

**BACK
GROUND**

APR 2015

*EN 13432 CERTIFIED BIOPLASTICS
PERFORMANCE IN INDUSTRIAL COMPOSTING*



1. INTRODUCTION

The Directive on Packaging and Packaging Waste (PPWD) was first issued in 1994. Its main purpose was to increase the recovery rate of packaging waste and to cut disposal (landfilling). Apart from mechanical recycling also biological (organic) recycling¹ was defined, and a specific standard for identifying "packaging recoverable by means of biodegradation and composting" was requested from CEN. The standard prepared under the EC Mandate M200² was finalised in 2000 at the same time as other standards on reuse, mechanical recycling and energy recovery. However, it was the only one to be immediately accepted by the EC as a harmonised standard³, while another round of standardisation work was required for the others.

The EN 13432 standard "Packaging - Requirements for packaging recoverable through composting and biodegradation - Test scheme and evaluation criteria for the final acceptance of packaging" specifies requirements and procedures to determine the compostability and anaerobic treatability of packaging and packaging materials. It addresses the following characteristics: biodegradability, disintegration during biological treatment, effect on the biological treatment process and effect on the quality of the resulting compost. Typical examples of compostable plastics are cellulose films, starch blends, polylactic acid and PBAT⁴. Biodegradability does not depend on the origin of the material but exclusively on its chemical structure. The term bioplastics thereby refers to plastics that are biobased, biodegradable or both⁵.

This paper aims to show that the requirements for bioplastics to be certified according to EN 13432 are well described and more than sufficient to make them processable for industrial composting. Furthermore, EN 13432 certified packaging and bags can positively contribute to an increased collection of organic waste, leading to a diversion of organic waste out of landfills and into biological treatment, thereby reducing methane emissions from landfills⁶.

2. FACTS ABOUT EN 13432

The requirements for bioplastics to be certified as compostable have been well established and proven in different field tests. The European standard EN 13432 defines the minimum requirements packaging has to meet in order to be processed by industrial composting. Similar requirements are in place in the European Standard EN 14995 for non-packaging plastic items. EN 13432 requires that the following four characteristics are tested in a laboratory:

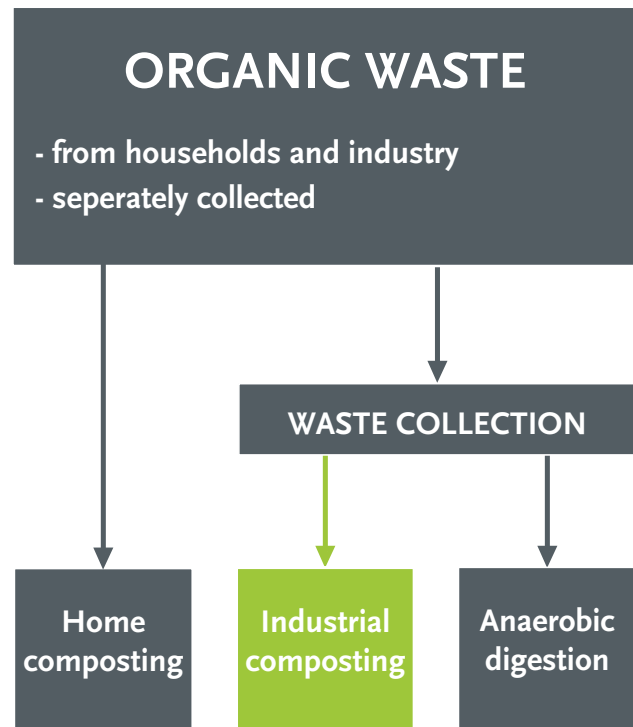


FIGURE 1: OPTIONS FOR ORGANIC WASTE MANAGEMENT

This paper focuses exclusively on the performance of EN 13432 certified plastics in industrial composting and does not consider its suitability for home composting or other means of disposal. The paper begins by introducing the most important aspects of EN 13432 and provides insight into existing composting infrastructures and mechanisms.

