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Karakterizacija odpadkov - Navodilo za uporabo ekotoksikoloških preskusov za odpadke

Characterization of waste - Guidance on the use of ecotoxicity tests applied to waste

Charakterisierung von Abfällen - Anleitung zur Beurteilung von Biotests zur ökotoxikologischen Charakterisierung von Abfällen

Caractérisation des déchets - Lignes directrices pour l'utilisation des essais d'écotoxicité appliqués aux déchets

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Characterization of waste - Guidance on the use of ecotoxicity tests applied to waste

Caractérisation des déchets - Lignes directrices pour l'utilisation des essais d'écotoxicité appliqués aux déchets

Charakterisierung von Abfällen - Anleitung zur Anwendung von Ökotoxizitätsprüfungen auf Abfälle

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Foreword

This document (CEN/TR 16110:2010) has been prepared by Technical Committee CEN/TC 292 “Characterization of waste”, the secretariat of which is held by NEN.

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Introduction

Ecotoxicity can be estimated using two approaches: a chemical-specific approach and a toxicity-based approach. In the first situation, chemical analyses are compared to quality criteria or threshold values to estimate toxicity. In the second case, toxicity is measured directly using toxicity tests. These two approaches complement each other. However, determination of pollutants in complex mixtures of unknown composition (a characteristic of many wastes) does not allow a relevant estimation of toxicity. For such samples, the toxicity-based approach is usually recognised to be the best approach to assess toxicity. Ecotoxicity tests integrate the effects of all contaminants including additive, synergistic and antagonistic effects. They are sensitive to the bioavailable fraction of the contaminants only and integrate the effects of all contaminants, including those, not considered or detected by chemical analyses.

Ecotoxicity tests may be applied to wastes to identify their potential hazardous intrinsic properties with respect to the environment for basic characterization or to assess the risk related to a site-specific exposure scenario.

The majority of existing ecotoxicity tests being internationally harmonized were developed to describe the ecotoxic potential of a test substance when added to water or to soil/soil material, of waste water or of eluates. These methods can be applied with some modifications for the ecotoxicological characterization of wastes. In this situation, users of these methods should be aware that the validation of the methods is not complete. Several studies as well as an International ring test have been conducted to validate some test methods for waste samples and the results have been used as background information.

1 Scope

Ecotoxicity tests can be applied to wastes to identify their potential hazardous properties with respect to the environment or to assess the risk related to a site-specific exposure scenario. This document provides guidance for the selection and use of ecotoxicity tests for both applications.

This document focuses on the following selected field of applications:

a) Basic ecotoxicological characterization;

b) Site-specific exposure scenario;

c) Landfill management:

   1) monitoring of leachates;

   2) mineral waste going to non-controlled landfill sites.

d) Re-use of waste:

   1) use of sludge in agriculture;

   2) use of mineral waste in road construction.

The user should be aware that other fields of application can also be covered by ecotoxicological testing not being in the scope of the document. The ecotoxicological assessment of waste within other scenarios might need the development of other test strategies.

Depending on the waste type and the assessment goal, relevant criteria are described for the selection of a test strategy and the suitable ecotoxicity test(s).

This document also provides guidance for individual ecotoxicity test protocols to meet the specific demands of waste testing (e.g. limitations, test design, confounding factors).The tests recommended represent a minimum test battery that may be accomplished by additional tests or even be replaced by others according to the waste, the intended use or protection goal envisaged.

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.

EN 12457-1:2002, *Characterisation of waste — Leaching — Compliance test for leaching of granular waste materials and sludges — Part 1:One stage batch test at a liquid to solid ratio of 2 l/kg for materials with high solid content and with particle size below 4 mm (without or with size reduction)*

EN 12457-2:2002, *Characterisation of waste — Leaching — Compliance test for leaching of granular waste materials and sludges — Part 2: One stage batch test at a liquid to solid ratio of 10 l/kg for materials with particle size below 4 mm (without or with size reduction)*

EN 12457-4:2002, *Characterisation of waste — Leaching — Compliance test for leaching of granular waste materials and sludges — Part 4: One stage batch test at a liquid to solid ratio of 10 l/kg for materials with particle size below 10 mm (without or with size reduction)*

EN 12920:2006, *Characterization of waste — Methodology for the Determination of the Leaching Behaviour of Waste under Specified Conditions*

CEN/TR 13097:2010, *Characterization of sludges — Good practice for sludge utilisation in agriculture*

CEN/TS 14405:2004, *Characterization of waste — Leaching behaviour test — Up-flow percolation test (under specified conditions)*

CEN/TS 14429:2005, *Characterization of waste — Leaching behaviour tests — Influence of pH on leaching with initial acid/base addition*

EN 14735:2005, *Characterization of waste — Preparation of waste samples for ecotoxicity tests*

EN 14899:2005, *Characterization of waste — Sampling of waste materials — Framework for the preparation and application of a Sampling Plan*

