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Ambient air - Biomonitoring with Higher Plants - Method of the standardized tobacco exposure

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

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English Version

Ambient air - Biomonitoring with Higher Plants - Method of the standardized tobacco exposure

Air ambiant - Biosurveillance à l'aide de plantes supérieures - Méthode de l'exposition normalisée du tabac

Außenluft - Biomonitoring mit Höheren Pflanzen - Verfahren der standardisierten Tabak-Exposition

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Ref. No. EN 16789:2016 E

Contents

Page

European foreword

This document (EN 16789:2016) has been prepared by Technical Committee CEN/TC 264 “Air quality”, 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of an identical text or by endorsement, at the latest by February 2017, and conflicting national standards shall be withdrawn at the latest by February 2017.

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.

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Introduction

0.1 General

The impact of air pollution is of growing concern worldwide. Local and regional assessment is necessary as a first step to collect the fundamental information, which can be used to avoid, prevent or minimize harmful effects on human health and the environment as a whole. Biomonitoring can serve as a tool for this purpose. As the effects on indicator organisms are a time-integrated result of complex influences, combining the influences of both air quality and local climatic conditions, this holistic biological approach is considered particularly relevant to human and environmental health end points and thus is of value in air quality management.

It is important to emphasize that biomonitoring data differ from those obtained through physico-chemical measurements (ambient concentrations and deposition) and computer modelling (emissions and dispersion data). Biomonitoring provides evidence of the effects that airborne pollutants have on organisms. As such it reveals biologically relevant, field-based, time- and space-integrated indications of environmental health as a whole. Legislation states that there should be no harmful environmental effects from air pollution. This requirement can be met only by investigating the effects at the biological level. The application of biomonitoring in air quality and environmental management requires rigorous standards and a recognized regime so that it can be evaluated as robustly as physico-chemical measurements and modelling in pollution management.

Biomonitoring is the way through which environmental changes have historically been detected. Various standard works on biomonitoring provide an overview of the state of the science at the time, e.g. [1; 2; 3]. The first investigations of passive biomonitoring are documented in the middle of the 19th century: by monitoring the development of epiphytic lichens it was discovered that the lichens were damaged during the polluted period in winter and recovered and showed strong growth in summer [4]. These observations identified lichens as important bioindicators. Later investigations also dealt with bioaccumulators. An active biomonitoring procedure with bush beans was first initiated in 1899 [5].

0.2 Biomonitoring and EU legislation

Biomonitoring methods in terrestrial environments address a variety of requirements and objectives within EU environmental policy, primarily in the fields of air quality (Directive 2008/50/EC on ambient air quality and cleaner air for Europe [6]), integrated pollution prevention and control (Directive 2010/75/EU on industrial emissions IED [7]) and conservation (Habitats Directive). It is also relevant to the topics food chain [8] and animal feed [9; 10; 11].

For air quality in Europe, legislators require adequate monitoring of air quality, including pollution deposition as well as avoidance, prevention or reduction of harmful effects. Biomonitoring methods are relevant for both short-term and long-term air quality assessment.

Directive 2004/107/EC of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air [12] states that “the use of bio indicators may be considered where regional patterns of the impact on ecosystems are to be assessed”.

With respect to IED for industrial installations, the permit procedure includes two particular environmental conditions for setting adequate emission limit values. The asserted concepts of “effects” and “sensitivity of the local environment” open up opportunities for application of biomonitoring methods in relation to the general impact on air quality and the deposition of installation-specific pollutants. The basic properties of biomonitoring methods can be used advantageously for applications such as reference inventories prior to the start of a new installation, mapping of the potential pollution reception areas and (long-term) monitoring of the impact caused by industrial activity. The environmental inspection of installations demands examination against a range of environmental effects. For the competent authority, biomonitoring data contribute to the decision-making process, e.g. concerning the question of tolerance of impacts at the local scale.

The Habitats Directive (92/43/EEC on the conservation of natural habitats and of wild fauna and flora [13]) requires competent authorities to assess or adapt planning permission and other activities affecting a site designated at the European level where the integrity of the site could be adversely affected. The Directive also provides for the control of potentially damaging operations, whereby consent may only be granted once it has been shown through appropriate assessment that the proposed operation will not adversely affect the integrity of the site. The responsibility lies with the applicant to demonstrate that there is no adverse effect on such a conservation area. For this purpose, biomonitoring is well suited as a non-intrusive form of environmental assessment.

