INTERNATIONAL STANDARD

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Specifications for compostable plastics

Spécifications pour les plastiques compostables

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 17088 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical-chemical properties*.

This second edition cancels and replaces the first edition (ISO 17088:2008), of which it constitutes a minor revision to clarify the wording of the second paragraph in Subclause 6.3.1.

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.

As interest in composting (biological or organic recycling) grows, it will be necessary to identify correctly plastics, and products made from plastics, which will disintegrate and biodegrade satisfactorily under composting conditions and will not leave any persistent or toxic residues.

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. The handling of these materials in the context of the application of this International Standard might be further controlled by national and/or regional legislation.

1 Scope

This International Standard specifies procedures and requirements for the identification and labelling of plastics, and products made from plastics, that are suitable for recovery through aerobic composting. The four following aspects are addressed:

a) biodegradation;

b) disintegration during composting;

c) negative effects on the composting process and facility;

d) negative effects on the quality of the resulting compost, including the presence of high levels of regulated metals and other harmful components.

This specification is intended to establish the requirements for the labelling of plastic products and materials, including packaging made from plastics, as “compostable” or “compostable in municipal and industrial composting facilities” or “biodegradable during composting” (for the purposes of this International Standard, these three expressions are considered to be equivalent). The labelling will, in addition, have to conform to all international, regional, national or local regulations (e.g. European Directive 94/62/EC).

NOTE The recovery of compostable plastics through composting can be carried out under the conditions found in well-managed composting plants, 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 will disintegrate and biodegrade at rates comparable to yard trimmings, kraft paper bags and food scraps.

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

ISO 472, *Plastics — Vocabulary*

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

ISO 20200, *Plastics — Determination of the degree of disintegration of plastic materials under simulated composting conditions in a laboratory-scale test*

EN 13432:2000, *Packaging — Requirements for packaging recoverable through composting and biodegradation — Test scheme and evaluation criteria for the final acceptance of packaging*

ASTM D5338, *Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions, Including Thermophilic Temperatures*

ASTM D6400, *Standard Specification for Compostable Plastics*

OECD Guidelines for the Testing of Chemicals — Guideline 208: *Terrestrial Plants, Growth Test*

3 Terms and definitions

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

3.1
biodegradable during composting
synonymous with “compostable” (see definition of “compostable plastic”)

3.2
catalyst
substance, used in small proportion, that augments the rate of a chemical reaction and, in theory, remains unchanged chemically at the end of the reaction

3.3
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

3.4
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

3.5
composting
aerobic process designed to produce compost

3.6
disintegration
physical breakdown of a material into very small fragments

3.7
filler
relatively inert solid material added to a plastic to modify its strength, permanence, working properties or other qualities, or to lower costs

3.8
theoretical amount of evolved carbon dioxide
$ThCO_2$
maximum theoretical amount of carbon dioxide evolved after completely oxidizing a chemical compound, calculated from the molecular formula and expressed as milligrams of carbon dioxide evolved per milligram or gram of test compound

3.9
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

3.10
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

3.11
volatile solids
amount of 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 of the same sample

NOTE The volatile-solids content is an indication of the amount of organic matter present.

4 Principle

4.1 The purpose of this specification is to establish standards for identifying and labelling plastic products and materials that will compost satisfactorily in well-managed 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.). Products meeting the requirements outlined below are appropriate for labelling as “compostable”, “compostable in municipal and commercial facilities” or “biodegradable during composting”.

4.2 The test used simulates an intensive aerobic composting process. It measures

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 in the compost.

The test is terminated when the plateau phase of the biodegradation has been attained; the standard time for termination is 45 days, but the test could continue for up to six months.

5 Basic requirements

5.1 In order to compost satisfactorily, a plastic product or material shall demonstrate each of the characteristics found in 5.1.1 to 5.1.4 and quantified in Clause 6.

5.1.1 Disintegration during composting

The plastic product or material shall disintegrate during composting such that any remaining plastic is not readily distinguishable from the other organic materials in the finished compost. Additionally, the plastic product or material shall not be found in significant quantities during screening prior to final distribution of the compost.

5.1.2 Ultimate aerobic biodegradation

The ultimate level of aerobic biodegradation shall be established by testing under controlled conditions.

5.1.3 No adverse effect on ability of compost to support plant growth

The plastic product or material tested shall have no adverse effect on the ability of the compost to support plant growth, when compared to blank composts to which no test or reference substance has been added at the start of testing.

5.1.4 Compliance with national regulations

Based on the relevant national and/or regional regulations, the plastic product or material shall not, upon decomposition, release unacceptably high levels of regulated metals or other toxic substances into the environment. It is the responsibility of the user to conform to the applicable national and/or regional regulations dealing with metals, other elements and toxic substances in the environment.

5.2 The term “biodegradable” shall not be used to describe the performance of plastics which meet this specification unless the conditions typically found in composting and described in ISO 14855-1 and ISO 14855-2 are included (for example “biodegradable during composting”).

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 and 6.4, using appropriate laboratory tests representative of the conditions found in aerobic composting facilities. 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 remains otherwise the same.