CEN/TR 15584:2007, *Characterisation of sludges — Guide to risk assessment especially in relation to use and disposal of sludges*

EN ISO 6341:1996, *Water quality — Determination of the inhibition of the mobility of* Daphnia magna Straus *(*Cladocera, Crustacea*) — Acute toxicity test (ISO 6341:1996)*

EN ISO 8692:2004, *Water quality — Freshwater algal growth inhibition test with unicellular green algae (ISO 8692:2004)*

EN ISO 11348-1:2008, *Water quality — Determination of the inhibitory effect of water samples on the light emission of* Vibrio fischeri *(Luminescent bacteria test) — Part 1: Method using freshly prepared bacteria (ISO 11348-1:2007)*

EN ISO 11348-2:2008, *Water quality — Determination of the inhibitory effect of water samples on the light emission of* Vibrio fischeri *(Luminescent bacteria test) — Part 2: Method using liquid-dried bacteria (ISO 11348-2:2007)*

EN ISO 11348-3:2008, *Water quality — Determination of the inhibitory effect of water samples on the light emission of* Vibrio fischeri *(Luminescent bacteria test) — Part 3: Method using freeze-dried bacteria (ISO 11348-3:2007)*

EN ISO 20079:2006, *Water quality — Determination of the toxic effect of water constituents and waste water on duckweed (*Lemna minor*) — Duckweed growth inhibition test (ISO 20079:2005)*

EN ISO/TS 21268-2:2007, *Soil quality — Leaching procedures for subsequent chemical and ecotoxicological testing of soil and soil materials — Part 2: Bach test using a liquid to solid ratio of 10 L/kg dry matter (ISO/TS 21268-2:2007)*

EN ISO/TS 21268-3:2007, *Soil quality — Leaching procedures for subsequent chemical and ecotoxicological testing of soil and soil materials — Part 3: Up-flow percolation test (ISO/TS 21268-3:2007)*

EN ISO/TS 21268-4:2007, *Soil quality — Leaching procedures for subsequent chemical and ecotoxicological testing of soil and soil materials — Part 4: Influence of pH on leaching with initial acid/base addition (ISO/TS 21268-4:2007)*

ISO 10706:2000, *Water quality — Determination of long term toxicity of substances to* Daphnia magna Straus *(*Cladocera, Crustacea*)*

ISO 11268-2;1998, *Soil quality — Effects of pollutants on earthworms (*Eisenia fetida*) — Part 2: Determination of effects on reproduction*

ISO 11269-2:2005, *Soil quality — Determination of the effects of pollutants on soil flora — Part 2: Effects of chemicals on the emergence and growth of higher plants*

ISO 14238:1997, *Soil quality — Biological methods — Determination of nitrogen mineralization and nitrification in soils and the influence of chemicals on these processes*

ISO 16387:2004, *Soil quality — Effects of pollutants on* Enchytraeidae *(*Enchytraeus sp.*) — Determination of effects on reproduction and survival*

ISO 17616:2008, *Soil quality — Guidance on the choice and evaluation of bioassays for ecotoxicological characterization of soils and soil materials*

ISO 18772:2008, *Soil quality — Guidance on leaching procedures for subsequent chemical and ecotoxicological testing of soils and soil materials*

ISO 20665:2008, *Water quality — Determination of chronic toxicity to* Ceriodaphnia dubia

3 Terms and definitions

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

3.1
ecotoxicological properties
potential adverse effects to ecological systems which a waste has an inherent capacity to cause

3.2
eluate
aqueous solution recovered from a leaching test

3.3
waste
any substance or object in the categories set out in Annex I which the holder discards or intends or is required to discard

[Directive 2006/12/EC]

3.4
leachant
liquid used in a leaching test. For the purpose of this Technical report the leachant is water

3.5
leaching test
test during which a waste is put into contact with a leachant and some constituents of the material are extracted

3.6
leachate
any liquid percolating through the deposited waste and emitted from or contained within a landfill

3.7
inert waste
waste that does not undergo any significant physical, chemical or biological transformations

NOTE Inert waste does not dissolve, burn or otherwise physically or chemically react, biodegrade, or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface and/or groundwater. [adapted from Directive 1993/31/EC]

4 General information provided by the content of the guidance document

This document gives guidance for the selection of a suitable test design e.g. determination of concentration/effect relationship, single concentration test (limit test). Additionally leaching tests are suggested for each field of application and, for some ecotoxicity tests, information about confounding factors or interactions with the test material is given.

Where test strategy and selection of test methods for basic characterization is favoured by standardization and harmonization, a site-specific scenario might require a more tailor-made approach. Comparisons with other locations and situations become less important, which open the way for the use of less known organisms, specific exposure scenarios or non-standardized methods. Other criteria as sensitivity, practicability and cost efficiency however still holds.

