Designation: D8410 – 21

Standard Specification for Evaluation of Cellulosic-Fiber-Based Packaging Materials and Products for Compostability in Municipal or Industrial Aerobic Composting Facilities[1]

This standard is issued under the fixed designation D8410; 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 cellulosic-fiber-based packaging materials and products associated with food, landscape waste, and other compost feedstocks, which are intended to be composted under aerobic conditions in municipal and industrial composting facilities, where thermophilic temperatures are achieved.

1.2 This specification covers cellulosic-based uncoated and coated packaging materials and products and covers whole packaging products. Products covered in this specification include cellulosic fiber-based products produced from cellulosic pulp, corrugated materials, containerboard, paper, paperboard, and molded fiber.

1.3 This specification excludes end items where thermoplastic polymer is laminated or extruded to cellulosic substrates.

1.4 This specification is intended to establish the requirements for labeling cellulosic-fiber-based packaging materials and products as "compostable in aerobic municipal and industrial composting facilities" in accordance with the guidelines issued by the Federal Trade Commission,[2] provided the label includes proper qualifications as to the availability of such facilities.

1.5 The properties in this specification are those required to determine if packaging materials and products will compost satisfactorily in large-scale aerobic municipal or industrial composting where maximum throughput is a high priority and where intermediate stages of biodegradation must not be apparent to the end user for aesthetic reasons.

1.6 This specification is technically equivalent to ISO 18606.1.7.

1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 *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.*

1.9 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D996 Terminology of Packaging and Distribution Environments

D1968 Terminology Relating to Paper and Paper Products

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

2.2 *Organization for Economic Development (OECD) Standard:*[4]

OECD Guideline 208 Terrestrial Plants, Growth Test

2.3 *European Standards (EN):*[5]

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

[1] This specification is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.19 on Sustainability & Recycling.

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

[3] 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.

[4] Available from Organisation for Economic Cooperation and Development (OECD), 2 rue André Pascal, F-75775, Paris Cedex 16, France, http://www.oecd.org.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

2.4 *ISO Standards:*[5]

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 Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test

ISO 18606 Packaging and the environment — Organic recycling

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

2.5 *Standard Methods for the Examination of Water and Wastewater:*[6]

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

2.6 *Government Standards:*

USEPA Method 1684 Total, Fixed, and Volatile Solids in Water, Solids, and Biosolids[7]

40 CFR Part 503.13 Standards for the Use or Disposal of Sewage Sludge[8]

3. Terminology

3.1 *Definitions*—Terms appearing in this specification are found in Terminologies D996 and D1968, unless otherwise noted.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *additive, n pl*—substances added to cellulosic fiber to impart or enhance material properties or to improve production efficiencies. Additives can be mixed and incorporated into or applied to the surface of the cellulosic material as a coating.

3.2.2 *blank composts, n*—compost generated without the addition of the test material.

3.2.3 *cellulosic, adj*—material derived from or containing cellulose.

3.2.4 *materials of natural origin, n*—chemically unmodified ligno-cellulosic and other naturally occurring organic materials, such as wood, wood fiber, cotton fiber, starch, recycled fiber pulp, or jute.

3.2.5 *mesophilic, adj*—the moderate-temperature phase where certain microorganisms are active. Mesophilic microorganisms are primarily active up to 40 °C and then activity trails off towards thermophilic temperatures.

3.2.6 *package component, n*—the identifiable parts that together constitute the packaging product. Examples of components include paper, paperboard, inks, and adhesives.

3.2.7 *packaging product, n*—the final article in the form in which it is to be used as packaging and ultimately composted. The product may consist of a single or multiple component(s).

3.2.8 *positive control, n*—a reference material known to be biodegradable used to validate the viability of the microbial community, and to provide a comparison with the test material under evaluation. The positive reference material is typically microcrystalline cellulose.

3.2.9 *thermophilic, adj*—the high-temperature phase where certain microorganisms are active. Thermophilic microorganisms begin to become active around 40 °C with highest activity between 50 °C and 60 °C. Thermophilic microorganisms begin to die off above 65 °C.

3.2.10 *volatile organic solids, n*—determined by comparing the dry weight to the mass remaining after incineration at 550 °C which determines the amount of organic matter.

4. Classification

4.1 This specification covers one type of packaging material: cellulosic-fiber-based packaging, with or without additives, or adhesives.

4.2 The packaging product is intended to be used to protect, hold or transport contents that are or become desirable organic wastes for composting.

4.3 The purpose of this specification is to allow for the identification of these packaging materials as satisfactorily composting in commercial and municipal aerobic composting facilities. Products meeting the requirements outlined below shall be eligible to be labeled as "compostable in municipal or industrial aerobic composting facilities" in accordance with the guidelines issued by the Federal Trade Commission[2] as long as proper qualifications as to the availability of such facilities are included on the label.

5. Materials and Manufacture

5.1 For packaging components and products that are made in multiple thicknesses or densities, only the thickest or most dense products need to be tested for disintegration as long as the chemical composition and structure remains otherwise the same. It is presumed that lower thickness and densities of the same products will also compost satisfactorily.

5.2 If the packaging product is too large to be tested in its entirety in the disintegration test, it is acceptable to take a representative portion of that product, provided the thickest or densest portions of the product are used.

5.3 If additives are present in test samples at a given dry weight percentage of the whole product and the product satisfies the requirements of Section 6, then the same product with lower levels of the same additives also satisfy the requirements.

