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Plastics — Organic recycling — Specifications for compostable plastics

Plastiques — Recyclage organique — Spécifications pour les plastiques compostables

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 14, *Environmental aspects*.

This third edition cancels and replaces the second edition (ISO 17088:2012), which has been technically revised.

The main changes compared to the previous edition are as follows:

— in Clause 3:

  — the following terms have been added: organic recycling, anaerobic digestion, per- and poly-fluorinated compound, well-managed industrial composting process, industrial composting, organic constituents, home composting;

  — the term catalyst has been deleted;

— 6.1.4 has been deleted;

— a new subclause, 6.2.2, on variation in permitted thickness has been added;

— in 6.3, requirements regarding biodegradability of constituents have been revised;

— in 6.3.1.1, the following references have been added as additional laboratory test methods for biodegradation testing: ISO 14851, ISO 14852, ISO 17556;

— a new subclause, 6.3.2, on potential for biogas production has been added;

— 6.4 has been extended covering ecotoxicity tests with representative species from three trophic levels;

— in 6.5, new requirements regarding control of constituents with respect to per- and poly-fluorinated compounds (PFCs) and hazardous substances (as specified in Annex B) have been included;

— the list of regulated metals in EU + EFTA countries has been revised;

— new annexes, Annex B, Annex C, Annex E and Annex F, have been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Management of solid wastes is a problem of growing interest around the world. Cities, towns and countries are attempting to divert more materials from disposal (landfills and incineration without energy recovery) by performing different recovery options in order to transform waste into usable products. Plastics recovery technologies include material recovery (mechanical recycling, chemical or feedstock recycling, and biological or organic recycling) and the recovery of energy in the form of usable heat under controlled combustion conditions.

This document intends to correctly identify compostable plastics, and compostable products made from plastics, which can be recovered by organic recycling, i.e. will disintegrate and biodegrade satisfactorily together with biowaste producing compost as an outcome, in composting or in anaerobic digestion followed by composting, and will not leave any persistent or hazardous residues.

Plastics — Organic recycling — Specifications for compostable plastics

WARNING — Sewage, activated sludge, soil and compost might contain potentially pathogenic organisms. Therefore, appropriate precautions should be taken when handling them. Toxic test, compounds and those whose properties are unknown should be handled with care.

1 Scope

This document specifies procedures and requirements for plastics, and products made from plastics, that are suitable for recovery through organic recycling. The four following aspects are addressed:

a) disintegration during composting;

b) ultimate aerobic biodegradation;

c) no adverse effects of compost on terrestrial organisms;

d) control of constituents.

These four aspects are suitable to assess the effects on the industrial composting process.

This document is intended to be used as the basis for systems of labelling and claims for compostable plastics materials and products.

This document does not provide information on requirements for the biodegradability of plastics which end up in the environment as litter. It is also not applicable to biological treatment undertaken in small installations by householders.

NOTE 1 The recovery of compostable plastics through composting can be carried out under the conditions found in well-managed industrial composting processes, where the temperature, water content, aerobic conditions, carbon/nitrogen ratio and processing conditions are optimized. Such conditions are generally obtained in industrial and municipal composting plants. Under these conditions, compostable plastics disintegrate and biodegrade at rates comparable to yard trimmings, kraft paper bags and food scraps.

NOTE 2 "Compostable" or "compostable in municipal and industrial composting facilities" are expressions considered to be equivalent to organically recyclable for the purposes of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 472, *Plastics — Vocabulary*

ISO 11268-1, *Soil quality — Effects of pollutants on earthworms — Part 1: Determination of acute toxicity to Eisenia fetida/Eisenia andrei*

ISO 11268-2, *Soil quality — Effects of pollutants on earthworms — Part 2: Determination of effects on reproduction of Eisenia fetida/Eisenia andrei*

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

ISO 14851, *Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by measuring the oxygen demand in a closed respirometer*

ISO 14852, *Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by analysis of evolved carbon dioxide*

ISO 14855-1, *Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions — Method by analysis of evolved carbon dioxide — Part 1: General method*

ISO 14855-2, *Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions — Method by analysis of evolved carbon dioxide — Part 2: Gravimetric measurement of carbon dioxide evolved in a laboratory-scale test*

ISO 15685, *Soil quality — Determination of potential nitrification and inhibition of nitrification — Rapid test by ammonium oxidation*

ISO 16929, *Plastics — Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test*

ISO 17556, *Plastics — Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved*

EN 14582, *Characterization of waste — Halogen and sulfur content — Oxygen combustion in closed systems and determination methods*

OECD (2006), Test No. 208: *Terrestrial Plant Test: Seedling Emergence and Seedling Growth Test*, OECD Guidelines for the Testing of Chemicals, Section 2, OECD Publishing, Paris,

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
compost
organic soil conditioner obtained by biodegradation of a mixture consisting principally of vegetable residues, occasionally with other organic material and having a limited mineral content

[SOURCE: ISO 472:2013, 2.1735]

3.2
compostable plastic
plastic that undergoes degradation by biological processes during composting to yield CO_2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and leave no visible, distinguishable or toxic residue

Note 1 to entry: "Hazardous" is used synonymously to "toxic".

