



Designation: D 6400 – 04

Standard Specification for Compostable Plastics¹

This standard is issued under the fixed designation D 6400; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers plastics and products made from plastics that are designed to be composted in municipal and industrial aerobic composting facilities.

1.2 This specification is intended to establish the requirements for labeling of materials and products, including packaging made from plastics, as “compostable in municipal and industrial composting facilities.”

1.3 The properties in this specification are those required to determine if plastics and products made from plastics will compost satisfactorily, including biodegrading at a rate comparable to known compostable materials. Further, the properties in the specification are required to assure that the degradation of these materials will not diminish the value or utility of the compost resulting from the composting process.

1.4 The following safety hazards caveat pertains to the test methods portion of this standard: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate health and safety practices and to determine the applicability of regulatory limitations prior to use.*

NOTE 1—No equivalent ISO specifications exist for this standard.

2. Referenced Documents

2.1 ASTM Standards:²

D 883 Terminology Relating to Plastics

D 5338 Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions

D 6002 Guide for Assessing the Compostability of Environmentally Degradable Plastics

2.2 Organization for Economic Development (OECD) Standard:³

OECD Guideline 208 Terrestrial Plants, Growth Test

2.3 Comite Europeen de Normalisation (CEN):⁴

EN 13432: 2000, 2000–CEN/TC 261/SC 4 N 99 Packaging—Requirements for Packaging Recoverable through Composting and Biodegradation—Test Scheme and Evaluation Criteria for the Final Acceptance of Packaging (EN 13432)

EN 13432 Requirements for Packaging Recoverable through Composting and Biodegradation—Test Scheme and Evaluation Criteria for the Final Acceptance of Packaging

2.4 ISO Standard:⁴

ISO 14855 Evaluation of the Ultimate Aerobic Biodegradability and Disintegration of Plastics under Controlled Composting Conditions—Method by Analysis of Evolved Carbon Dioxide

ISO 16929 Plastics—Determination of the Degree of Disintegration of Plastic Materials under Defined Composting Conditions in a Pilot-Scale Test

2.5 U.S. Government Standard:⁵

40 CFR Part 503.13 Standards for the Use or Disposal of Sewage Sludge

2.6 Canadian Government Standard:⁶

Trade Memorandum T-4-93 Standards for Metals in Fertilizers and Supplements

3. Terminology

3.1 *Definitions*—Definitions appearing in this specification are found in Terminology D 883, unless otherwise noted.

3.1.1 *biodegradable plastic*—a degradable plastic in which the degradation results from the action of naturally occurring microorganisms such as bacteria, fungi, and algae.

¹ This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.96 on Environmentally Degradable Plastics and Biobased Products.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from Organization for Economic Development, Director of Information, 2 rue Andre' Pascal, 75775 Paris Cedex 16, France.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁵ *Code of Federal Regulations*, available from U.S. Government Printing Office, Washington, DC 20402.

⁶ Available from the Canadian Food Inspections Agency, Fertilizer Section, Ottawa, Canada

*A Summary of Changes section appears at the end of this standard.

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3.1.2 *compostable plastic*—a plastic that undergoes degradation by biological processes during composting to yield CO₂, water, inorganic compounds, and biomass at a rate consistent with other known compostable materials and leave no visible, distinguishable or toxic residue.

3.1.3 *composting*⁷—a managed process that controls the biological decomposition and transformation of biodegradable materials into a humus-like substance called compost: the aerobic mesophilic and thermophilic degradation of organic matter to make compost; the transformation of biologically decomposable material through a controlled process of biooxidation that proceed through mesophilic and thermophilic phases and results in the production of carbon dioxide, water, minerals, and stabilized organic matter (compost or humus).

3.1.3.1 *Discussion*—Composting uses a natural process to stabilize mixed decomposable organic material recovered from municipal solid waste, yard trimmings, biosolids (digested sewage sludge), certain industrial residues and commercial residues.

3.1.4 *degradable plastic*—a plastic designed to undergo a significant change in its chemical structure under specific environmental conditions, resulting in a loss of some properties that may be measured by standard test methods appropriate to the plastic and the application in a period of time that determines its classification.

3.1.5 *plastic*—a material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state, and, at some stage in its manufacture or processing into finished articles, can be shaped by flow.

3.1.6 *polymer*—a substance consisting of molecules characterized by the repetition (neglecting ends, branch junctions, other minor irregularities) of one or more types of monomeric units.

4. Classification

4.1 The purpose of this specification is to establish standards for identifying products and materials that will compost satisfactorily in commercial and municipal composting facilities. Products meeting the requirements outlined below are appropriate for labeling as “compostable” in accordance with the guidelines issued by the Federal Trade Commission.⁸

5. Basic Requirements

5.1 In order to compost satisfactorily, a product or material must demonstrate each of the characteristics found in 5.1.1-5.1.3, and which are quantified in Section 6.

5.1.1 *Disintegration During Composting*—A plastic product or material will disintegrate during composting such that any remaining plastic residuals are not readily distinguishable from the other organic materials in the finished product. Additionally, the material or product must not be found in significant quantities during screening prior to final distribution of the compost.

