

Australian Standard[®]

**Biodegradable plastics—Biodegradable
plastics suitable for home composting**



This Australian Standard® was prepared by Committee EV-017, Degradability of Plastics. It was approved on behalf of the Council of Standards Australia on 6 July 2010. This Standard was published on 26 July 2010.

The following are represented on Committee EV-017:

- Australasian Bioplastics Association
 - CSIRO
 - National Association of Testing Authorities Australia
 - National Environment Protection and Heritage Council
 - NSW Advisory Council on Recreational Fishing
 - Planet Ark foundation
 - Plastics and Chemicals Industries Association
 - Queensland University of Technology
 - Waste Management Association of Australia
-

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PREFACE

This Standard was prepared by the Standards Australia Committee EV-017, Degradability of Plastics, to assist authorities that regulate polymeric materials entering into the Australian market, and ensure product quality with respect to biodegradability and toxicity claims.

This Standard forms part of a series of test methods and performance standards to enable certification bodies to validate and, if appropriate, support claims.

The Environment Protection and Heritage Council agreed to initiate the development of Australian Standards on degradation of plastics for disposal environments in Australia. The objective being to reduce accumulation of polymeric waste materials in the environment by composting, and other aerobic and anaerobic microbial degradation.

This Standard applies the principles of AS 4736—2006, *Biodegradable plastics—Biodegradable plastics suitable for composting and other microbial treatment*, to determine the suitability of biodegradable plastics for home composting.

In the preparation of this Standard, the Committee also referred to the following:

- (a) OK Compost HOME: Initial acceptance tests, Program OK 2 Home compostability of products, AIB-VINCOTTE International, Edition C.
- (b) AIB-VINCOTTE International, Edition C.
- (c) ISO 17088:2008, *Specifications for compostable plastics*.

Test methods and limit values for compost may be introduced into future revisions of this Standard as more experience is gained.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard

Biodegradable plastics—Biodegradable plastics suitable for home composting**1 SCOPE**

This Standard specifies requirements and procedures to determine whether a plastic material is biodegradable in home composting conditions and provides the basis to allow labelling of materials or products made from plastics as ‘home compostable’, for use in home composting systems.

This Standard stipulates pass/fail criteria addressing biodegradability, disintegration during biological treatment, effect on the biological treatment process and effect on the quality of the resulting home compost.

Home composting systems vary considerably in their design, construction and operation; hence their performance also varies considerably compared to commercial composting facilities. Consequently, this Standard, in comparison to AS 4736, uses lower temperatures in test environments and a longer test duration, to account for such variations in home composting performance.

2 REFERENCED DOCUMENTS*

The following documents are referred to in this Standard:

AS

4454 Composts, soil conditioners and mulches

4736 Biodegradable plastics—Biodegradable plastics suitable for composting and other microbial treatment

AS ISO

14852 Plastic materials—Determination of the ultimate aerobic biodegradability in an aqueous medium—Method by analysis of evolved carbon dioxide

14855 Plastic materials—Determination of the ultimate aerobic biodegradability and disintegration under controlled composting conditions—Method by analysis of evolved carbon dioxide

ISO

10634 Water quality—Guidance for the preparation and treatment of poorly water-soluble organic compounds for the subsequent evaluation of their biodegradability in an aqueous medium

14851 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium—Method by measuring the oxygen demand in a closed respirometer

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

* For additional information see documents listed in Appendix B.

ASTM	
E1676	Standard guide for conducting laboratory soil toxicity or bioaccumulation tests with the Lumbricid Earthworm <i>Eisenia fetida</i> and the Enchytraeid Potworm <i>Enchytraeus albidus</i>
EN	
13432	Packaging—Requirements for packaging recoverable through composting and biodegradation—Test scheme and evaluation criteria for the final acceptance of packaging

3 DEFINITIONS

For the purposes of this Standard, the following definitions apply:

3.1 Biodegradability

The ability of organic substances to be broken down by micro-organisms in the presence of oxygen (aerobic) to carbon dioxide, water, biomass and mineral salts or any other elements that are present (mineralization).