3.3
composting
aerobic process designed to produce compost starting from biodegradable waste

Note 1 to entry: Composting is classified into industrial composting, home composting and worm composting.

3.4
disintegration
physical breakdown of a material into very small fragments

3.5
filler
relatively inert solid material added to a plastic to modify its strength, permanence, working properties or other qualities, or to lower costs

3.6
organic recycling
aerobic (composting) or anaerobic (digestion) treatment of plastics waste under controlled conditions using micro-organisms to produce, in the presence of oxygen, stabilized organic residues (compost), carbon dioxide and water or, in the absence of oxygen, stabilized organic residues (compost), methane and carbon dioxide

Note 1 to entry: The term “biological recycling” is used synonymously.

[SOURCE: ISO 15270:2008, 3.5, modified — "biodegradable" has been omitted and "(compost)" has been added.]

3.7
total dry solids
amount of solids obtained by taking a known volume of test material or compost and drying at about 105 °C to constant mass

3.8
ultimate aerobic biodegradation
breakdown of an organic compound by microorganisms in the presence of oxygen into carbon dioxide, water and mineral salts of any other elements present (mineralization) plus new biomass

3.9
volatile solid
solids obtained by subtracting the residue of a known volume of test material or compost after incineration at about 550 °C from the *total dry solids* (3.7) of the same sample

Note 1 to entry: The volatile-solids content is an indication of the amount of organic matter present.

3.10
anaerobic digestion
process of controlled decomposition of biodegradable materials under managed conditions where free oxygen is absent, at temperatures suitable for naturally occurring mesophilic or thermophilic anaerobic and facultative bacteria species, that convert the inputs to a methane rich biogas and digestate

Note 1 to entry: In a second phase, the digestate is typically stabilised by means of a composting (aerobic) process.

3.11
per- and poly-fluorinated compound
PFC
organofluorine compound containing only carbon-fluorine bonds and carbon-carbon bonds but also other heteroatoms

3.12
well-managed industrial composting process
composting process performed under controlled conditions where the temperature, water content, aerobic conditions, carbon/ nitrogen ratio and other conditions are optimized

3.13
industrial composting
composting process performed under controlled conditions on industrial scale with the aim of producing compost for the market

Note 1 to entry: In some regions industrial composting is referred to as professional composting.

3.14
organic constituent
chemical constituent that contains carbon covalently linked to other carbon atoms and to other elements, most commonly hydrogen, oxygen or nitrogen

Note 1 to entry: Inorganic carbonates, carbides, cyanides and simple oxides such as carbon monoxide and carbon dioxide are not considered as organic constituent.

Note 2 to entry: Allotropes of carbon, such as diamond, graphite, carbon black, fullerenes, and carbon nanotubes are also not considered as organic constituent.

3.15
home composting
practice performed by a private individual with the aim of producing compost for his own use

4 General

4.1 The purpose of this document is to establish requirements for plastics materials and plastics products that can be recovered by means of organic recycling in well-managed industrial composting facilities where the typical conditions of composting can be consistently obtained (i.e. a long thermophilic phase, aerobic conditions, sufficient water content, a suitable carbon/nitrogen ratio, etc.).

4.2 The following characteristics are determined:

a) the ultimate level of aerobic biodegradation of the test material;

b) the degree of disintegration obtained;

c) any negative effects on the finished compost;

d) the maximum concentration of regulated metals and other elements and per- and poly-fluorinated compounds (PFCs) (determined as fluorine) in the test material.

In addition, the use of other hazardous substances as specified in Annex B in the test material is assessed.

5 Basic requirements

5.1 General

In order to comply with this document, plastics products and materials shall demonstrate each of the characteristics found in 5.2 to 5.5, as quantified in Clause 6.

5.2 Disintegration during composting

The plastics product or material shall disintegrate during composting as quantified in 6.2.

5.3 Ultimate aerobic biodegradability

The ultimate level of aerobic biodegradation shall be established by testing under controlled conditions as quantified in 6.3.

5.4 No adverse effect of compost on terrestrial organisms

The composting of plastics products or materials shall have no adverse effects on terrestrial organisms as quantified in 6.4.

Ecotoxic effects on terrestrial organisms shall be determined by comparing compost produced with and without the addition of a plastics product or a material.

