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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).

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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.

