BUREAU OF INDIAN STANDARDS

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भारतीय मानक मसौदा

विभिन्न परिस्थितियों में प्लास्टिक की जैवनिम्नीकरणीयता का आकलन

(आईएस 17899टी *का नियमितीकरण*)

Draft Indian Standard

Assessment of Biodegradability of Plastics in Varied Conditions

(*Regularization of* IS 17899T)

(ICS 83.080.01)

Plastics Sectional Committee, PCD 12	Last date for receipt of comment 01 November 2025

FOREWORD

(*formal clause to be added later*)

Through Plastic Waste Management (PWM) Rules 2021, the Government of India prohibited the manufacturing, import, stocking, distribution, sale and use of several single use plastics (SUPs) from 1st July 2022. The Rule 10 of PWM Rules 2016 "Protocols for Compostable Plastic Material" was substituted with "Protocols for Compostable and Biodegradable Plastic Materials" through PWM Rules 2022. The rule stipulates that the biodegradable plastics shall conform to the standard notified by the Bureau of Indian Standards.

In view of the urgent need of Indian Standard for implementation of PWM Rules, the Plastics Sectional Committee decided to formulate a comprehensive indigenous Indian Standard for biodegradable plastic. As the technology was new and there were no established international standards and validated data on the biodegradation of plastics in environment like aqueous and marine medium, the Committee initially (in 2022) formulated a provisional Indian Standard as per Rule 27 of BIS Rules, 2018, specifying the procedures for assessment of the biodegradability of plastic in available varied conditions.

The standard specified the procedures for assessment of biodegradability of plastics, negative effects of resulting biomass on terrestrial plant growth/organism and regulated heavy metals present in the biomass. The emphasis of the standard was on the assessment of biodegradability of plastics in composting medium, soil medium, municipal solid waste medium and aqueous medium.

The limits of regulated heavy metals were specified to ensure safe application of biomass. The values of the regulated heavy metals given in Table 3 and Table 4 are aligned to Schedule II of Solid Waste Management Rules, 2016.

This Indian Standard was originally published as provisional Indian Standard in 2022. As the provisional Indian Standard is only valid for 2 years, review of this standard was undertaken in 2024 so as to finalize the provisional standard as a regular Indian Standard. However, owing to the need for additional data before formalization, the Plastics Sectional Committee, PCD 12 after reviewing the comments received during the wide circulation period, decided to extend the provisional Indian Standard for additional two years, till 2026, as per Rule 27 of BIS Rules, 2018.

The major changes incorporated in the 2024 version of this Indian Standards are as follows:

— Definition of biodegradable plastic has been added;
— Method of test for microplastic determination has been included;
— Method of tests have been specified as per the medium for which they have been tested and found passing.
— Packing and marking clause has been included; and
— Editorial corrections have been done.

As the provisional Indian Standard is only valid for 2 years and may be extended only once, the review of this provisional Indian Standard is being undertaken to finalize it as a regular Indian Standard.

Due to the varying nature of marine environment in Indian context at different beaches/zones, this standard does not cover biodegradability under marine environment.

This standard has no implication on determination of the service life or durability aspects of the plastic material under consideration.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1 SCOPE

1.1 This Indian standard specifies the procedures and assessment of biodegradability of plastics under varied conditions. This standard addresses the following aspects:

a) Biodegradation in varied conditions, as specified
b) Analysis of effects of resulting biomass on terrestrial plant growth/organism; and
c) Negative effects of the quality of the resulting biomass including the presence of high levels of regulated heavy metals.

1.2 The standard is applicable for assessing the biodegradability of plastics under aerobic, anaerobic conditions.

1.3 The standard is not applicable for assessing the biodegradability of plastics under marine environment.

1.4 The assessment of biodegradability of plastic, if done through composting conditions

only, vide IS/ISO 14855-1 and IS/ISO 14855-2, the plastic shall be certified as compostable plastic, and not as biodegradable plastic as defined under PWM Rules 2016, as amended.

1.5 This standard excludes compostable plastics as per IS/ISO 17088, as per PWM Rules 2016, as amended.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

3 TERMINOLOGY

For the purpose of this standard, definition given below and in IS 2828 shall apply.