- Disintegration, namely fragmentation and loss of visibility in the final compost - this is measured in a pilot composting test (EN 14045) in which specimens of the test material are composted with biowaste for 3 months. After this time, the mass of test material residues has to amount to less than 10% of the original mass.

¹ European Directive 94/62/EC of 20 December 1994. Article 3, Paragraph 9. 'Organic recycling' shall mean the aerobic (composting) or anaerobic (biomethanisation) treatment, under controlled conditions and using microorganisms, of the biodegradable parts of packaging waste, which produces stabilized organic residues or methane. Landfill is not considered to be a form of organic recycling. Official Journal L 365, 31/12/1994 P. 0010 - 0023

² M/200 Mandate to CEN for standardisation and study related to packaging and packaging waste

³ 2001/524/EC: Commission decision of 28 June 2001. Official Journal L 190, 12/07/2001 P. 0021 - 0023

⁴ Poly(butylene adipate-co-terephthalate)

⁵ The term bioplastics constitutes two main groups: 1. Biobased, non-biodegradable plastics, such as biobased PE or biobased PET; 2. Compostable / biodegradable plastics, e.g. starch blends or PLA.

⁶ As compostable products are usually rich in carbon and low in nitrogen they can also have a favourable influence on the C/N ratio of biowaste and the resulting compost. Biowaste often has a low C/N ratio leading to ammonia toxicity and odour problems. Compostable products thus can make the separate adding of carbon-rich co-substrates to biowaste unnecessary.

- Biodegradability, namely the capability of the compostable material to be converted into CO₂ under the action of microorganisms. The standard contains a mandatory threshold of at least 90 percent biodegradation that must be reached in less than 6 months (laboratory test method EN 14046).
- Absence of negative effects on the composting process.
- Amount of heavy metals has to be below given maximum values, and the final compost must not be affected negatively (no reduction of agronomic value and no ecotoxicological effects on plant growth).

The following section shows that biodegradable plastics meeting the requirements of EN 13432 perform well in industrial composting plants.

3. COMPOSTING INFRASTRUCTURE

In quite a number of European countries, e.g. Austria, Belgium, Germany, Italy and the Netherlands, industrial composting is already well established and a widely accepted part of the waste recovery infrastructure. Other EU countries still need to catch up to achieve an equivalent level of industrial composting. However, a decent separate waste collection system is fundamental to implementing organic recycling and thus industrial composting.⁷

Plastics certified according to EN 13432 can be recognised by the “Seedling” logo (figure 2). Together with a proper communication, this label helps consumers to correctly identify the compostable material. The certified, compostable plastics are sent to industrial composting plants by disposal as organic waste, whereas non-compostable plastics can be treated as usual in the appropriate waste streams (e.g. mechanical recycling).



compostable

FIGURE 2: THE SEEDLING LOGO (EUROPEAN BIOPLASTICS TRADEMARK) IS A LABEL FOR COMPOSTABLE PACKAGING CERTIFIED ACCORDING TO EN 13432.

4. (INDUSTRIAL) COMPOSTING MECHANISM

Industrial composting is a controlled process that can be divided into two distinct phases: active composting (rotting) followed by curing (post-rotting). The duration of the active composting phase depends on the type of composting. Under normal composting conditions, microorganisms grow on the organic waste, breaking it down into CO₂ and water and using it as a nutrient and energy source. Part of the energy is released into the surrounding environment as heat. Organic waste is amassed in piles during composting and, as a consequence, the temperature within the piles rises. With increasing temperature, the microbial populations in the composting pile shift; microbes adapted to ambient temperature (mesophiles) stop activity or even die and are replaced by microbes adapted to living at high temperature (thermophiles). At industrial composting facilities, temperatures in the composting heaps range between 50°C and 60°C. The rate of decomposition declines to a slow and steady pace during the curing phase and the compost matures at

temperatures in the lower mesophilic range (< 40°C) with synthesis of humic substances. In practice, a broad range of composting plant technologies exists. Table 1 (adapted from the C.A.R.M.E.N. study from 2011⁸) gives an overview of the six most commonly used composting systems in Germany⁹ and their usual active composting times.