5.5 Control of constituents

The plastics product or material under investigation shall be identified and characterized prior to testing including:

— determination of the presence of regulated metals and other elements;

— determination of the presence per- and poly-fluorinated compounds (PFCs) (determined as fluorine);

— evaluation of the presence of other hazardous substances as specified in Annex B;

— determination of volatile solids;

as quantified in 6.5, taking legal compliance into consideration.

6 Detailed requirements

6.1 General

6.1.1 In order to be identified as compostable, products and materials shall meet the requirements of 6.2, 6.3, 6.4 and 6.5, using appropriate laboratory tests representative of the conditions found in industrial composting facilities.

6.1.2 Test samples shall not be subjected to conditions or procedures designed to accelerate disintegration or biodegradation prior to testing as described in 6.2 or 6.3.

6.1.3 If the products or materials under test include inorganic fillers, the fillers shall be present when the products or materials are tested as described in 6.2, 6.3, 6.4, 6.5.2 and 6.5.3. However, their inorganic carbon content shall be excluded from the mineralization calculations in 6.3. Products or materials to which fillers are subsequently added, or in which the filler content is changed, shall be retested to demonstrate that the new material meets the requirements of 6.2, 6.3, 6.4, 6.5.2 and 6.5.3. Manufacturers may establish an acceptable range by testing the highest and the lowest concentrations. In addition, fillers shall be identified and assessed according to 6.5.4 with respect to potential hazardous properties as defined in Annex B. Examples of inorganic fillers include (but are not limited to) calcium carbonate and titanium dioxide.

An exception shall be made for materials containing calcium carbonate or other carbonates as a filler. For biodegradation, these materials should be tested without the carbonate filler as this might disturb an exact measurement. For chemical analyses, disintegration and toxicity the material should however be tested with the carbonate filler included.

6.2 Disintegration during composting

6.2.1 General

When testing finished articles and products, testing shall be conducted starting with the articles and products in the same form as they are intended to be used. For products and materials that are made in several different thicknesses or densities, such as films, containers and foams, only the thickest or most dense products and materials need to be tested as long as the chemical composition and structure of the respective articles and products remain the same.

NOTE 1 In general, for practical reasons, samples of the plastic material are tested in order to define the maximum thickness allowing disintegration. Finished articles and products are then manufactured with thicknesses below the maximum thickness.

A plastics product is considered to have demonstrated satisfactory disintegration if, after 84 days in a controlled composting test, it is completely disintegrated into less than 2 mm fragments. This is proven if no more than 10 % of its original dry mass remains after sieving through a 2,0 mm sieve.

NOTE 2 The 90 % threshold is the result of complete disintegration (100 %) minus 10 % tolerance. A 10 % tolerance is applied in order to take into consideration the variability occurring in biological processes.

The test shall be carried out in accordance with ISO 16929.

Alternatively, the lab-scale test in accordance with ISO 20200 can be used. The initial test item concentration shall be 1 % (wet mass) in each of these tests following the procedure given in ISO 16929.

In case of differing results, ISO 16929 results shall prevail.

Special attention should be given to the visual aspects of compost. Visual contamination of compost as evidenced by reduction of aesthetic acceptability should not be significantly increased by any post composting residues of the introduced plastics product or material. Therefore, any residue shall be indistinguishable to the naked eye from the other matter in the compost at a distance of 500 mm. The visible assessment of the compost shall be documented by means of photography.

6.2.2 Variation in permitted thickness

In some cases, specific composting technologies require early sieving and fast disintegration. In this case, the following rule shall apply in order to identify the maximum thickness.

If disintegration is achieved for the maximum thickness (X) in 12 weeks, it shall be deemed given that a thickness of X x 0,45 will achieve sufficient disintegration within 42 days. Alternative declarative statements are not permitted.

6.3 Ultimate biodegradation

6.3.1 Aerobic biodegradation

6.3.1.1 Laboratory test methods

Only biodegradation tests that provide unequivocal information on the intrinsic and ultimate biodegradability of the material or its significant organic constituents shall be used. The test under conditions of controlled aerobic composting in accordance with ISO 14855-1 and ISO 14855-2 shall be applied preferentially unless inappropriate to the type and properties of the material under test (e.g. in the case of printing inks, additives or colorants). Alternatively, the biodegradation tests according to ISO 14851, ISO 14852 or ISO 17556 (after six months duration) shall be used. Inorganic carbon is excluded from the calculation of biodegradation.

The ultimate aerobic biodegradation shall be determined for the whole material or for each organic constituent.

6.3.1.2 Biodegradability of constituents

Biodegradability of organic constituents, which are present in the material at a concentration between 1 % and 15 % (by dry mass) shall be proven separately according to 6.3.1.1.

