will lead to an increased measurement uncertainty.

The objective of measurement planning is to analyse a given measurement problem and derive the associated requirements for organization, the measurement method, the sampling strategy, the evaluation of the measured data, quality assurance and reporting.

The requirements set out in this technical specification are to ensure that plant-related ambient air measurements of microbial air pollution are planned in such a way as to enable a given task to be processed with sufficient accuracy and at justifiable cost. The aim is to ensure that the measured data obtained meet the applicable standards for representativeness and hence, enable maximum possible comparability.

The procedure described in this document is based on VDI 4251 Part 1 [1].

1 Scope

This document describes the general requirements to be taken into account in planning and implementing plant-related plume measurements of microbial air pollutants. A basic principle of this method is to compare the concentrations in air unaffected by the activities of the plant (i.e. background air sampled upwind of the plant) with the concentration of bioaerosols in air downwind of the plant. It is this comparison that allows an assessment of the plant-related contribution and the mean spatial impact range to be made. As it has so far not been possible to set limit values based on dose-response relationships, the mean impact range is to be used as a first criterion for assessing the environmental impact of a plant.

The scale of work for the plume measurements described is necessary to obtain statistically representative data about the impact range of the plant and/or source, taking into account the great variety of influencing factors.

Plant-related measurements of bioaerosol concentrations in ambient air may be required in a number of regulatory situations. Examples of typical measurement objectives and indicative application scenarios are presented in the document. This method specifies the simultaneous measurement of background and downwind air quality to reduce the risk of invalid comparisons resulting from changing background air concentrations. Another important principle of this method is the requirement for repeated measures to take into account day to day and seasonal variations in the processes governing bioaerosol emissions and dispersion.

The objective is to analyse a given measurement problem and derive the associated requirements for organization, the measurement method, the sampling strategy, the evaluation of the measured data, quality assurance and reporting.

2 Normative references

The following referenced documents are indispensable for the application 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.

CEN/TS 16115-1, *Ambient air quality - Measurement of bioaerosols - Part 1: Determination of moulds using filter sampling systems and culture-based analyses*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)*

EN 13098:2000, *Workplace atmosphere - Guidelines for measurement of airborne micro-organisms and endotoxin*

3 Terms and definitions

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

3.1
additional impact
contribution of the plant under study to the ambient air pollution at a receptor point

3.2
area source
emitting area of a relevant size, normally horizontally orientated; area sources are distinguished into sources *with* a defined volumetric flow rate (e.g. biofilter, aerated composting windrow) and sources *without* defined volumetric flow rate (e.g. landfills, agricultural land)

3.3
bioaerosol
airborne particles of biological origin

[SOURCE: EN 13098, 3.3, modified]

Note to entry 1: The term bioaerosols as used in this standard designates all airborne accumulations of particles carrying, containing or forming fungi (spores, conidia, hyphal fragments), bacteria, viruses and/or pollen as well as their cell wall components and associated metabolites (e.g. endotoxins, mycotoxins) ([5]; [6]).

3.4
concentration
as defined in this standard denotes the number of microorganisms in concentration of bioaerosol expressed in the according units e.g. in colony forming units (CFU) per unit volume or Endotoxin units (EU) per volume

3.5
emission
microbial air pollution emanating from the plant under review; the emission is determined at the point of transition of the bioaerosols from the emission source to the atmosphere; the result of an emission measurement is the bioaerosol flow calculated as the product of the concentration and the volumetric flow rate; emission concentrations of bioaerosols are indicated in CFU/m³, emission mass flows in CFU/h, for instance; the bioaerosol flow is also used as a basis for estimating the geometric centroid of a source or source system of a plant or for impact forecasts

3.6
extended source
emission source of a spatial structure consisting of a number of individual sources (e.g. Figure 2)

3.7
impact range
distance at which a plant impact can still be detected

Note to entry 1: The plant- or source-related measurement parameter-specific mean impact range described here designates the distance from the source at which the ambient air concentration of a measurement parameter has declined to the level of the upwind concentration. The “mean impact range” is determined with the aid of an exponential depletion curve as described in Annex B.