5.4 Packaging products which are constructed from components that have satisfied the requirements of this specification combined with some components that have not, must still be shown to satisfy the requirements.

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

[7] Available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, https://www.epa.gov/sites/production/files/2015-10/documents/method_1684_draft_2001.pdf

[8] Available from U.S. Government Publishing Office (GPO), 732 N. Capitol St., NW, Washington, DC 20401, http://www.gpo.gov.

6. Basic Requirements

6.1 In order to comply with the requirements of this specification satisfactorily, a packaging product must demonstrate each of the characteristics found in 6.1.1 – 6.1.4, and quantified in Section 7.

6.1.1 *Disintegration During Composting*—A packaging product shall disintegrate during composting such that any remaining residuals (are not readily distinguishable from the other organic materials in the finished compost product. This means that any remaining fragments after sieving must not differ significantly in appearance, texture, or size from the surrounding compost.

6.1.2 *Biodegradation*—A level of biodegradation for the fiber-based packaging product, including any additives, shall be established by tests under controlled conditions.

6.1.3 *No Adverse Impacts on Ability of Compost to Support Plant Growth*—After incorporation with soils, the composted packaging shall not adversely impact on the ability of the compost to support plant growth, when compared to composts derived from biowaste without any addition of tested products, materials, or reference materials.

6.1.4 *Chemical Composition*—The packaging products and its components must not introduce unacceptable levels of heavy metals or other toxic substances into the environment, upon material decomposition. Also, the packaging product must be at least 50 % volatile organic matter. This shows that the majority of the product adds compostable material and not just inert matter.

NOTE 1—To better understand why these criteria are important, consult the U.S. Composting Council's Compost Facility Operating Guide[9] and EN 13432.

7. Detailed Requirements

7.1 In order to be identified as compostable in municipal or industrial aerobic facilities, packaging products, and components, must pass the requirements of 7.2 – 7.5, using the appropriate laboratory tests, representative of the conditions found in aerobic composting facilities.

7.2 *Disintegration During Composting*—Packaging products shall be tested in the same form as they are intended to be used or, if too large, a suitably sized sample shall be taken from the product. A packaging product, or component, 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. The particles or pieces which cannot be differentiated from the compost for color, structure, dimension, moisture feeling are considered to be compost.

7.2.1 The test shall be carried out in accordance with ISO 16929 with a minimum vessel volume of 35 L or ISO 20200 with a minimum vessel volume of 5 L and operated under thermophilic aerobic composting conditions.

NOTE 2—Using ISO 20200, it is advisable to test larger volumes than the minimum 5 L, because larger volumes can accommodate larger-sized samples that represent the packaging products more realistically, as larger volumes are more representative of the physical interactions in composting operations.

7.2.2 Any remains of the composted packaging product, component, or additive must not significantly reduce the visual acceptability of the compost.

7.3 *Biodegradation*—Each packaging product, component or additive must be established as biodegradable as a whole or for each organic component or additive.

NOTE 3—*Biodegradation* must not be confused with disintegration. Biodegradation reflects the inherent nature of the material to be consumed by microorganisms, whereas disintegration demonstrates that the material will degrade physically into fragments during the composting process. Biodegradation takes place on the molecular level.

7.3.1 A packaging product or component, or additive is considered to have achieved a satisfactory level of biodegradation if it has demonstrated that 90 % of the organic carbon in the test sample has been converted to carbon dioxide within 180 days when tested at 58 °C (±2 °C), using Test Method D5338 or ISO 14855.

7.3.1.1 Alternatively, a satisfactory level of biodegradation is achieved if 90 % of the organic carbon in the test sample has been converted to carbon dioxide relative to the conversion of the carbon in the positive control at the same point in time of the test. In this case the carbon dioxide generation of the reference control material must have reached a plateau before the relative comparison is made. The maximum duration of the composting is 180 days.

7.3.2 The cellulosic fiber-based substrate or components are permitted to fulfill the requirements of biodegradation without testing if they are "materials of natural origin," demonstrated by showing that over 95 % of their carbon comes from biobased resources, using Test Methods D6866. Materials of natural origin are assumed to be biodegradable.

7.3.3 Any organic component or material present in the packaging product at between 1 % and 10 %, based on dry weight, shall separately meet the requirements of 7.3.1 and 7.3.2.

7.3.4 Organic packaging components or additives present in the packaging product at less than 1 % by dry weight do not need to demonstrate biodegradability. However, the total amount of components or additives shall not exceed 5 % of the packaging product by weight.

7.4 *No Adverse Impacts on Ability of Compost to Support Plant Growth*—If a fiber-based packaging product fulfills the requirements in 7.4.1 and 7.4.2, it will have demonstrated satisfactory terrestrial plant safety.

7.4.1 The germination rate and the plant biomass of the sample composts shall be no less than 90 % of the values obtained from the corresponding blank composts for two different plant species, following OECD Guideline 208 with the modifications found in Annex B of ISO 18606.

7.4.2 The sample and blank composts to be used for the plant toxicity tests of 7.4.1 shall be prepared according to ISO 16929, with both composts being produced from the same feedstock. The sample compost shall begin the pilot-scale composting with a 10 % input loading of the packaging product. If individual package materials are tested separately

[9] *Compost Facility Operating Guide*, U.S. Composting Council, Raleigh, NC, 1995.