As an alternative, the level of biodegradation of an organic constituent may be determined using an artificial blend of the same plastics material. This artificial blend shall consist of at least 15 % of the respective organic constituent (by dry mass). The chemical composition and the structure of the plastics material shall remain the same, but the amount of the organic constituent under consideration shall be increased to a minimum of 15 % (by dry mass). The artificial blend shall be produced following the same processing conditions (e.g. extrusion) as used for the production of the original plastics material containing less than 15 % (by dry mass) of the respective constituent.

In case the artificial blend meets the criteria specified in 6.3.1.3 and 6.3.1.4, the constituent is considered biodegradable in the context of this document. The constituent can then be used at the same (15 %) or lower concentration (<15 %; by dry mass) in a material that also contains the same co-substrate as the tested material.

NOTE 1 The objective of testing an artificial blend is to verify a synergistic effect on biodegradation of a constituent in the presence of a biodegradable co-substrate in the same material.

NOTE 2 The concentration of the constituent in the artificial blend is set at a minimum of 15 % in order to avoid false positive results, as theoretically a material with e.g. 10 % of a non biodegradable constituent can still reach the pass level for biodegradation specified in 6.3.1.3 and 6.3.1.4.

Constituents that turned out to be readily biodegradable in a ready biodegradation test according to an OECD test guideline (OECD 301, Methods A to F[3]; OECD 310[19]) are considered biodegradable in the context of this document.

Constituents which are present at concentrations of less than 1 % (by dry mass) do not need to demonstrate biodegradability. However, the sum of such constituents shall not exceed 5 % (by dry mass). Non-biodegradable plastic materials should generally not intentionally be added.

6.3.1.3 Criteria and pass level

For all polymers, ≥90 % of the organic carbon (relative to a reference material) shall have been converted to carbon dioxide by the end of the test period after 180 d (see 6.3.1.4). Both the reference material and the test sample shall be composted for the same period and the results compared at the same point in time after, for example, the activity of both has reached a plateau. The reference material used shall be microcrystalline cellulose.

As an alternative, 90 % (in absolute terms) of the organic carbon shall have been converted to carbon dioxide by the end of the test period.

NOTE Biodegradability is assessed by measuring the mineralization level, i.e. the conversion of the organic carbon of a plastics product or a material into CO_2 with the consumption of O_2, or into CO_2 and CH_4 under anaerobic conditions. During biodegradation, part of the organic carbon is also assimilated as biomass. This biomass yield typically ranges from 10 % to 40 %, depending on the substrate. As a consequence, the mineralization level will rarely reach 100 % also when the biodegradation is 100 %, because of biomass formation. Standard test methods for the accurate determination of plastics product´s or material`s carbon assimilated in biomass during biodegradation are not available at the time of publication.

6.3.1.4 Test duration

If the level of biodegradation exceeds 90 % (relative to a reference material or in absolute terms; see 6.3.1.3), then the biodegradation test (see 6.3.1.1) can be terminated. However, the test period shall be no longer than 180 days.

6.3.2 Potential for biogas production

Compost is not only the final product of the aerobic composting process but also the aerobically stabilized product of the anaerobic digestion process. The level of anaerobic biodegradation can be established by testing under controlled conditions using ISO 14853 or ISO 15985, in order to estimate the amount of biogas recovered during the first anaerobic phase.

No pass/fail requirement for the percentage of anaerobic biodegradation has been set because most commercial biogasification plants provide for a follow-on second phase of aerobic organic recycling. In order to meet the requirements of this document, a material or plastics product shall meet the compostability criteria set forth in Clause 6.

6.4 No adverse effects of compost on terrestrial organisms

6.4.1 General

In order to ensure that the composting of plastic products or materials does not have any harmful effects on the finished compost or on the environment, all requirements specified in 6.4.3, 6.4.4 (or 6.4.5) and 6.4.6 shall be met.

6.4.2 Ecotoxicity test scheme

Ecotoxicity tests are performed with compost samples produced with and without the addition of a plastics product or a material to determine and assess possible harmful effects on terrestrial organisms.

The test scheme considers:

— all relevant terrestrial organism groups such as plants, earthworms (invertebrates) and microorganisms;

— important ecological processes critical due to their role in maintaining soil functions such as breakdown of organic matter, formation of soil structure and cycling of materials;

— relevant exposure pathways of degradation products such as pore water and soil material.

The ecotoxicity test scheme is shown in Table 1.