3.8
indicator organism
microorganisms that are characteristic of the emission of a plant and can be detected by currently available sampling and analysis methods. Indicator organisms that are characteristic of a defined source (process) may also be present – usually in small concentrations – in the ambient air outside the zone of influence of this source; this is due to the ubiquitous nature of many microorganisms

3.9
measurement parameter
constituent of the ambient air for which a defined measured quantity is to be determined; in the present case, the microbial air pollutant of interest, e.g. bacteria, moulds

3.10
measurement strategy
methodology applied for the spatial and temporal sampling of air pollutants in order to obtain valid (representative) random samples in terms of the task at hand; the measurement strategy mainly comprises the definition of the measurement area, sampling locations, measurement parameters, time of measurement and the sampling frequency and duration; secondary factors influencing the selection of the measurement strategy include, for instance, the meteorological conditions, sampling equipment, resource intensity for the necessary analyses and evaluation; moreover, tertiary influencing factors such as unfavourable conditions during frost events may have to be considered

3.11
mesophilic[1)]
property of microorganisms which depend on a temperature of between 20 °C and 45 °C for optimum growth and reproduction

3.12
microbial air pollutant
concentration of airborne microorganism which are not naturally present in the respective species distribution and/or respective quantities in the ambient air at the given location and time

3.13
microorganism
any microbiological entity, cellular or non-cellular, capable of replication or of transferring genetic material, or entities that have lost these properties

[SOURCE: EN 13098, 3.16, modified]

3.14
moulds
filamentous fungi of the taxonomic classes *zygomycetes*, *ascomycetes* and *deuteromycetes* (fungi imperfecti) producing a mycelium and spores so that they become macroscopically visible as a (frequently coloured) mould layer

Note to entry 1: Taxonomically, moulds do not represent a uniform class.

Note to entry 2: The various groups of filamentous fungi form conidia (deuteromycetes) or sporangiospores (zygomycetes) and, more rarely, ascospores (ascomycetes). In practice, all these reproductive stages are subsumed under the term “spores”.

3.15
point source
emission source occupying a small “point-shaped” area and having a concentrated output. Point sources are classified into sources *with* a defined volumetric flow rate (e.g. exhaust air stack) and sources *without* defined volumetric flow rate (e.g. building openings)

[1)] The psychrophilic, mesophilic and thermophilic temperature regions do not have clear cut-off points and are differently defined in the literature.

3.16
psychrophilic[2)]
property of microorganisms which depend on a maximum temperature of around 20 °C for optimum growth and reproduction

3.17
sampling location
local point within a defined measurement area at which sampling is performed

3.18
sensitive receptors
humans, animals and plants, soil, water, cultural and other assets as well as the atmosphere itself that may be exposed to harmful environmental impacts caused by air pollution

3.19
tenacity
resistance to chemical and physical environmental influences (temperature, chemicals, radiation, open air factors, etc.)

3.20
thermophilic[3)]
property of microorganisms which depend on a temperature of above 45 °C to about 80 °C for optimum growth and reproduction

Note to entry 1: Temperature optimum for hyperthermophilic species: above 80 °C; for extremely thermophilic species: 70 °C to 80 °C; for strictly thermophilic species: above 60 °C, for thermotolerant species: below 45 °C (growth above 45 °C possible).

3.21
upwind concentration
by convention, the upwind concentration (Luv) in terms of this standard is determined by a concentration measurement at a sufficient distance upwind of the plant performed simultaneously with the downwind (Lee) ambient air measurements; any direct influences of other plants on the measured upwind concentration shall be minimized

3.22
downwind concentration
by convention, the downwind concentration in terms of this standard is determined by concentration measurements at distances downwind of the plant performed simultaneously with the upwind ambient air measurements

4 Key principles of sampling and assessment

A variety of industrial (e.g. waste management) and agricultural (e.g. animal production) activities are known to generate bioaerosols and release them into ambient air (Annex A). This document describes a method for determining the contribution made by such activities to the concentration of bioaerosols in ambient air.

[2)] The psychrophilic, mesophilic and thermophilic temperature regions do not have clear cut-off points and are differently defined in the literature.

[3)] The psychrophilic, mesophilic and thermophilic temperature regions do not have clear cut-off points and are differently defined in the literature.

Bioaerosols are ubiquitous in ambient air. They are generated naturally (e.g. as a result of the air-borne dissemination of fungal spores) and anthropogenically. A basic principle of this method is to compare the concentration of bioaerosols in air unaffected by the activities of the plant (i.e. background air sampled upwind of the plant) with the concentration of bioaerosols in air downwind of the bioaerosol emission source of interest (the plant). It is this comparison that allows an assessment of the plant-related contribution to be made.