3.1 Biodegradable plastic[1]

"Biodegradable plastics", means plastics, other than compostable plastics, which undergoes degradation by biological processes in specific environment such as soil, landfill, sewage sludge, fresh water, marine, without leaving any micro plastics or visible or distinguishable or toxic residue, which has adverse environment impact.

NOTE — The definition of biodegradable plastic is as per *PWM Rules* 2016, as amended.

3.2 Compostable Plastics[2]

Plastic that undergoes degradation by biological process during composting to yield carbon dioxide, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and leave no visible, distinguishable or toxic residue.

3.3 Large Microplastic[3]

Any solid plastic particle insoluble in water with any dimension between 1 mm and 5 mm.

3.4 Microplastic[3]

Any solid plastic particle insoluble in water with any dimension between 1 μm and 1 000 μm (=1 mm).

3.5 Ultimate Aerobic Biodegradation[2]

Breakdown of an organic compound by microorganisms in the presence of oxygen into carbon dioxide, water and mineral salts of any other elements present (mineralization) plus new biomass.

3.6 Ultimate Anaerobic Biodegradation[4]

Breakdown of an organic compound by microorganisms in the absence of oxygen to carbon dioxide, methane, water, and mineral salts of any other elements present (mineralization) plus new biomass.

NOTES:

1. [1] As per PWM Rules, 2016, as amended.
2. [2] As per IS/ISO 17088.
3. [3] As per ISO 24187.
4. [4] As per IS/ISO 15985.

4 REQUIREMENTS

4.1 The purpose of this standard is to establish the requirements for plastics to meet the desired criteria under varied conditions. In order to comply with this document, plastics shall demonstrate biodegradation (aerobic or anaerobic), safe limits for toxic residue and no adverse effects on environment as mentioned in **4.2** to **4.4**.

4.2 The level of biodegradability of the plastics shall be assessed by testing under controlled conditions as given below.

4.2.1 *Ultimate Aerobic Biodegradability*

The ultimate level of aerobic biodegradation shall be established by testing under different mediums accordance with the standards given in Table 1.

Table 1 Medium under Aerobic Biodegradation
(*Clause* 4.2.1)

Sl No.	*IS Number*	*Medium*
(1)	(2)	(3)
i)	IS/ISO 14851	Aqueous medium (activated sludge from a sewage treatment plant)
ii)	IS/ISO 14852	Aqueous medium (activated sludge from a sewage treatment plant)
iii)	IS/ISO 14855 (Part 1)	Composting
iv)	IS/ISO 14855 (Part 2)	Composting
v)	IS/ISO 17556	Soil

4.2.2 *Ultimate Anaerobic Biodegradability*

The ultimate level of anaerobic biodegradation shall be established by testing under typical anaerobic digestion conditions in different medium accordance with the standards given in Table 2.

Table 2 Medium under Anaerobic Biodegradation
(*Clause* 4.2.2)

Sl No.	*IS Number*	*Medium*

(1)	(2)	(3)
i)	IS/ISO 15985	Municipal solid waste
ii)	IS/ISO 14853	Aqueous medium (sludge with reduced inorganic carbon content less than 20 mg/l)

NOTES:

1 The plastic meeting the biodegradability criteria as per IS/ISO 14855-1 and IS/ISO 14855-2, shall only be considered for certification as 'Compostable plastics' in accordance with PWM Rules 2016, as amended.

2 Further, this standard excludes 'Compostable plastics' as per IS/ISO 17088, under PWM Rules 2016, as amended.

4.3 Assessment of Toxic Residues

4.3.1 The assessment of toxic residues (regulated metal content) can only be analyzed after successful completion of the biodegradation phase.

4.3.2 The resultant biomass shall be analyzed for heavy metal content as per Table 3 and Table 4 and tested as per IS 3025 (Part 65).

4.4 Assessment of Adverse Effect on Environment

4.4.1 The plastics shall have no adverse effect on the environment, which includes terrestrial organisms. Thus, the analysis requires determination of eco toxicity testing as per column 4 of Table 3 and Table 4, for assessment of adverse effect of resulting biomass on terrestrial environment and plant growth test.