Table 1 — Ecotoxicity testing scheme for the assessment of adverse effects of compost on terrestrial organisms

Organism group	Ecological process	Soil exposure pathway	Test methods
plants: — higher plants	primary production	mainly soil pore water (by root uptake)	plant growth test according to OECD 208 or ISO 11269-2 with the modifications specified in Annex C
invertebrates: — earthworms	breakdown of organic matter; formation of soil structure	diverse and multiple uptake routes: — soil pore water: — ingestion of soil material; — soil air.	acute earthworm test according to ISO 11268-1 with the modifications given in Annex D or alternatively chronic earthworm toxicity test according to ISO 11268-2 with the modifications specified in Annex E
mircoorganisms: (optional) — bacteria	recycling of nutrients	mainly soil pore water	nitrification inhibition test with soil microorganisms according to ISO 15685 with the modifications specified in Annex F

6.4.3 Plant growth test (mandatory)

The seedling germination rate and the plant biomass of the tested plant species in the sample compost exposed to the test material shall be more than 90 % of those from the corresponding blank compost not exposed to the test material, determined in accordance with OECD 208 or ISO 11269-2 with the modifications specified in Annex C.

Plastics products or materials that have already been assessed for plant toxicity following EN 13432, EN 14995, ISO 18606, ASTM D6400, ASTM D6868, AS 4736, AS 5810, EN 17033 or equivalent standard specifications and fulfilled the pass level for plant toxicity laid down in this document do not need to be retested.

6.4.4 Acute earthworm toxicity test (mandatory)

The survival and the biomass of the surviving adult earthworms in the sample compost exposed to the test material shall be more than 90 % of those from the corresponding blank compost not exposed to the test material, determined in an acute earthworm test according to ISO 11268-1 with the modifications specified in Annex D.

Plastics products or materials that have been already assessed for acute toxicity to earthworms following AS 4736, AS 5810, EN 17033 or equivalent standard specifications and fulfilled the pass level for toxicity to earthworm laid down in this document do not need to be retested.

6.4.5 Chronic earthworm toxicity test (mandatory)

As an alternative to the acute toxicity test (see 6.4.4), adverse effects of materials on the reproduction of earthworms may be determined in a test according to ISO 11268-2 with the modifications specified in Annex E.

After an incubation period of 28 days, the survival and the biomass of the surviving adult earthworms in the sample compost exposed to the test material shall be more than 90 % of those from the corresponding blank compost not exposed to the test material.

After an incubation period of 56 d, the observed number of offspring in sample compost exposed to the test material shall be more than 90 % of those from the corresponding blank compost not exposed to the test material.

Test items that have been already assessed for chronic toxicity to earthworms following EN 17033 or equivalent standard specifications and fulfilled the pass level for long-term toxicity to earthworm laid down in this document do not need to be retested.

6.4.6 Nitrification inhibition test with soil microorganisms (optional)

The nitrite formation in the sample compost exposed to the test material shall be more than 80 % of those from the corresponding blank compost to which no test material was added at the start of testing, determined in a nitrification inhibition test with soil organisms in accordance with ISO 15685 with the modifications specified in Annex F.

Plastics products or materials that have been already assessed for toxicity to soil microorganisms following EN 17033 or equivalent standard specifications and fulfilled the pass level for toxicity to soil microorganisms laid down in the standard specification do not need to be retested.

NOTE This test is optional but can be required due to national regulations or requirements.

6.5 Control of constituents

6.5.1 General

In order to ensure that the composting of plastics products or materials does not have any harmful effects on the finished compost or on the environment all requirements specified in 6.5.2 to 6.5.4 shall be met.

6.5.2 Regulated metals and other elements

The concentrations of regulated metals and other elements in the plastics product or material shall be less than 50 % of those prescribed for sludges, fertilizers and composts in the country where the final product will be placed on the market or disposed of (see Annex A for examples).

6.5.3 Per- and poly-fluorinated compounds (PFCs)

From a precautionary perspective, per- and poly-fluorinated substances compounds (PFCs) shall not be intentionally added to a plastics product or a material.

NOTE Most of per- and poly-fluorinated substances compounds (PFCs) are extremely persistent in the environment and in addition, certain PFCs are suspected to have bioaccumulative properties and adverse effects for environment and human health.

The concentration of per- and poly-fluorinated compounds (PFCs) in the plastics product or material shall be determined as fluorine.

6.5.4 Other hazardous substances

From a precautionary perspective, hazardous substances as specified in Annex B shall not be intentionally added to a plastics product or a material.

The applicable international and/or local regulations where the material is put on the market shall be taken into consideration for identification and assessment. Information on the use of hazardous substances shall be recorded and can be based on a self-declaration.

6.5.5 Volatile solids

The plastics product or material shall contain a minimum of 50 % of volatile solids.

7 Declaration of results

7.1 Plastics products or materials meeting all the requirements specified in Clause 6 may be considered as “recoverable by organic recycling”, “organically recyclable”, “compostable in industrial composting”, or “suitable for organic recycling”.

7.2 The term "biodegradable" shall not be used to describe the performance of plastics that meet this specification in supplier-to-consumer communications.

7.3 This document is not applicable to biological treatment undertaken in small installations by householders. Hence, it shall not be used for unqualified claims as “compostable in small installations by householders”, “suitable for home composting” and similar.