Concentrations of bioaerosols in upwind and downwind air of an emission source are both subject to *temporal variation* (see Clause 12). The rate of bioaerosol emissions from natural and anthropogenic sources may vary diurnally or seasonally depending upon the source and the controlling factors involved. Further temporal variation in air quality may be influenced by the prevailing meteorological conditions which can influence the dispersion characteristics and viability/culturability of bioaerosols. This method specifies the simultaneous measurement of upwind concentration and downwind air quality to reduce the risk of invalid comparisons resulting from changing upwind concentration air concentrations. Another important principle of this method is the requirement for repeated measures to take into account day to day and seasonal variations in the processes governing bioaerosol emissions and dispersion. In essence, the validity of the assessment of the plant-related contribution is enhanced as the number of measurement days increases.

Spatial variation (see Clause 11) in the concentrations of bioaerosols in air is potentially a significant factor influencing our ability to determine the impact of the bioaerosol emission source of interest (the plant) on ambient air quality. Localized differences in air quality are driven by a number of factors including: the spatial arrangement of sources of bioaerosol emissions; changes in wind direction and meteorological conditions affecting dispersion; topographical features affecting dispersion; and environmental factors influencing microbiological die-off processes[4] [2]. The method described in this document seeks to characterize and account for spatial variability in several ways. In simple terms, the bioaerosol concentration is normally expected to decline with distance downwind from source (as a result of dispersion, deposition and die-off processes), ultimately returning to a value approximating the upwind value. This pattern can be characterized by sampling upwind and at a number of different distances downwind of the emission source. A simple linear traverse may serve this purpose but may not be able to account for localized variability at the time of sampling induced by changes in wind direction and multiple emission sources. A fan-like arrangement of sampling points is more likely to capture such spatial and temporal variability.

5 Measurement objective and applications

5.1 General

The prime objective of measuring plant-related microbial ambient air pollution is to identify the ambient air microbial concentration contributed by the plant. More specific objectives are to be formulated depending on the application.

5.2 Indicative applications

Possible indicative applications of plant-related plume measurement are:

a) Licensing application procedure

[4] Die-off processes are mainly determined by the tenacity of the microorganism. Main factors influencing the tenacity of airborne microorganisms can include the type of carrier particles, relative humidity, temperature, open air factors such as UV radiation and micro-biocidal atmospheric trace gases.

An assessment of the bioaerosol concentration at a neighbouring environment, e.g. population areas or other sensitive receptors may be needed as part of the licensing procedure, e.g. for new constructions or for an extension to or major modifications of an existing plant.

Concentration levels measured at selected sites (e.g. sensitive receptor locations) may be used for a comparison with the results of emission impact forecasts[5)]). To this end, it is imperative that the measurement strategy be selected such as to cover the temporal, spatial and meteorological reference frame of the associated emission impact forecast.

b) Verifying compliance with licensing requirements within the scope of plant monitoring

When monitoring bioaerosol emissions and/or ambient air bioaerosol concentrations with regard to licence compliance of the operations under review, the data to be determined derive from the collateral licensing requirements. Details of measurement planning such as measurement area, number of sampling locations, number of measurements, measurement parameters and plant operating conditions should be coordinated with the licensing authority.

c) Verifying the effectiveness of emission control measures or monitoring operational changes

Remediation measures or major changes in a plant's operations may have a significant influence on the emissions of a plant. In addition to measuring the emissions from area or point sources, ambient air measurements should be considered especially in cases where the (reduced) additional environmental impact is to be documented.

d) Complaints

In the case of complaints, any additional impacts upon the neighbouring environment, e.g. general population or other sensitive receptors (e.g. food processing facility, hospital) are to be determined. The choice of measurement parameters is governed by the type of sensitive receptor, e.g. if the sensitive receptor is the neighbouring population, health relevant measurement parameters should be included (see Table A.1).

6 Relevant plants

Bioaerosol emissions may originate from all plants in which materials containing microorganisms or their components are handled. Their dispersal is primarily influenced by the meteorological conditions and the tenacity of the species involved. The most comprehensive experience with bioaerosol emissions available so far relates to biological waste treatment plants. Relevant plant types in different industrial sectors are listed below:

a) Waste management and disposal

1) Composting and anaerobic digestion plants

2) Materials recovery and reprocessing plants (recyclable wastes)

3) Waste transfer stations

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5) Dispersion models are available for modelling the dispersal of air pollution, e.g. for particles and odours. See for example in Germany www.austal2000.de and VDI 4251-3 and for the Netherlands the New National Model; (http://www.infomil.nl/onderwerpen/klimaat-lucht/luchtkwaliteit/regelgeving/wet-milieubeheer/beoordelen/koppeling/nieuw-nationaal/)