4.4.2 The biodegradability of the plastics under various conditions shall conform to the biodegradation requirement using any mentioned standards along with the other requirements as specified in Table 3 or Table 4.

4.5 In case of disputes on testing results of different laboratories, the analysis of remnant sample as per Annex E of IS/ISO 17556 can also be done.

4.6 Biodegradability of constituents

Biodegradability of organic constituents, which are present in the material at a concentration between 1 percent and 15 percent (by dry mass) shall be proven separately according to the test methods listed in Table 3 or Table 4.

Table 3 Assessment of Aerobic Biodegradability in Plastics under varied conditions

(*Foreword, Clauses* 4.3.2, 4.4.1, 4.4.2 *and* 4.6)

Sl No.	Characteristics	Requirement	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Ultimate aerobic biodegradability of plastic materials under composting conditions, *Min*	90 percent by the end of the test period of 180 days	IS/ISO 14855-1 or IS/ISO 14855-2
ii)	Ultimate aerobic biodegradability of plastic materials in an aqueous medium, *Min*	- do -	IS/ISO 14851 or IS/ISO 14852
iii)	Ultimate aerobic biodegradation of plastic materials in soil, *Min*	90 percent of the max level of biodegradation has been reached typically not exceeding six months but no longer than 2 years	IS/ISO 17556
iv)	Large microplastics	NIL	FTIR method as per ISO 24187
v)	Microplastics	NIL	FTIR method as per ISO 24187
Regulated Heavy Metal Analysis			
vi)	Arsenic (as As), mg/kg on dry mass basis, *Max*	10.00	IS 3025 (Part 65)
vii)	Cadmium (as Cd), mg/kg on dry mass basis, *Max*	5.00	
viii)	Chromium (as Cr), mg/kg on dry mass basis, *Max*	50.00	
ix)	Copper (as Cu), mg/kg on dry mass basis, *Max*	300.00	
x)	Lead (as Pb), mg/kg on dry mass basis, *Max*	100.00	
xi)	Mercury (as Hg), mg/kg on dry mass basis, *Max*	0.15	
xii)	Nickel (as Ni), mg/kg on dry mass basis, *Max*	50.00	
xiii)	Zinc (as Zn), mg/kg on dry mass basis, *Max*	1000.00	
Eco-toxicity Test			
xiv)	Assessment of adverse impact on environment (Terrestrial plants growth test), *Min*	90 percent plant germination and plant biomass compared to control.	OECD 208 / ISO 11269-2 / Annex C of IS/ISO 17088

xv)	Determination of acute/chronic ecotoxicity effects to earthworm, *Min*	90 percent of surviving earthworm grown in sample compost exposed to test material as well as reference compost exposed to reference material.	ISO 11268-1 / Annex D of IS/ISO 17088 And ISO 11268-2 / Annex E of IS/ISO 17088

Table 4 Assessment of Anaerobic Biodegradability in Plastics
(Foreword, *Clauses* 4.3.2, 4.4.1, 4.4.2 and 4.6)

Sl No.	Characteristics	Requirement	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Ultimate anaerobic biodegradation, *Min*	90 percent within 2 years	IS/ISO 15985 or IS/ISO 14853
ii)	Large microplastics	NIL	FTIR method as per ISO 24187
iii)	Microplastics	NIL	FTIR method as per ISO 24187
Regulated Heavy Metal Analysis			
iv)	Arsenic (as As), mg/kg on dry mass basis, *Max*	10.00	IS 3025 (Part 65)
v)	Cadmium (as Cd), mg/kg on dry mass basis, *Max*	5.00	
vi)	Chromium (as Cr), mg/kg on dry mass basis, *Max*	50.00	
vii)	Copper (as Cu), mg/kg on dry mass basis, *Max*	300.00	
viii)	vii) Lead (as Pb), mg/kg on dry mass basis, *Max*	100.00	
ix)	Mercury (as Hg), mg/kg on dry mass basis, *Max*	0.15	
x)	Nickel (as Ni), mg/kg on dry mass basis, *Max*	50.00	
xi)	Zinc (as Zn), mg/kg on dry mass basis, *Max*	1000.00	
Eco-toxicity Test			
xii)	Assessment of adverse impact on environment (Terrestrial plants growth test), *Min*	90 percent plant germination and plant biomass compared to control.	OECD 208 / ISO 11269-2 / Annex C of IS/ISO 17088
xiii)	Determination of acute/chronic ecotoxicity effects to earthworm, *Min*	90 percent of surviving earthworm grown in sample compost	ISO 11268-1 / Annex D of IS/ISO 17088 and

		exposed to test material as well as reference compost exposed to reference material.	ISO 11268-2 / Annex E of IS / ISO 17088