3.2 Component

A part of a plastic product that can be separated by hand or by using simple physical means.

3.3 Composting

The aerobic degradation of organic matter to make compost.

3.4 Constituent

The chemical materials and substances of which a plastic is composed.

3.5 Disintegration

The physical breakdown of material into very small fragments (ISO 20200).

3.6 Home compost

The product of privately or home generated organic waste, such as food, garden and paper product waste, which has been subjected to composting, and which product is applied to private property soils without any commercial transaction.

3.7 Home compost system

A system to produce home compost.

3.8 Plastic

A material that contains large molecular weight organic polymeric substances as an essential ingredient.

3.9 Reference substance

A micro-crystalline cellulose powder with known characteristics for comparison with samples under test

NOTE: Avicel has been found to be a suitable reference substance.

3.10 Total dry solids

The amount of solids obtained by drying material at 105–110°C to a constant weight.

3.11 Volatile solids

The amount of solids obtained by subtracting the residues of a material after incineration at 550–580°C from the total dry solids content. The volatile solids content is an indication of the amount of organic matter in the material.

4 GENERAL REQUIREMENTS AND CONSIDERATIONS

4.1 Equivalent form

A plastic demonstrated to be ‘home compostable’ in a particular form shall be accepted as being home compostable in any other form having the same or a smaller mass-to-surface ratio or wall thickness.

NOTES:

- 1 For a plastic of equivalent form that has been accepted using a higher thickness or mass to surface area ratio, no further testing is required.
- 2 For a plastic of equivalent form that has been accepted using a lower thickness or mass to surface area ratio, further testing is required only for the assessment of disintegration.

4.2 Different components

In the case of a plastic product formed from different components, some of which are compostable and some others not, the product itself, as a whole shall not be designated ‘home compostable’. However, if the components can be separated by hand before disposal, the compostable components may be effectively considered and treated as such, once separated from the non-compostable components.

NOTE: The user should report whether the plastic product (i.e. test material) is a single (i.e. monocomponent) product or an assembly (i.e. multicomponent) product. If it is to be tested as a single plastic material then any attached components (e.g. adhesive labels, caps/closures) likely to be separated by a user at the end of the product’s life, are to be first physically separated. If the product is a multicomponent product (e.g. nappy) then the entire assembly should be tested.

4.3 Conditions prior to entering a home composting process

The following should be considered in advance of the market release of plastic intended for entering a home compost system:

- (a) The fulfillment of the quality criteria for compost input material alone will not necessarily lead to the production of quality compost.
- (b) The contents filled into a compostable plastic container that remains in parts or as a whole in the plastic container after the normal use should be home compostable and neither toxic nor hazardous.
- (c) If the shape of the plastic component is a hollow body, it should not be closed and should preferably be empty.

5 ASSESSMENT

5.1 Designation

The plastic product or plastic component shall only be designated as ‘home compostable’ if all the criteria set out in this Clause 5 are met.

5.2 Assessment

Assessment of plastics shall include the following four procedures, which are covered in Clauses 5.3 to 5.6:

- (a) Characterization.
- (b) Biodegradability.
- (c) Disintegration.
- (d) Compost quality (including toxicity).

5.3 Characterization

5.3.1 General

Characterization is the determination of the constituents of plastics. This is important because some constituents can be harmful to the environment.

5.3.2 Criteria

Each plastic under investigation shall be identified and characterized prior to testing as follows:

- The information about and identification of each component of the plastic (e.g. thickness) shall be determined or obtained, and recorded.
- The volatile solids content of the plastic shall be determined and recorded. The plastic shall maintain a minimum of 50% of volatile solids.
- The presence of heavy metals and other toxic and hazardous substances shall be determined and recorded. The concentration of any constituent present in a plastic shall not exceed the value given in Table 1.
- The organic carbon content and total dry solids of the plastic shall be determined and recorded.
- The thickness of the plastic shall be determined and recorded.
- The colour constituents of the plastic shall be determined and recorded.