In 2003, as an important element within its integrated environmental policy, the European Commission adopted a European Environment and Health Strategy [14] with the overall aim of reducing diseases caused by environmental factors in Europe. Chapter 5 of this document states that the “community approach entails the collection and linking of data on environmental pollutants in all the different environmental compartments (including the cycle of pollutants) and in the whole ecosystem (bioindicators) to health data (epidemiological, toxicological, morbidity)”. The European Environment and Health Action Plan 2004-2010 [15] which followed the adoption of this strategy focuses on human biomonitoring, but emphasizes the need to “develop integrated monitoring of the environment, including food, to allow the determination of relevant human exposure“.

0.3 Development of the standardized tobacco exposure

Ozone is a phytotoxic gas, which is a secondary pollutant formed in the atmosphere. It can lead to growth losses in plants and therefore to reduced yields in agriculture [16; 17; 18; 19; 20; 21; 22; 23]. Ground-level ozone also contributes to the development of forest decline [24; 25; 26; 27]. Effects of ozone on wild plants are the subject of numerous investigations [e.g. 28; 29; 30; 31; 32; 33; 34; 35; 36].

Ozone does not accumulate in plant organs, but can cause visible leaf injury (necrosis). For that reason, the leaf injury of sensitive plants can be used for assessing the effects of ozone [37; 38; 39; 40; 41; 42; 43; 44].

The origins of tobacco cultivars for biomonitoring are described in detail by [45]. They arose as a result of research initiated in 1957 to identify the cause of “weather fleck” in the USA – a mysterious disease which followed periods of hot sunny weather and devastated tobacco crops due to the appearance of extensive foliar lesions. Subsequently it was identified that ground-level ozone was the cause. During the course of a programme of breeding resistance into tobacco a supersensitive individual was identified from which the response indicator cultivar Bel-W3 was developed. In a similar manner the less sensitive Bel-C and tolerant Bel-B were developed. In Europe studies with Bel-W3 commenced in the late 1960s to early 1970s in the UK, Federal Republic of Germany, Belgium and the Netherlands [46; 47; 48; 49; 50].

The extent of the ozone-caused injury to the response indicator plant depends on the ozone dose absorbed. This is partly associated with the ozone concentration measured in the ambient air. High ozone concentrations are usually associated with high temperatures and low relative air humidity which can induce stomatal closure thereby decreasing the absorbed ozone dose. Moreover, high wind speed also decreases the concentration gradient between the ambient air and leaf surface thereby increasing ozone uptake. The tobacco exposure provides a direct measure of the impact of ozone on plants.

Significant relationships between the variables of ozone concentration or dose and ozone-induced leaf injury (=bioindicator response) in some species (e.g. wild and cultivated tomato species) have been reported by [51] and [52]. Ozone-induced injury on the extremely sensitive tobacco cultivar Bel-W3, however, cannot directly be translated into impact on native vegetation or crops. Nevertheless, leaf injury in tobacco Bel-W3 can be used as an indicator of the potential vegetation injury, i.e. the maximum vegetation injury to be expected under given pollution and climate conditions [53].

Since 2000, many investigations have employed widespread biomonitoring with Bel-W3 [54; 55; 56; 57; 58; 59; 60]. The largest international survey in Europe was conducted under the auspices of the EuroBionet-programme involving 12 cities in eight countries [61].

1 Scope

This European Standard applies to the determination of the impact of ground-level ozone on a bioindicator plant species (tobacco *Nicotiana tabacum* cultivars Bel-W3, Bel-B and Bel-C) in a given environment.

The present document specifies the procedure for setting-up and use of a system designed to expose these plants to ambient air. It also describes the procedure for leaf injury assessment.

Leaf injury caused by ozone appears in the form of necrosis or accelerated aging (senescence) on the leaves of the bioindicator. The macroscopically detectable leaf injury is used as the effect measure (see pictures in Annex A). The measure is the percentage of dead leaf area on the entire leaf surface.

The results of the standardized tobacco exposure indicate ozone-caused injury of the exposed bioindicators and thus enable a spatial and temporal distribution of the impact of ozone on plants to be determined.

This Standard applies to the outside atmosphere in all environments. This standard does not apply to the assessment of air quality inside buildings.

The method described in this European Standard does not replace modelling or physico-chemical methods of direct measurement of air pollutants, it complements them by demonstrating the biological effect.

koniec náhľadu – text ďalej pokračuje v platenej verzii STN