5 PACKING AND MARKING

5.1 Packing

The material shall be packed in suitable form of packing protected from exposure to sunlight. The packing medium shall be as agreed to between the purchaser and the supplier.

5.2 Marking

5.2.1 Each bag and/or unit package whichever is smallest in size that is being delivered to the customer shall be marked clearly in which medium and under which condition the product is biodegradable i.e. 'Biodegradable in …….. medium under ……. condition'.

For example, if the material under test passes the biodegradability test by using the test method IS/ISO 17556, the material shall be marked as 'Biodegradable in **soil** medium under **aerobic** condition.

Table 5 Details of Conditions and Medium
(*Clause* 5.2.1)

Sl No.	Test Method	Condition	Medium
(1)	(2)	(3)	(4)
i)	IS/ISO 14851	Aerobic condition	Aqueous medium (activated sludge from a sewage treatment plant)
ii)	IS/ISO 14852		Aqueous medium (activated sludge from a sewage treatment plant)
iii)	IS/ISO 14855 (Part 1)		Composting
iv)	IS/ISO 14855 (Part 2)		Composting
v)	IS/ISO 17556		Soil
vi)	IS/ISO 15985	Anaerobic condition	Municipal solid waste
vii)	IS/ISO 14853		Aqueous medium (sludge with reduced inorganic carbon content less than 20 mg/l)

5.2.2 *BIS Certification Marking*

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the Bureau of Indian Standards Act, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

ANNEX A
(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No./Other publication	*Title*
IS 2828 : 2019/ ISO 472 : 2013	Plastics — Vocabulary (*second revision*)
IS 3025 (Part 65) : 2025/ ISO 17294-2 : 2023	Methods of Sampling and Test Physical and Chemical for Water and Wastewater Part 65 Application of Inductively Coupled Plasma Mass Spectrometry ICP-MS Determination of Selected Elements Including Uranium Isotopes (*second revision*)
IS/ISO 14851 : 2022	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by measuring the oxygen demand in a closed respirometer (*first revision*)
IS/ISO 14852 : 2021	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by analysis of evolved carbon dioxide (*first revision*)
IS/ISO 14853 : 2016	Plastics — Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system — Method by measurement of biogas production (*first revision*)
IS/ISO 14855–1 : 2012	Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions — Method by analysis of evolved carbon dioxide : Part 1 General method (*first revision*)
IS/ISO 14855-2 : 2018	Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions — Method by analysis of evolved carbon dioxide: Part 2 Gravimetric measurement of carbon dioxide evolved in a laboratory-scale test (*first revision*)
IS 15109 (Part 2) : 2013 /ISO 11269-2 : 2012	Soil quality — Determination of the effects of pollutants on soil flora: Part 2 Effects of contaminated soil on the emergence and early growth of higher plants (*first revision*)
IS/ISO 15985 : 2014	Plastics — Determination of the ultimate anaerobic biodegradation under high-solids anaerobic-digestion conditions — Method by analysis of released biogas (*first revision*)
IS/ISO 17088 : 2021	Compostable plastics — Specification (*second revision*)
IS/ISO 17556 : 2019	Plastics — Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved (*second revision*)
ISO 11268-1 : 2012	Soil quality — Effects of pollutants on earthworms — Part 1 : Determination of acute toxicity to Eisenia fetida/Eisenia Andrei
ISO 11268-2 : 2023	Soil quality — Effects of pollutants on earthworms — Part 2 : Determination of effects on reproduction of Eisenia fetida/Eisenia Andrei and other earthworm species
ISO 24187	Principles for the analysis of microplastics present in the environment
OECD 208 : 2016	Terrestrial plant test: Seedling emergence and seedling growth test