NOTE: Colourants can affect the outcomes of test, in particular, ecotoxicity.

TABLE 1
MAXIMUM ELEMENT CONTENT OF PLASTIC

Element	Maximum content mg/kg	Element	Maximum content mg/kg
Zn	150	Cr	50
Cu	50	Mo	1
Ni	25	Se	0.75
Cd	0.5	As	5
Pb	50	F	100
Hg	0.5		

NOTE: This is based on the table included in EN 13432:2000 and AS 4736.

5.4 Biodegradability

5.4.1 General

This process involves the alteration of the chemical structure of plastic brought about by biological action, resulting in the loss of a specific property of the substance.

Biodegradability shall be determined for all organic constituents of the plastic as a total material including dyes, inks and colours.

5.4.2 Aerobic biodegradability

5.4.2.1 Criteria

Test samples shall not be subjected to conditions that will accelerate biodegradation prior to testing.

The maximum period of this test shall be 12 months.

The test sample shall degrade at least 90% w/w (dry weight) in total or equal to the maximum degradation of a suitable reference substance (see Clause 3.9). The maximum percentage biodegradation of the reference substance shall only be obtained after a plateau has been reached in the rate of biodegradation.

The ultimate aerobic biodegradability shall be determined for the whole material or for each organic constituent that is present in the material at a concentration of more than 1% (by dry mass). Constituents that are present at concentrations of less than 1% do not need to demonstrate biodegradability. However, the sum of such constituents shall not exceed 5%.

5.4.2.2 *Test method*

The limit value for biodegradation is based on conversion of the carbon of the test material into carbon dioxide and biomass. The details of calculation depend on the test and analytical methods used.

AS ISO 14855 shall be used as the standard test method, unless inappropriate for the type and properties of the plastic under test. When alternative methods are necessary, either ISO 14851 or AS ISO 14852 shall be used. For all test methods (AS ISO 14855, ISO 14851, and AS ISO 14852), the test environment shall be at an ambient temperature of $25 \pm 5^\circ\text{C}$. The temperature shall be kept below 30°C for the duration of the test.

Information on how to handle materials having poor water solubility for use in aquatic biodegradation tests may be obtained from ISO 10634.

5.5 Disintegration

5.5.1 *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 providing the chemical composition and structure remains otherwise the same.

Due to the nature and analytical conditions of the disintegration test, the test results cannot differentiate between biodegradation and abiotic disintegration. It shall be demonstrated that a sufficient disintegration of the test material is achieved within the specified treatment time of 180 days.

When tests on ecotoxicity are performed it is important to use compost from disintegration tests that have been run with and without the test material to compare the test results directly and to find out any relative ecotoxic effects.

Special attention should be given to the visual aspects of compost.

NOTES:

- 1 The compost generated from the disintegration test may be used for assessment of compost quality (see Clause 5.6).
- 2 If the compost quality of the product has already been assessed under AS 4736, the result from AS 4736 can be used to meet ecotoxicity criteria, as outlined under Clause 5.6.3 of this Standard.
- 3 Two evaluative methods are available for assessment of disintegration. If a product is to be tested only for disintegration, either ISO 20200 or a slide frame test may be used. If a product is to be tested for disintegration and ecotoxicity in one test series (as per Clause 5.6) it is necessary to use the method as outlined in ISO 20200.

5.5.2 *Criteria*

When tested to ISO 20200 as modified by Clause 5.5.3 below, a plastic product shall be considered to have demonstrated satisfactory disintegration if, after 180 days in a controlled composting test, no more than 10% w/w (dry weight) of the original dry weight of test material fails to pass through a 2 mm fraction sieve. Any remaining plastic residue shall not be distinguishable from the other material in the compost at 500 mm as observed by the naked eye.

For the slide frame test as set out in Clause 5.5.3, the criterion for evaluation is that 90% of the film has disintegrated from the slide frame and any remaining plastic residue shall not be distinguishable from the other material in the compost at 500 mm as observed by the naked eye.