In addition, whenever the risk exists of misunderstanding by the consumer of a plastics product, it is recommended that the following warning shall be given: “not suitable for composting in small installations by householders” or “not suitable for home composting”.

8 Test report

The test report shall provide all pertinent information, including:

a) all information necessary to identify and describe the product or material tested;

b) references to all standards, guidelines and regulations that are relevant to 6.5.2 regarding the content of regulated metals and other elements, to 6.5.3 regarding the content of per- and poly-fluorinated compounds (PFCs) and to 6.5.4 regarding other hazardous substances as defined in Annex B.

A table of regulated metals shall be presented, specifying each such reference and stating the prescribed limit for each metal, the concentration determined in the test and the percentage of the prescribed limit. In addition, the concentration of per- and poly-fluorinated compounds (PFCs) shall be determined as fluorine and reported. Information on the use of other hazardous substances

as specified in Annex B shall be assessed and recorded and can be based on a self-declaration considering international and/or local regulations where the material is put on the market;

c) a description of other relevant requirements in the referenced documents and a statement, for each such requirement, as to whether the test result was in conformity with the requirement or not.

Annex A
(informative)

Examples of maximum concentrations of regulated metals and other elements

Table A.1 — Examples of maximum concentrations of regulated metals and other elements

Values given in mg/kg of dry material

Element[f]	US[a]	Canada[b]	EU + EFTA countries[c]	Japan[d]	China[e]	Test method
Zn	1 400	463	150	180	150	ISO 17294-2
Cu	750	189	50	60	50	ISO 17294-2
Ni	210	45	25	30	25	ISO 17294-2
Cd	17	5	0,5	0,5	0,5	ISO 17294-2
Pb	150	125	50	10	50	ISO 17294-2
Hg	8,5	1	0,5	0,2	0,5	ISO 12846
Cr	—	265	50	50	50	ISO 17294-2
Mo	—	5	—	—	1	ISO 17294-2
Se	50	4	—	—	0,75	ISO 17294-2
As	20,5	19	—	5	5	ISO 17294-2
Co	—	38	—	—	38	ISO 17294-2

[a] The maximum metal concentrations given here for the US are 50 % of those prescribed by 40 CFR 503.13, Table 3 (as per ASTM D6400 requirements).

[b] The maximum metal concentrations for Canada are those prescribed in 6.1 of BNQ 9011-911-1/2007.

[c] The maximum metal concentrations are 50 % of those prescribed in ecological criteria for the award of the Community eco-label to soil improvers [COMMISSION DECISION (EU) 2015/2099 of 18 November 2015 establishing te ecological criteria for the award of the EU Ecolabel for growing media, soil improvers and mulch (notified under document C(2015) 7891].

[d] The maximum metal concentrations for Japan are 10 % of those prescribed in the Fertilizer Control Law (Ministry of Agriculture, Forestry and Fisheries) and Guidelines for Quality of Composts (Central Union of Agricultural Co-operatives).

[e] GB/T 35795-2017. Biodegradable Mulching film for Agricultural Uses. GB Standard of the People's Republic of China.

[f] Countries not listed in the table shall use one of the available maximum concentrations.

The test methods given in Table 1 shall be used to determine the regulated metals. Alternatively, other appropriate recognized international or national standards may be used. The applied test methods shall be reported in the test report.

Annex B
(normative)

Detection of per- and poly-fluorinated compounds and maximum concentrations of other hazardous substances

B.1 Per- and poly-fluorinated compounds

From a precautionary perspective per- and poly-fluorinated substances compounds (PFCs) (determined as fluorine) shall not be intentionally added to a plastics material. The fluorine concentration shall be analysed using EN 14582 as the test method.

NOTE Talcum or Talc is an inert mineral composed of hydrated magnesium silicate with the chemical formula $Mg_3Si_4O_{10}(OH)_2$. The mineral is used in many applications including baby care products, cosmetics and packaging and packaging materials. Depending on the geographical origin of the inorganic natural product, it can contain appreciable amounts of fluorine. As fluorine is almost entirely fixed in the matrix of Talcum, just a marginal proportion of it is water-soluble and hence bioavailable. Talcum is not classified as hazardous to the environment.

B.2 Other hazardous substances

From a precautionary perspective a plastics product or plastics material shall not

1) be classified as hazardous according to the UN Globally Harmonized System for Classification and Labelling of Chemicals (GHS)[4]

and

2) be intentionally produced with a hazardous substance

— meeting criteria of classification according to the UN Globally Harmonized System for Classification and Labelling of Chemicals (GHS)[4] as

  a) carcinogenic (category 1A or 1B) or

  b) mutagenic (category 1A or 1B) or

  c) toxic for reproduction (category 1A or 1B) or

— having endocrine disrupting properties[5] or

— having persistent, bioaccumulative and toxic properties or

— having very persistent and very bioaccumulative properties

and

— exceeding a concentration limit of 0,1 % (by weight) in the plastics product or plastics material.