EN 13432 demands 90 percent disintegration within 12 weeks to be demonstrated in a pilot test. Studies carried out by the ISR-ASTM (Institute for Standard Research) in the USA in the early 90s showed that the degradation results obtained in the laboratory are conservative in comparison to those from real-scale plants¹⁰. Therefore, the direct application of limits and duration defined for laboratory testing on full-scale plants is not advisable. A full-scale test should be carried out at a specific plant with a specific composting technology in case doubts remain about the suitability of an

⁷ A “European Composting Landscape” is currently being developed by European Bioplastics as a separate project.

⁸ B. Fink et al. “How compatible are compostable bags with major industrial composting and digestion technologies?”, C.A.R.M.E.N., 2011.

⁹ The study by C.A.R.M.E.N. focussed on industrial composting technologies in Germany only. However, similar types of composting systems also exist in other EU countries.

¹⁰ De Wilde, Bruno; Tillinger Richard; ASTM Institute for standard research (1996): ISR Degradable Polymeric Materials Research Program: Final Program Report. West Conshohocken, PA.

EN 13432 packaging waste. Most compostable plastics disintegrate in a much shorter period of time and, therefore, are suitable with most of the composting systems listed above. Especially plants with forced ventilation and intensive rotting achieve much faster composting rates than those simulated in a laboratory. If residues are discovered, they will degrade during the post-rotting step. The C.A.R.M.E.N. study carried out tests to investigate the processability and composting of different plastics in industrial composting plants. The materials tested have all been certified according to EN 13432. The examinations cover a range of the most popular materials, i.e. different starch compositions (like thermoplastic starch in combination with biodegradable polyesters), polylactic acid based materials (blended with biodegradable polyester), and PBAT, which is also often blended with PLA.

The thickness of the material plays an important role in meeting the requirements of EN 13432. The 12-week test duration is linked to a maximum thickness specified in the final results of the tests. The vast majority of materials on the market, especially compostable bags, are much thinner and therefore require less than 12 weeks to degrade¹¹. Most systems also include a sieving step between the active composting and the post-rotting phase with an internal recycling loop. Materials not fully composted (often including natural materials such as branches) go back to the start of the active composting process.

TABLE 1: MOST COMMON COMPOSTING TECHNIQUES TO BE FOUND IN GERMANY (FROM C.A.R.M.E.N. 2011)

Type of composting system	Description of system	Active composting	Post-rotting
Rotting boxes (e.g. Herhof type)	Closed, air-forced, no turning applicable, humidification by process and industrial water	7-10 days	56-70 days
Tunnel system (e.g. Horstmann WTT)	Conditioned organic waste loaded into a tunnel, final composting in windrow, forced aeration, no turning applicable, humidification by process and industrial water	2-3 weeks	5 weeks
Enclosed windrow (e.g. Bühler-Wendelin)	Forced aeration, automatic turning process included, humidification by industrial and process water (up to 4 1/2 weeks)	9 weeks	3-4 weeks
Trapezoidal windrow (open air)	Prefermentation, includes a 3-week anaerobic period, turning performed, additional aeration not applicable, humidification up to 2 1/2 weeks (industrial and process water used during turning process)	5 weeks	8-12 weeks
Triangular windrow, covered	Simplest form of composting, no forced aeration, turning performed weekly (later every 3 weeks), humidification up to 2 weeks (industrial and process water used during turning process when required)	4 weeks, average 4-6 months	n.a.
Triangular windrow, not covered	Flexible composting time and degree of composting, additional aeration not applicable, turning required at least every four weeks, humidification by industrial and process water (up to 3 weeks during turning process when required)	At least 6 weeks, average 3 months	n.a.

¹¹ The starch-based Mater-Bi® is certified compostable up to 200 µm, whereas bags on the market are usually not thicker than 60 µm.

