



Designation: D6400 – 23

Standard Specification for Labeling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities¹

This standard is issued under the fixed designation D6400; 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 under aerobic conditions in municipal and industrial aerobic composting facilities, where thermophilic conditions are achieved.

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

1.3 The properties in this specification are those required to determine if end items (including packaging), which use plastics and polymers as coatings or binders will compost satisfactorily, in large scale aerobic municipal or industrial composting facilities. Maximum throughput is a high priority to composters and the intermediate stages of plastic disintegration and biodegradation not be visible to the end user for aesthetic reasons.

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 safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—This test method is equivalent to ISO 17088.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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.

Current edition approved Feb. 1, 2023. Published February 2023. Originally approved in 1999. Last previous edition approved in 2022 as D6400 - 22. DOI: 10.1520/D6400-23.

2. Referenced Documents

2.1 ASTM Standards:²

D883 Terminology Relating to Plastics

D5338 Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions, Incorporating Thermophilic Temperatures

D6866 Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis

D6868 Specification for Labeling of End Items that Incorporate Plastics and Polymers as Coatings or Additives with Paper and Other Substrates Designed to be Aerobically Composted in Municipal or Industrial Facilities

2.2 Organization for Economic Development (OECD) Standard:³

OECD Guideline 208 Terrestrial Plant Test: Seedling Emergence and Seedling 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)

2.4 ISO Standard:⁴

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

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, <http://www.ansi.org>.

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

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 17088 Specifications for Compostable Plastics

ISO 20200 Determination of the degree of disintegration of plastic materials under simulated composting conditions in a laboratory-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

Guidelines for Compost Quality, Canadian Council of Ministers of the Environment (CCME), and Ontario Compost Quality Standards, Ontario Ministry of the Environment

2.7 *Standard Methods for the Examination of Water and Wastewater*:⁷

2540G Total, Fixed, and Volatile Solids in Solid and Semi-solid Samples

3. Terminology

3.1 *Definitions*: Definitions appearing in this specification are found in Terminology **D883**, 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.

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*⁸—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).

3.1.4 *degradable plastic*—a plastic designed to undergo a significant change in its chemical structure under specific environmental conditions, resulting in a loss of properties as 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.

3.1.7 *volatile organic solids*—amount of organic matter present determined as the ratio of the difference between the dry mass of test sample and the mass remaining after incineration at 550 °C by the dry mass of test sample.

4. Classification

4.1 The purpose of this specification is to establish requirements for identifying items made from plastics or polymers so that they do not interfere with their satisfactorily composting in commercial and municipal aerobic composting facilities. Products meeting the requirements outlined below be labeled as “compostable in municipal or industrial aerobic facilities” in accordance with the guidelines issued by the Federal Trade Commission⁹ as long as proper qualifications as to the availability of such facilities are included on the label.

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.

5.1.2 *Biodegradation*—A level of biodegradation for the plastic products shall be established by tests under controlled conditions.

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 derived from biowaste without any addition of tested products or reference materials. Additionally, the polymeric products or materials must not introduce unacceptable levels of regulated metals or hazardous substances into the environment, upon sample decomposition.

NOTE 2—For a better understanding of why these criteria are important, consult the *Compost Facility Operating Guide*,⁸ and CEN/TC 261/SC 4 N 99.

6. Detailed Requirements

6.1 In order to be identified as compostable in municipal or industrial aerobic facilities, products must pass the requirements of **6.2**, **6.3**, and **6.4** using the appropriate laboratory tests,

⁹ *Guidelines for the Use of Environmental Marketing Claims*, Federal Trade Commission, Washington, DC, 1992.

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

⁶ Available from the Canadian Council of Ministers of the Environment, and the Ontario Ministry of the Environment.

⁷ Available from Standard Methods, <http://www.standardmethods.org>, (877) 574-1233 or American Public Health Association (APHA), P.O. Box 933019, 6 Atlanta, GA 31193-3019, (888) 320-APHA (2742), <http://www.apha.org/publications/pubscontact>.

⁸ *Compost Facility Operating Guide*, Composting Council, Alexandria, VA, 1995.

representative of the conditions found in aerobic composting facilities, which reach thermophilic temperatures. Finished articles and products shall be tested 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 (84 days) in a controlled composting test, no more than 10 % of its original dry weight remains after sieving on a 2.0-mm sieve. The test shall be carried out in accordance with ISO 16929 with a minimum vessel volume of 35 L, or ISO 20200 under thermophilic aerobic composting conditions.

6.3 Biodegradation—A plastic product must demonstrate a satisfactory rate of biodegradation by achieving the following ratio of conversion to carbon dioxide found in **6.3.1** and **6.3.1.1** within 180 days using Test Method **D5338**, ISO 14855–1, or ISO 14855–2.

6.3.1 Ninety percent (90 %) of the organic carbon in the whole item or for each organic constituent, which is present in the material at a concentration of more than 1 % (by dry mass), shall be converted to carbon dioxide by the end of the test period when compared to the positive control or in the absolute.

6.3.1.1 Organic constituents present at levels between 1 to 10 % shall be tested individually for compliance to **6.3.1**.

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

6.3.3 Ligno-cellulosic substrates are permitted to fulfill the requirements of **6.3** by demonstrating that they are “materials of natural origin” as defined in Specification **D6868**, and therefore assumed to be biodegradable by showing that over 95 % of their carbon comes from biobased resources, using Test Methods **D6866**. Any polymers or additives derived from biobased sources that are blended with ligno-cellulosic substrates shall separately demonstrate that they meet the requirements of **6.3** if they are more than 1 % of the dry weight of the end item.

6.3.4 Plastic product test samples shall not be subjected to conditions designed to accelerate biodegradation, prior to testing in **6.3**.

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.

6.4 A plastic or product demonstrates satisfactory terrestrial safety if it fulfills all the requirements in **6.4.1**, **6.4.2**, and **6.4.3**:

6.4.1 The plastic or product shall have concentrations of regulated 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 metal concentrations are found in Table 3 of 40 CFR Part 503.13. In Canada, the regulated metals concentrations are found in Table 1 for Compost Category A in Guidelines for Compost Quality published by the Canadian Council of Ministers of the Environment (CCME), and Category AA of the Ontario Compost Quality Standards, published by Ontario Ministry of the Environment.

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.

NOTE 4—Sample composts generated in accordance with ISO 20200 should not be used for ecotoxicity testing unless the concentration of the test items at the start of testing is in accordance with the requirements of ISO 16929.

6.4.3 The plastic or product must contain at least 50 % volatile organic solids content. This is determined by subtracting the residue of a known mass of test sample after incineration at 550 °C from the total dry solids of the same sample, according to Standard Method 2540G:

$$\% \text{ volatile organic solids} = \quad (1)$$

$$\frac{\text{Mass of dried residue} - \text{Mass of residue after ignition}}{\text{Mass of dried residue}} \times 100$$

Where: “Mass of dried residue” (in milligrams) is the dry mass of the test sample used in the incineration test and “Mass of residue after ignition” (in milligrams) is the mass of the test sample or material remaining after incineration.

NOTE 5—For a better understanding of why it is important that the majority of the product adds compostable material and not just inert matter, consult *The Composting Handbook*.¹⁰

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

¹⁰ *The Composting Handbook*, Compost Research & Education Foundation, Elsevier Inc., Editors: Robert Rynk, Ginny Black, Jane Gilbert, Johannes Biala, Jean Bonhotal, Mary Schwarz, Leslie Cooperband, 2021, ISBN: 9780323856027.