NOTE 1 Safety Data Sheets or other reliable sources such as the website of the European Chemicals Agency (ECHA)[7] which provide comprehensive information about a substance or a mixture, can be used for the identification of hazardous substances fulfilling the above-mentioned criteria.

NOTE 2 In the European Union, hazardous substances meeting the above outlined criteria are categorized as substances of very high concern (SVHC). SVHCs are those which appear on the Candidate List of substances of very high concern for Authorization[6].

Annex C
(normative)

Determination of ecotoxic effects on higher plants

C.1 General

The basis for the determination of ecotoxic effects on higher plants is the OECD 208 or ISO 11269-2. The principles of the standard test methods shall be followed, and the modifications given in this annex are required to meet the special needs for testing compost samples.

C.2 Properties of the reference substrate

Any reference substrate is suitable if it allows a normal seed germination and plant growth. It should preferably have a composition and structure similar to the compost samples. Fertilizers shall not have been added.

Suitable reference substrates are all those which are defined by European national standards for analysis of compost quality, for example: Standard soil EE0[1)], mixtures of culture substrate with backed clay granules (see ÖNORM S2023) or mixtures of peat and siliceous sand.

C.3 Preparation of samples

Compost samples to be used for plant toxicity tests shall be prepared according to ISO 16929 using a 10 % (wet mass) sample input concentration. The ecotoxicity testing shall be carried out on mature compost as described in ISO 16929.

Prepare a mixture of the reference substrate with a mass fraction or a volume fraction of 50 % (documented in the report) of compost. Use the compost obtained after disintegration of the test material (sample compost) and the blank compost, obtained from the parallel process without addition of test material.

If transient toxicity effects are likely to occur due to the rapid biodegradation of the test material in compost, mixtures with the reference material (microcrystalline cellulose) may be prepared in addition to mixtures with the test substances in order to asses potential transient toxicity effects and the degree of maternity of compost.

C.4 Selection of plant species

Use at least one plant species from each family:

— Monocotyledonae (e.g. summer barley: *Hordeum vulgare*; wheat: *Triticum aestivum*; perennial ryegrass: *Lolium perenne*);

— Dicotyledonae (e.g. white mustard: *Sinapis alba*; garden cress: *Lepidium sativum*; radish: *Raphanus sativus*; mung bean: *Phaseolus aureus*).

1) Bundesgütegemeinschaft Kompost e. V., Germany.

C.5 Performing the tests

Fill each tray with a minimum of 200 g (dry weight) of the samples (see C.3) and add as a minimum 50 seeds (see C.4) on the top. Cover the seeds with a thin layer of inert material, such as siliceous sand or perlite. Perform the tests in four parallels for each mixture. Add water until 70 % to 100 % of the water holding capacity is reached. Supply evaporated water periodically during the whole test duration as needed. The trays are kept under conditions that allow a satisfactory development of the selected species, i.e. 14 d to 21 d after at least 50 % of the seedlings have emerged in the control trays.

Nutrients may be added to the samples (see C.3) in order to compensate nutrient depletion in compost samples caused by the increase of microbial biomass during previously performed disintegration test according to ISO 16929 and in order to maintain good growth vigor and plant vitality. Recommendations for nutrient solutions are given in ISO 11269-2:2012, Annex D. Applied measures shall be documented in the report.

NOTE It is an advantage to keep the trays at a dark place or to cover them during the germination period.

C.6 Validity of the tests

The validity criteria of the test as stated in OECD 208 or, if applicable, in ISO 11269-2 shall be fulfilled in blank compost samples (see C.3).

C.7 Evaluation of the results

The germination numbers (number of grown plants) and the plant biomass of the sample compost and the blank compost are compared. Germination rate and plant biomass (dry mass or fresh mass) are both calculated as per cent of the corresponding values obtained with the blank compost. If applicable the same procedure applies to compost samples exposed to the reference material (microcrystalline cellulose).

If the germination rate and the plant biomass of the tested plant species grown on samples exposed to the test material as well as on samples exposed to the reference material (microcrystalline cellulose) is less than 90 % of those from the corresponding blank samples not exposed to any material (see C.3), then this could be considered as an indication that a transient phytotoxicity caused by the biodegradation of the high amount of biodegradable materials added to the compost is present and affecting the test. The test is to be considered as invalid and shall be repeated after a further maturation of the compost.

Annex D
(normative)

Determination of acute ecotoxic effects to earthworm

D.1 General

The basis for the determination of acute ecotoxic effects to earthworm is ISO 11268-1. The principles of the standard test method shall be followed, and the modifications given in this annex are required to meet the special needs for testing compost samples.