5.5.3 *Test method*

For measurement of the degree of disintegration either ISO 20200 or 35 mm photographic slide frames may be used.

ISO 20200 shall be used with the following modifications:

- (a) The test environment shall be at a temperature of $25 \pm 5^\circ\text{C}$.
- (b) The test duration shall be 180 days.

If using the slide frame test, the test material shall be prepared as a plastic film clamped to standard 35 mm photographic slide frames (5 cm × 5 cm). The slide frames, mixed with the compost inoculum, shall be incubated at ambient temperatures in the dark. Care shall be taken during regular turning and mixing of the compost to ensure structural integrity of the slides is maintained. At the termination of the test, slide frames shall be retrieved and visually inspected.

For measurement of the degree of disintegration and ecotoxicity in one test series, ISO 20200 shall be used, with the following modification:

The plastic sample shall be added to the biowaste in a concentration of 10% (wet weight basis) before starting the compost process.

5.6 **Compost quality**

5.6.1 *General*

As the quality of compost may be influenced by any plastic added, it is preferable that evaluation of any possible environmental risk attaching to such compost be based upon the best available criteria on compost quality. This may be achieved, for example, by determination of the ecotoxicological effects of the biodegradation products of plastic or by performing ecotoxicological tests with compost produced with and without plastic and comparison of the test results.

5.6.2 *Negative effect*

5.6.2.1 *Criteria*

The quality of compost produced by a given control waste treatment process shall not be negatively affected by the addition of the plastic under test.

The physical and chemical parameters of the compost with and without addition of plastic shall be compared as set out in Clause 5.6.2.2.

5.6.2.2 *Test method*

The following parameters shall be measured in accordance with AS 4454 and used for the comparison:

- (a) Volumetric weight (density).

- (b) Total dry solids.
- (c) Volatile solids.
- (d) Salt content.
- (e) pH value.
- (f) The presence of total nitrogen, ammonium nitrogen, phosphorus, magnesium and potassium.

5.6.2.3 Report

The comparison of the parameters measured in the procedure shall be recorded.

5.6.3 Ecotoxicity

5.6.3.1 General

Any toxicity effect of biodegraded metabolites of plastic can have an adverse effect on plant germination, plant growth and earthworms. Therefore, it is necessary to assess any such effects on those species due to the presence of plastic residues and metabolites.

5.6.3.2 Criteria

Ecotoxic effects on two higher plants shall be determined as set out in Clause 3.6.3.3, using Appendix E of EN 13432 to compare the compost produced with and without addition of plastic. The germination rate and the plant biomass of the sample composts of both plant species shall be more than 90% of those from the corresponding blank compost.

Ecotoxic effects on worms shall be determined by ASTM E1676, if there is greater than 10% difference in the morbidity or mean weight of surviving worms between the treated compost and the control, this criterion is not met.

5.6.3.3 Test method

5.6.3.3.1 General

ASTM E1676 14-day *Eisenia fetida* earthworm toxicity test shall be used in addition to the plant growth test method in Appendix E of EN 13432.

5.6.3.3.2 Reference substrate

Any reference substrate is suitable if it allows normal seed germination and plant growth. It should preferably have a composition and structure similar to the compost samples. Fertilizers shall not have been added.

Suitable reference substrates are given in AS 4454.

5.6.3.3.3 Preparation of samples

The samples shall be prepared as follows:

- (a) Prepare mixtures of the reference substrate with 25% and 50% (w/w or v/v) of compost.
- (b) Use the compost obtained after disintegration of the test material (sample compost) and the blank compost, obtained from the parallel process without addition of test material.

5.6.3.3.4 Procedure

The procedure shall be as follows:

- (a) Fill each tray with a minimum of 200 g of the samples as in Clause 5.6.3.3.3.
- (b) Add as a minimum 100 seeds comprising at least two species as specified in Appendix E of EN 13432, on the top. It is recommended to spread seeds out when planting to reduce the effect of enhanced germination from planting seeds clumped together.