⁷ *Compost Facility Operating Guide*, Composting Council, Alexandria, VA, 1995.

⁸ *Guidelines for the Use of Environmental Marketing Claims*, Federal Trade Commission, Washington, DC, 1992.

5.1.2 *Inherent Biodegradation*—A level of inherent biodegradation shall be established by tests under controlled conditions, that are comparable to known compostable materials.

5.1.3 *No Adverse Impacts on Ability of Compost to Support Plant Growth*—The tested materials shall not adversely impact on the ability of composts to support plant growth, when compared to composts using cellulose as a control, once the finished compost is placed in soil. Additionally, the polymeric products or materials must not introduce unacceptable levels of heavy metals or other toxic substances into the environment, upon sample decomposition.

NOTE 2—For a better understanding of why these criteria are important, consult Guide D 6002 and *Compost Facility Operating Guide*,⁷ and CEN/TC 261/SC 4 N 99.

6. Detailed Requirements

6.1 In order to be identified as compostable, products must pass the requirements of 6.2, 6.3, and 6.4 using the appropriate laboratory tests, representative of the conditions found in aerobic composting facilities. Test finished articles and products in the same form as they are intended to be used. For products that are made in multiple thicknesses or densities, such as films, containers and foams, only the thickest or most dense products need to be tested as long as the chemical composition and structure remains otherwise the same. It is assumed that thinner gages and lower densities will also compost satisfactorily. Similarly, if additives are present in test samples that pass testing, lower levels of the same additives are similarly passed.

6.2 Disintegration During Composting:

A plastic product is considered to have demonstrated satisfactory disintegration if after twelve weeks in a controlled composting test, no more than 10 % of its original dry weight remains after sieving on a 2.0-mm sieve. Generate laboratory thermophilic composting conditions by performing Test Method D 5338 without CO₂ trapping component, or ISO 16929.

6.3 Inherent Biodegradation:

A plastic product must demonstrate a satisfactory rate of biodegradation by achieving one of the following ratios of conversion to carbon dioxide found in 6.3.1 or 6.3.2 within the time periods specified in 6.3.3 or 6.3.4, using Test Method D 5338 as outlined in 7.3.1 and 7.3.3 of Guide D 6002:

6.3.1 For products consisting of a single polymer (homopolymers or random copolymers), 60 % of the organic carbon must be converted to carbon dioxide by the end of the test period when compared to the positive control.

6.3.1.1 For products consisting of more than one polymer, each individual polymer component, present at more than 1 % concentration, must achieve the 60 % specification for homopolymers, as described in 6.3.1.

6.3.2 For products consisting of more than one polymer (block copolymers, segmented copolymers, blends, or addition of low molecular weight additives), 90 % of the organic carbon must be converted to carbon dioxide by the end of the test period when compared to the positive control.

6.3.3 For materials that are not radiolabeled, the test period shall be no greater than 180 days.

6.3.4 If radiolabeled materials are used, then the test period shall be no greater than 365 days.

NOTE: 3—While the end points of biodegradation include incorporation into biomass or humic substances as well as carbon dioxide, no recognized standard test methods and specifications exist to quantify these outcomes. When these tests and specifications become available, this standard will be revised.

NOTE: 4—Plastic product test samples shall not be subjected to conditions designed to accelerate biodegradation, prior to testing in 6.3.

6.4 A plastic product can demonstrate satisfactory terrestrial and aquatic safety if it fulfills the requirements in 6.4.1 and 6.4.2:

6.4.1 The plastic or product shall have concentrations of regulated heavy metals less than 50 % of those prescribed for sludges or composts in the country where the product is sold. Specifically in the United States, the regulated heavy metal concentrations are found in Table 3 of 40 CFR Part 503.13. In Canada, the regulated metals concentrations are found in Table II of the Trade Memorandum T-4-93.

6.4.2 The germination rate and the plant biomass of the sample composts shall be no less than 90% that of the corresponding blank composts for two different plant species following OECD Guideline 208 with the modifications found in Annex E of EN 13432.

7. Sampling

7.1 Sampling shall be conducted as indicated in the specified test method.

8. Specimen Preparation

8.1 Specimen preparation shall be in accordance with the specified test method.

9. Marking and Labeling

9.1 Marking and labeling shall conform to national and local regulations.

10. Keywords

10.1 biodegradable; compostable plastic; composting; degradable plastics; labeling

SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or reasons for the changes, or both.

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(1) Most of the proposed changes are designed to harmonize this specification with the wording used in the newer standard, Specification D 6868 - 03. This is the rationale for the changes in Sections 6.2; 6.3.1; 6.3.2, 6.4 and 6.4.2. There are no changes in the rates of biodegradation and disintegration.

(2) The change in 6.4.1 recognizes that regulated metals standards are different in the US and Canada. Now that this standard is being used by Canadian organizations, such as

EcoLabel, it is appropriate to add these heavy metal requirements.

(3) Note 4 is recommended in order to minimize the possibility of confusion on sample preparation. For example, the proposed ASTM Guide for Oxo-Biodegradable Plastics calls for the use of accelerated testing conditions to promote oxidation prior to biodegradation. The use of these techniques is not appropriate for this specification.

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