For some site-specific scenarios, choices regarding test strategy and test methods might strongly depend on available information. For example, the outcome of the assessment before treatment should be taken into account in the re-assessment of treated waste. In other situations emphasis should be paid to expected changes in the waste material after application. For example, in the reuse of sludge as well as for the reuse of mineral waste, changes in physico-chemical composition after application can be expected which influence availability of toxicants and as a consequence possible ecological effects. The overall strategy should cover these aspects.

In most other cases of site-specific characterization of waste material the principles for the definition of test strategy and selection of test methods do not differ strongly from those proposed for the site-specific assessment of contaminated soils in general. For guidance on these aspects, reference is therefore made to general textbooks, reviews and guidelines (e.g. ISO 17616, ISO 18772).

5 Sampling, transport, storage and sample preparation

Before waste is assessed by any of the methods proposed, samples need to be collected from the site of waste origin and, depending on the potential reuse scenario, from the site of future reapplication. Sampling of waste should be carried out by trained operators with sufficient knowledge of sampling, handling of samples and safety measures at waste treatment plants, industrial sites or contaminated locations. The sampling strategy and handling should be determined according to the waste or site to be investigated, the kind of contamination and the aim of the biological tests.

Instructions on the design of sampling plan, transport, storage and sample preparation are given in the documents EN 14899, CEN/TR 15310-1 to -5 and EN 14735.

Addition of preservatives (e.g. acids, basic solutions, biocides) in order to retard chemical and biological activity is prohibited.

6 Leaching procedures for ecotoxicological testing

6.1 Overview of methods

6.1.1 General

For the selected fields of application, a key aspect regards the assessment of ecotoxic effects on organisms exposed via the water phase. Indeed, the release of soluble constituents upon contact with water can be regarded as a main mechanism of release which results in a potential risk to the environment during the reuse or disposal of waste materials.

In order to generate a water extract from a solid material, several methods have been developed and a wide variety of test protocols is available in literature. The following sub-clause does not intend to describe all types

of extraction methods but gives some relevant information on the selection of the appropriate method according to the aim of the study.

The leaching of contaminants from waste is controlled by several parameters and external factors. These factors include the physical/chemical nature of the waste especially in terms of pH, reducing properties and degradable organic matter content, the nature of the leachant, the contact time of the leachant with the waste, the particle size and the liquid to solid ratio (L/S). The outcome of which also influences the ecotoxicological response of the waste leachate (see Van der Sloot & van Zomeren, 2009; Postma et al, 2009).

European Standards have been developed to investigate mainly inorganic constituents from waste. They do not take into account the particular characteristics of non-polar organic constituents nor the consequences of microbiological processes in organic degradable wastes, and need to be adapted in some cases (e.g. table 3). Some information is provided in EN ISO/TS 21268-3 and EN ISO/TS 21268-4 to address organic contaminants.

Leaching tests, performed to characterise waste materials according to the Landfill Directive, can be divided into three categories: basic characterisation, compliance tests and on-site verification tests.

6.1.2 Basic characterization

Leaching tests belonging to this category are used to obtain information on the short and long term leaching behaviour and characteristic properties of waste materials. They allow characterizing the source term in accordance with a given scenario which can either be generic or site specific. Liquid/solid (L/S) ratios, leachant composition, factors controlling leachability such as pH, redox potential, complexing capacity and physical parameters are addressed in these tests. They can be subdivided as follows:

— **Parametric tests.** These tests are intended for measuring an intrinsic property of a material or the effects (correlated) of specific parameters on release on the basis of a contaminated material in a defined scenario. CEN/TS 14429 is a typical parametric test;

— Temperature, pH-value, liquid/solid ratio, redox potential, chemical properties or leaching agent flow rate are examples of specific parameters which influence the behaviour towards leaching;

— **Multiparametric tests.** These tests are intended to measure the combined effect of different parameters on release from a contaminated material in a relevant scenario. For a typical multiparametric leaching test (see CEN/TS 14405).

NOTE A methodology for the determination of the leaching behaviour of waste has been developed within TC 292 and formulated in EN 12920.

6.1.3 Compliance tests

Tests belonging to this category are used to determine whether the waste complies with specific reference values. They also allow intercomparison and classification of different types of wastes. These tests focus on key variables and leaching behaviour identified by basic characterization tests. In contrast to characterization tests, this type of tests is relatively simple and quick. It is not designed to provide information on leaching mechanisms and controlling factors. However, it should be possible to link the information obtained with such tests to the more elaborated characterization tests.

Batch leaching tests developed by CEN/TC 292: EN 12457-1 to EN 12457-4 belong to this category and are based on different liquid to solid (L/S) ratios (2 - 10) and different particle sizes (4 mm – 10 mm).

6.1.4 "On-site verification"

Tests belonging to this category are used as a rapid check to confirm that the waste is the same as that which has been subjected to the compliance test(s).