PD CEN/TR 17910:2022



BSI Standards Publication

Biodegradable plastics — Status of standardization and new prospects

National foreword

This Published Document is the UK implementation of CEN/TR 17910:2022.

The UK participation in its preparation was entrusted to Technical Committee PRI/89, Plastics - Environmental Aspects.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Published by BSI Standards Limited 2023

ISBN 978 0 539 23191 5

ICS 13.020.20; 83.080.01

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This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 January 2023.

Amendments/corrigenda issued since publication

Date	Text affected

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER REPORT

CEN/TR 17910

December 2022

ICS 83.080.01; 13.020.20

English Version

Biodegradable plastics - Status of standardization and new prospects

Plastiques biodégradables - État de la normalisation et nouvelles perspectives

Bioabbaubare Kunststoffe - Stand der Normung und neue Perspektiven

This Technical Report was approved by CEN on 18 December 2022. It has been drawn up by the Technical Committee CEN/TC 249.

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Ref. No. CEN/TR 17910:2022 E

Contents

Page

European foreword **4**

Introduction **5**

1 Scope **6**

2 Normative references **6**

3 Terms and definitions **6**

4 Biodegradation **6**

5 Biodegradation of polymers **7**

6 The principles of the biodegradation tests for plastics **8**
6.1 Measuring biodegradation **8**
6.2 Reliability and replication **10**
6.3 Formation of biomass during biodegradation **12**
6.4 General discussion on the 90 % biodegradability requirement **12**

7 Current biodegradation tests **13**
7.1 General **13**
7.2 ISO 13975 ..... **14**
7.3 EN ISO 14851 ..... **15**
7.4 EN ISO 14852 ..... **16**
7.5 EN ISO 14853 ..... **16**
7.6 EN ISO 14855-1 ..... **17**
7.7 EN ISO 14855-2 ..... **18**
7.8 EN ISO 15985 ..... **18**
7.9 EN ISO 17556 ..... **19**
7.10 EN ISO 18830 ..... **19**
7.11 EN ISO 19679 ..... **20**
7.12 ISO 22404 ..... **20**
7.13 ISO 23977-1 ..... **21**
7.14 ISO 23977-2 ..... **21**
7.15 ISO 5148 ..... **21**

8 Additional testing used in product specifications **22**
8.1 General **22**
8.2 Test methods used to determine degradation other than biodegradation **22**
8.3 Test methods relating to eco-toxicity **22**

9 Biodegradation in different environments – Specifications and requirements **23**
9.1 General **23**
9.2 Biodegradation in Organic Recycling – Industrial Composting and Anaerobic Digestion **23**
9.2.1 Introduction **23**
9.3 The Organic Recycling Framework **24**
9.4 The technical content **25**
9.5 Compatibility of compostable packaging with specific composting plants **26**
9.6 Biodegradation in Home Composting **27**
9.6.1 The scope and general requirements of the relevant standard **27**
9.7 Discussion on home composting **27**
9.8 Biodegradation in Soil **29**
9.8.1 The scope and general requirements of the relevant standard **29**
9.9 General discussion on soil biodegradation **29**

9.10 Biodegradation in sea water **30**
9.10.1 The scope and general requirements of the relevant standard **30**
9.11 General discussion on marine biodegradability **31**
10 Biodegradation in open (uncontrolled) environment **31**
11 Discussion on Future standardization needs **35**
11.1 Organic Recycling **35**
11.2 Applications in agriculture **36**
11.3 Biodegradation in the open environment **36**
11.4 Reference materials **36**
11.5 Horizontal standardization **37**
Annex A (informative) **List of relevant Standards and OECD Tests** **38**
A.1 Introduction **38**
A.2 European Standards **38**
A.3 European/ISO Standards **38**
A.4 ISO Standards **39**
A.5 OECD Tests **40**
Bibliography **41**

European foreword

This document (CEN/TR 17910:2022) has been prepared by Technical Committee CEN/TC 249 “Plastics”, the secretariat of which is held by NBN.