5. BENEFITS OF COMPOSTABLE PLASTICS FOR ORGANIC WASTE

DIVERSION

Biodegradable plastics are used in a broad range of applications, including biowaste bags and compostable tableware. A secondary use of the carrier bags as organic waste bags is possible, provided that collection and composting schemes are established and accessible¹². Case studies in Germany and in Italy¹³ have revealed that the introduction of compostable waste bags for collecting biowaste does not lead to an increase in conventional non-biodegradable bags in the organic waste collection. Instead, a significant reduction in the use of non-compostable polyethylene (PE) bags has been observed due to the use of compostable bags as an alternative to conventional plastic bags in the organic waste collection. This confirms that compostable plastic bags certified according to EN 13432 and additionally marked with the "Seedling" logo can be clearly identified by consumers.

A project conducted by BASF in Berlin Germany has shown that the general willingness to collect organic waste increases when compostable bags are available, as people find it more hygienic to use these bags¹⁴. An increased amount of collected and separately recycled biowaste contributes to climate protection, as decomposition of organic material in landfill generates methane, which is approximately 25 times more harmful to the climate than CO₂. If all organic waste was collected separately in Europe, the greenhouse gas emission from waste disposal could be significantly decreased.

The use of compostable tableware provides additional value when used, for example, at large events (sports, concerts) and food restaurants, as it can then be disposed of together with the food waste in one single compostable waste stream¹⁵.

6. OPEN QUESTIONS

Over the last years composters and environmental organisations have raised questions concerning the detection of biodegradable plastics in biowaste and doubted their distinguishability from conventional plastics. Apart from the Seedling logo, which makes compostable plastics well recognisable, common NIR detection systems found at recycling plants are able to distinguish between different types of plastics, including compostable ones^{16, 17}.

The tests described in the EN 13432 are, for practical reasons, carried out at laboratory level and confirm biodegradability and disintegrability under the defined composting conditions. Despite the fact that the actual conditions found in composting plants can differ from the laboratory, EN 13432 has proven to be sufficient in covering composting practices in reality over the last 13 years.

7. CONCLUSION

As the studies mentioned above have shown, bioplastics certified according to EN 13432 perform well in industrial composting. Although the standard allows a 12-week period before the material achieves final degradation, most compostable bioplastics require less time to degrade. They fit well in the existing reality of most industrial composting plants. However, the exact duration of the process depends on the type of composting facility.

The acceptance of certified compostable plastics in industrial composting helps with the collection of organic waste and therefore reduces the emissions of GHGs at landfills.

EN 13432 is a globally known standard and is well suited to guaranteeing the applicability of certified compostable plastics in industrial composting. It also ensures that the breaking down of the material occurs via biodegradation, and no harmful substances remain.

Many commercial products are already certified according to EN 13432. The Seedling logo makes it easy to recognise EN 13432 certified materials and products. Clear, visible labelling of all compostable plastics is crucial for public acceptance of compostable plastics. This acceptance can be enhanced further by continuously providing clear and fact-based information about biodegradable and compostable plastics to the public and the stakeholders in the years to come.

¹² European Bioplastics, Position Paper "Plastic Shopping Bags", October 2013, http://en.european-bioplastics.org/wp-content/uploads/2013/publications/PositionPaper/EuBP_PositionPaper_Plastic_shopping_bags.pdf

¹³ Petrone, Paola; Vismara, Danilo: Separate collection of residential food waste in the city of Milan. Müll und Abfall 05/2014, p. 253ff. For a case study from Germany, see footnote 12.

¹⁴ M. Kanthak, F. Söling, "Analysis of the use of compostable ecovio® organic waste bags". Müll und Abfall 08/2012.

¹⁵ Working with compostable products and packaging in closed venue events. Final Report, WRAP, June 2013.

¹⁶ Domestic Mixed Plastics Packaging Waste Options, Final Project Report, WRAP, June 2008.

¹⁷ Technological challenges of sorting biopolymers, TOMRA, Presentation at the 5th International Seminar on Biopolymers and Sustainable Composites, Valencia, 2014