D.2 Selection of the reference substrate

The reference substrate prepared according to Annex C (see C.2) shall be used. Alternatively, standard soil according to ISO 11268-1 may be used.

D.3 Preparation of samples

Sample compost and blank compost prepared according to Annex C (see C.3) shall be used with the following modification. Prepare a mixture of the reference substrate with a mass fraction or a volume fraction of 25 % (documented in the report) of compost. If applicable, the same applies to compost obtained at the end of the pilot-scale test (see ISO 16929) to which 10 % reference material (microcrystalline cellulose) has been added to biowaste at the start of the pilot-scale test.

Unlike plants, earthworms can be very sensitive to salt. Salt content increases during composting and is usually higher in blank compost compared to sample compost. As a result, mortality can often be observed in the 50 % blank compost, while the 50 % sample compost shows significant survival. In order to avoid false positive results, the earthworm test is performed with a mixture of the reference substrate with 25 % of sample compost and, if applicable, with 25 % of reference compost exposed to the reference material (microcrystalline cellulose).

D.4 Selection of earthworm species

Adult earthworms of the species *Eisenia fetida* or *Eisenia andrei* should be used.

D.5 Performing the tests

Fill each test container with 500 g (dry weight) of samples (see D.3) and place 10 randomly selected worms (see D.4) to each test container. Perform the tests in four replicates. Add water until 40 % to 60 % of the water holding capacity is reached. Supply evaporated water periodically during the whole test duration as needed.

The number of dead earthworms is determined at day 7 and day 14 in each test container and the body weight of each surviving earthworm is recorded at the beginning (day 0) and at day 14.

The biomass changes of living earthworms in each test container (mean weight of surviving worms) is calculated as percent biomass of earthworms at the beginning (day 0).

D.6 Validity of the tests

The validity criteria as stated in ISO 11268-1 shall be fulfilled in blank compost samples (see D.3).

D.7 Evaluation of the results

The number of dead earthworms at day 7 and day 14 of sample compost and blank compost are compared and the mortality is calculated as percent of the corresponding value obtained with the blank compost. If applicable the same procedure applies to compost samples exposed to the reference material (microcrystalline cellulose).

In addition, the average loss of biomass (mean weight) of worms in sample compost and blank compost is compared and calculated as per cent of the corresponding values obtained with the blank compost. If applicable the same procedure applies to compost samples exposed to the reference material (microcrystalline cellulose).

If the survival and the biomass of the surviving adult earthworms grown in the sample compost exposed to the test material as well as in the reference compost exposed to the reference material (microcrystalline-cellulose) is less than 90 % of those from the corresponding blank compost not exposed to any material (see D.3), then this could be considered as an indication that a transient phytotoxicity caused by the biodegradation of the high amount of biodegradable materials added to the compost is present and affecting the test. The test is to be considered as not valid and to be repeated after a further maturation of the compost.

Annex E
(normative)

Determination of chronic ecotoxic effects to earthworm

E.1 General

The basis for the determination of chronic ecotoxic effects to earthworm is ISO 11268-2. The principles of the standard test method shall be followed, and the modifications given in this annex are required to meet the special needs for testing compost samples.

E.2 Selection of the reference substrate

The reference substrate prepared according to Annex C (see C.2) shall be used. Alternatively, standard soil according to ISO 11268-2 may be used.

E.3 Preparation of samples

Sample compost and blank compost prepared according to Annex C (see C.3) with the modification laid down in Annex D (see D.3) shall be used. If applicable, the same applies to compost obtained at the end of the pilot-scale test (see ISO 16929) to which 10 % reference material (microcrystalline cellulose) has been added to biowaste at start of the pilot-scale test.

E.4 Selection of earthworm species

Adult earthworms of the species *Eisenia fetida* or *Eisenia andrei* shall be used.

E.5 Performing the tests

Perform the test according to ISO 11268-2. Fill each test container with 500 g to 600 g (dry weight) of samples (see E.3) and place 10 randomly selected worms (see E.4) to each test container. Perform the tests in four replicates. Add water until 40 % to 60 % of the water holding capacity is reached. Supply evaporated water periodically during the whole test duration as needed. The earthworms are fed once a week during the test period. At the beginning the mass of living worms is measured in each container.

Remove after four weeks (28 days) the adult earthworms and record the total number and mass of living adult worms in each container. The biomass changes of earthworms in each test container (mean weight of surviving worms) is calculated as percent biomass of earthworms at the beginning (day 0).

Incubate the test containers for another period of four weeks to allow offspring to develop. At the beginning of this period, juveniles are fed once. After 56 days the number of offspring per test container hatched from the cocoons is counted.

E.6 Validity of the tests

The validity criteria as stated in ISO 11268-2 shall be fulfilled in blank compost samples (see E.3).