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Introduction

Biodegradable plastics have been developed starting from late 80s of the last century in parallel with the development of methodologies for the characterization of degradation (including biodegradation, disintegration, detection of potential ecotoxic by-products produced during biodegradation) of solid materials. The industry developed together with standardization and certification bodies a reliable governing framework needed to develop the market. After 30 years, a wide range of biodegradable products are commercially available. Standard test methods and specifications are available enabling the characterization and certification of those products.

There is an increasing interest to find out more information on the nature of biodegradable plastics and their fundamental characteristics that was fulfilled by going to the source, i.e. by directly examining the technical standards. The analysis of standards by persons who are not experts in the science of biodegradation or standardization and therefore unaware of the underlying reasons for some test schemes, has led to the direct application of such schemes in the context of communications, creating paradoxical situations. Several criticisms did surface based on the erroneous interpretation of the testing schemes. For example, many were puzzled by the 90 % mineralization pass level (rather than 100 % i.e. “complete”) required by the standard specifications to show biodegradability, ignoring that biodegradation involves biomass formation, a very basic knowledge in biochemistry and microbiology. This commingling between technical requirements and media communication created a great deal of confusion among the public and put the Industry, Standardization, and Certification under increased pressure.

CEN experts acknowledge the communication issues and therefore created the underlying document that summarizes the state of standardization and enters into the merits of the individual tests to explain the reasons for some technical solutions and the criteria adopted. This exercise also becomes a preliminary step to highlight potential gaps, the need for updating some standards, or new frontiers to be explored to complete the characterization of biodegradable plastic materials.

1 Scope

This document summarizes the state of standardization in the field of biodegradable plastics and plastics products at CEN and ISO level. It explains the underlying scientific principles of biodegradation that provide the foundations for relevant test methods and enters into the merits of the individual tests to explain and clarify the reasons for the adoption of specific solutions and criteria.

This document primarily focusses on standards adopted by CEN covering environmental biodegradation testing and relevant specifications. It also includes information on disintegration and eco-toxicity tests. A full list of the international standards considered in this document is provided in Annex A.

In a second part, this document highlights areas where standardization in this field is currently lacking and where future developments may be anticipated and useful.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at https://www.electropedia.org/

4 Biodegradation

Biodegradation is a term used in ecology to refer to the natural processes carried out by the decomposing microorganisms (fungi, bacteria, protozoa) that convert the organic substances produced during photosynthesis back into CO_2, water, inorganic substances and new biomass. Biodegradation and photosynthesis function in opposite directions in the ecological cycles, most notably in the carbon (biogeochemical) cycle.

Starting from atmospheric CO_2 and through the utilization of solar energy via photosynthesis, plants, algae, and all the autotrophic organisms synthesize sugars – the organic molecules that form the building blocks of the countless substances present in the biosphere. Through the food chain, the flow of substances and energy passes from plants (producers) to herbivores (primary consumers) and from those to carnivores (secondary consumers).

In the other direction, biodegradation breaks down these organic molecules into smaller intermediate constituents such as CO_2, CH_4, inorganic substances and new biomass. Ultimately, the carbon will be converted back into CO_2. Biodegradation is carried out by the decomposers which grow on dead organic matter; the solid waste of nature. The natural process of biodegradation is essential for the environment and its natural cycles that must get rid of waste and residues in order to make space for new life. Without biodegradation reactions releasing CO_2 back into the atmosphere, photosynthesis would be devoid of its key building block. Therefore, in the natural balance of the planetary ecosystem, biodegradation processes are in balance and harmony with photosynthesis process in the naturally occurring ‘circular economy’.

At the atomic level, once the carbon atoms which form part of CO_2 have reached the maximum state of oxidation they are considered as minerals and hence this final process of biodegradation is called mineralization. The complete burning of a wood log in a fireplace into CO_2, water and ashes with instant release of energy is a fast form of “mineralisation”. Microorganisms degrading the same wood log reproduce this process in a controlled way so that they can exploit the energy for living.