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 fillers, the fillers shall be present when the products or materials are tested as described in 6.2, 6.3 and 6.4. 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 and 6.4. Manufacturers may establish an acceptable range by testing the highest and the lowest concentrations. Examples of fillers include (but are not limited to) calcium carbonate and titanium dioxide.

6.1.4 Products or materials to which catalysts are subsequently added, or in which the content of the catalyst is changed, shall be retested to demonstrate that the new material meets the criteria specified in 6.2, 6.3 and 6.4. Manufacturers may establish an acceptable range by testing the highest and the lowest concentrations. Examples of catalysts include (but are not limited to) organo-metallic compounds such as metal carboxylates and metal complexes.

6.2 Disintegration during composting

A plastic product is considered to have demonstrated satisfactory disintegration if, after 84 days in a controlled composting test, no more than 10 % of its original dry mass remains after sieving through a 2,0 mm sieve. The test shall be carried out in accordance with ISO 16929, ISO 20200, ISO 14855-1 or ASTM D5338 under thermophilic composting conditions without the CO_2-trapping equipment.

6.3 Ultimate aerobic biodegradation

6.3.1 A plastic product is considered to have demonstrated a satisfactory rate and level of biodegradation if, when tested in accordance with ISO 14855-1, ISO 14855-2 or ASTM D5338, it achieves the ratio of conversion to carbon dioxide (CO_2/ThCO_2) specified in 6.3.2 within the time period specified in 6.3.3.

The ultimate aerobic biodegradability shall be determined for the whole material or for each organic constituent. For organic constituents which are present in the material at a concentration between 1 % and 10 % (by dry mass), the level of biodegradation shall be determined separately.

Constituents which are present at concentrations of less than 1 % do not need to demonstrate biodegradability. However, the sum of such constituents shall not exceed 5 %.

6.3.2 For all polymers, 90 % of the organic carbon (relative to a positive-control reference material) shall have been converted to carbon dioxide by the end of the test period (see 6.3.3). Both the positive control and the test sample shall be composted for the same length of time and the results compared at the same point in time after the activity of both has reached a plateau. The positive control 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 Although the biodegradation test includes the conversion of the polymers into biomass and humic substances in addition to carbon dioxide, no recognized standard test methods or specifications exist for the quantification of these conversion products. When such tests and specifications become available, this International Standard might be revised.

6.3.3 The test period shall be no longer than 180 days.

6.4 No adverse effects on ability of compost to support plant growth and compliance with regional and/or national regulations

6.4.1 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 and complies with appropriate regional and national regulations, all requirements specified in 6.4.2 to 6.4.4 shall be met.

6.4.2 The concentrations of regulated metals and other toxic substances in the plastic 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 and the Bibliography for examples).

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

6.4.4 The seedling germination rate of the finished compost and the plant biomass in the compost shall be no less than 90 % of that of corresponding blank composts to which no test or reference material was added at the start of testing, determined in accordance with OECD Guideline 208 with the modifications specified in Annex E of EN 13432:2000.

7 Marking and labelling

7.1 Plastic products or materials meeting all the requirements specified in Clause 6 may be labelled “compostable” or “biodegradable during composting”.

7.2 The labelling shall conform to international, regional, national or local regulations.

7.3 The name of the country where the plastic product or material is to be marketed or recycled by composting shall be indicated.

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 6.4.2 regarding the content of regulated metals and other toxic substances (a table of regulated metals and other toxic substances shall be presented, specifying each such reference and stating the prescribed limit for each metal and other toxic substance, the concentration determined in the test and the percentage of the prescribed limit);

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 toxic substances

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

Values given in mg/kg of dry material

Element	ASTM D6400		EN 13432[c]	Japan[d]
	US[a]	Canada[b]		
Zn	1 400	463	150	180
Cu	750	189	50	60
Ni	210	45	25	30
Cd	17	5	0,5	0,5
Pb	150	125	50	10
Hg	8,5	1	0,5	0,2
Cr	—	265	50	50
Mo	—	5	1	—
Se	50	4	0,75	—
As	20,5	19	5	5
F	—	—	100	—
Co	—	38	—	—

[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-I/2007.

[c] The maximum metal concentrations for the EC are 50 % of those prescribed in ecological criteria for the award of the Community eco-label to soil improvers (EC OJ L 219, 7.8.1998, p. 39).

[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).

Bibliography

[1] European Directive 94/62/EC on Packaging and Packaging Waste and its amendment European Directive 2004/12/EC

[2] ASTM Institute for Standards Research (ISR) Degradable Polymers Research Program, Final Report PCN 33-00019-19, Dec. 1996

Examples of national or regional legislation of relevance to 6.4.1:

[3] United States: Table 3 in 40 CFR Part 503.13, *Pollutant limits*

[4] Canada: BNQ 9011-911-I/2007, *Compostable Plastic Bags — Certification Program — Part 1: Product Requirements*, of the Bureau de normalisation du Québec

[5] European Union: Substances identified in ecological criteria for the award of the Community eco-label to soil improvers, Official Journal of the European Communities OJ L 219, 7.8.1998, p. 39, applied in EN 13432

[6] Japan: *Fertilizer Control Law*, the Ministry of Agriculture, Forestry and Fisheries, and *Guidelines for quality of composts*, The Central Union of Agricultural Co-operatives (available in Japanese only)

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