- (c) Cover the seeds with a thin layer of inert material, such as siliceous sand or perlite.
- (d) Perform the tests in accordance with ASTM E1676, in three parallels for each mixture.
- (e) Add water until 70% to 100% of the water holding capacity is reached.
- (f) Supply distilled water periodically during the whole test duration as needed. It is of advantage to keep the trays in a dark place or to cover them during the germination period.

5.6.3.3.5 *Calculation and comparison of results*

The germination numbers (number of grown plants) and the plant biomass of the sample compost and the blank compost shall be compared in all mixing rates. Both germination rate and biomass shall be calculated as a percent of the corresponding values obtained with the blank compost.

6 RECORDING OF ASSESSMENT OUTCOME

6.1 Check list

For each plastic sample the result of each assessment or test undertaken (as required in Clause 5.2) shall be recorded, for example, on an assessment check list. The documentation shall provide for the identification of any supplementary information (including externally sourced technical data) that is necessary to support the conclusions reached in the assessments. The documentation shall be retained and made available for inspection if required.

NOTE: A recommended check list is given in Appendix A.

6.2 Supporting documentation

The check list together with any other information (including externally sourced technical data) necessary to support the conclusions reached in the assessments shall be retained and made available for inspection if required.

7 ORGANIZATION OF A TEST SCHEME

To be designated ‘home compostable’ the plastic shall meet all the criteria of the five procedures set out in Clause 5.3 to Clause 5.6.

There is no requirement for the procedures to be organized in any particular way or sequence.

Where required, the disintegration test may also be used to obtain information on any negative effects that the plastic could have on the composting process.

APPENDIX A
RECOMMENDED FORMAT FOR A CONFORMITY
ASSESSMENT CHECK LIST

(Informative)

Identification of supplier:		Date: / /
Identification of plastic:		
Assessment file reference:		
Overall result of assessment		Accept Reject
Questions to be considered for each mono-plastic material	Pass/Fail	Other details/comments/ rationale/ test method No.
Characteristics		
Is information provided on the thickness and constituents of the plastic?		
Does the plastic meet the hazard material criteria?		
Is all information provided on the thickness, organic content, total dry solids and volatile solids?		
Biodegradability		
Are all the requirements of AS ISO 14855 met? (If ISO 14851 and AS ISO 14852 are considered, are all their requirements met?)		
Disintegration		
Are all the requirements of ISO 20200 met? (as modified by Clause 5.5.3)		
Compost quality		
Are all the requirements of EN 13432, Appendix E met?		
Are all the requirements of ASTM E1676 met?		
The plastic has previously been tested with higher mass to surface ratio. See assessment file reference:		
Minor changes have been made which do not influence the fulfilment of the Standard.		Yes/No
Nature of changes:		
Comment (if any):		
Signature and status of person responsible for this assessment:		
Signature: Status:		

APPENDIX B
BIBLIOGRAPHY

(Informative)

- 1 EN 12880, *Characterization of sludges—Determination of dry residue and water content.*
- 2 ISO 11074, *Soil quality—Vocabulary.*
- 3 ISO 11734, *Water quality—Evaluation of the ‘ultimate’ anaerobic biodegradability of organic compounds in digested sludge—Method by measurement of the biogas production.*
- 4 ISO 15985, *Plastics—Determination of the ultimate anaerobic biodegradability and disintegration under high-solids anaerobic-digestion conditions—Method by analysis of released biogas.*
- 5 ISO 17088, *Specifications for compostable plastics.*
- 6 ISO/TR 15462, *Water quality—Selection of tests for biodegradability.*
- 7 Commission Decision of 7 April 1998 establishing the ecological criteria for the award of the Community eco-label to soil improvers. *Official Journal of Australian Union, OJL, 219, 7.8.98, p.39.*
- 8 ÖNorm S 2201:2009, *Organic Waste—Quality requirements.*
- 9 EN 13040:2007, *Soil improvers and growing media. Sample preparation for chemical and physical tests, determination of dry matter content, moisture content and laboratory compacted bulk density.*

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