भारतीय मानक
Indian Standard

IS 17949 (Part 1) : 2022
ISO 22526-1 : 2020

प्लास्टिक — जैव आधारित प्लास्टिक के कार्बन और पर्यावरण फूटप्रिन्ट

भाग 1 सामान्य सिद्धांत

Plastics — Carbon and Environmental Footprint of Biobased Plastics

Part 1 General Principles

ICS 83.080.01, 13.020.40

भारतीय मानक ब्यूरो
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November 2022 **Price Group 7**

NATIONAL FOREWORD

This Indian Standard which is identical with ISO 22526-1 : 2020 'Plastics — Carbon and environmental footprint of biobased plastics — Part 1: General principles' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Methods of Sampling and Test for Plastics Sectional Committee and approval of the Petroleum, Coal and Related Products Division Council.

Other parts in this series are:

Part 2 Material carbon footprint, amount (mass) of CO_2 removed from the air and incorporated into polymer molecule

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standard for which Indian Standard also exist. The corresponding Indian Standard, which is to be substituted in its respective place, is listed below along with its degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 472 Plastics — Vocabulary	IS 2828 : 2019 /ISO 472 : 2013 Plastics — Vocabulary (*second revision*)	Identical with ISO 472 : 2013
ISO 14020 Environmental labels and declarations — General principles	IS/ISO 14020 : 2000 Environmental labels and declarations — General principles (*first revision*)	Identical with ISO 14020 : 2000
ISO 14040 Environmental management — Life cycle assessment — Principles and framework	IS/ISO 14040 : 2006 Environmental management — Life cycle assessment — Principles and framework (*first revision*)	Identical with ISO 14040 : 2006
ISO 14044 Environmental management — Life cycle assessment — Requirements and guidelines	IS/ISO 14044 : 2006 Environmental management — Life cycle assessment — Requirements and guidelines	Identical with ISO 14044 : 2006
ISO 16620-1 Plastics — Biobased content — Part 1: General principles	IS 17948 (Part 1) : 2022/ISO 16620-1 : 2015 Plastics — Biobased content: Part 1 General principles	Identical with ISO 16620-1 : 2015
ISO 16620-2 Plastics — Biobased content — Part 2: Determination of the biobased carbon content	IS 17948 (Part 2) : 2022/ISO 16620-2 : 2019 Plastics — Biobased content: Part 2 Determination of the biobased carbon content	Identical with ISO 16620-2 : 2019
ISO 16620-3 Plastics — Biobased content — Part 3: Determination of biobased synthetic polymer content	IS 17948 (Part 3) : 2022/ISO 16620-3 : 2015 Plastics — Biobased content: Part 3 Determination of biobased synthetic polymer content	Identical with ISO 16620-3 : 2015

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Introduction

Increased use of biomass resources for manufacturing plastic products can be effective in reducing global warming and the depletion of fossil resources.

Current plastic products are composed of biobased synthetic polymers, fossil-based synthetic polymers, natural polymers and additives that can include biobased materials.

Biobased plastics refer to plastics that contain materials wholly or partly of biogenic origin.

Indian Standard

PLASTICS — CARBON AND ENVIRONMENTAL FOOTPRINT OF BIOBASED PLASTICS

PART 1 GENERAL PRINCIPLES

1 Scope

This document specifies the general principles and the system boundaries for the carbon and environmental footprint of biobased plastic products. It is an introduction and a guidance document to the other parts of the ISO 22526 series.

This document is applicable to plastic products and plastic materials, polymer resins, which are based from biobased or fossil-based constituents.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 472, *Plastics — Vocabulary*

ISO 14020, *Environmental labels and declarations — General principles*

ISO 14040, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines*

ISO 14067, *Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification*

ISO 16620-1, *Plastics — Biobased content — Part 1: General principles*

ISO 16620-2, *Plastics — Biobased content — Part 2: Determination of biobased carbon content*

ISO 16620-3, *Plastics — Biobased content — Part 3: Determination of biobased synthetic polymer content*

ISO 16620-4, *Plastics — Biobased content — Part 4: Determination of biobased mass content*

ISO 16620-5, *Plastics — Biobased content — Part 5: Declaration of biobased carbon content, biobased synthetic polymer content and biobased mass content*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472, ISO 14067, ISO 16620-1, ISO 16620-2, ISO 16620-3, ISO 16620-4, ISO 16620-5 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
carbon and environmental footprint
life cycle assessment of biobased plastics products with considerations on the specific situations for biobased materials and products on the removal of CO_2 from the air in comparison with fossil-based plastics products

Note 1 to entry: The definition of the term "environmental footprint" used here is different from that of the one used in European Union, which is composed of "Product environmental footprint" and "Organization environmental footprint".

3.2
material carbon footprint
amount (mass) of CO_2 removed from the air and incorporated into 1 kg of polymer molecule

3.3
process carbon footprint
carbon footprint for the process of converting the starting feedstock/resource to product at factory gate

4 General principles

4.1 The general principles for the development and use of environmental labels and declarations established in ISO 14020 shall be followed for modifications that will fit the special assessment linked to the origin of the material.

4.2 The general principles for guidance for decisions relating to both the planning and the conducting of an LCA in ISO 14040 shall also be followed.

5 Carbon and environmental footprint of biobased plastics

5.1 Principle

Carbon is the major basic element that is the building block of all plastics, fuels, and even life itself. Therefore, discussions on sustainability and environmental responsibility centre on the carbon footprint of bioplastics using biocarbon content analysis and life-cycle assessment of biobased plastics, in which the fossil carbon is replaced by bio-based carbon, offer the intrinsic value of a reduced carbon footprint and are in complete harmony with the rates and time scale of the biological carbon cycle. Identification and quantification of bio-based content is based on the radioactive C-14 signature associated with (new) biocarbon. Using experimentally determined biocarbon content values, one can calculate the intrinsic CO_2 emissions reduction achieved by substituting petrocarbon with biocarbon — the material carbon footprint. The process carbon footprint arising from the conversion of feedstock to final product is computed using life-cycle assessment methodology. The issue is of managing carbon (carbon-based materials) in a sustainable and environmentally responsible manner. Indeed, the burning issue of today is concern over increasing human-made CO_2 emissions with no offsetting sequestration and removal of the released CO_2. Reducing our carbon footprint is a major challenge. Reduced CO_2 emissions translate to minimizing global warming-climate change problems.

5.2 Material carbon footprint

Switching the manufacturing base (the origins of the carbon) from fossil carbon feedstock to bio-based carbon feedstock offers an intrinsic zero material (i.e. referred to the feedstock of the product) carbon footprint potentiality. This can be seen by reviewing biological carbon cycle. Nature cycles carbon through various environmental compartments with specific rates and time scales, as shown in Figure 1. Carbon is present in the atmosphere as inorganic carbon in the form of CO_2. The current level of CO_2 in the atmosphere is around 380 ppm (parts per million) and is increasing. CO_2 and other greenhouse gases in the atmosphere trap the sun's heat from radiating back to space, thereby providing a life-sustaining average planet temperature of 7,2 °C (45 °F).

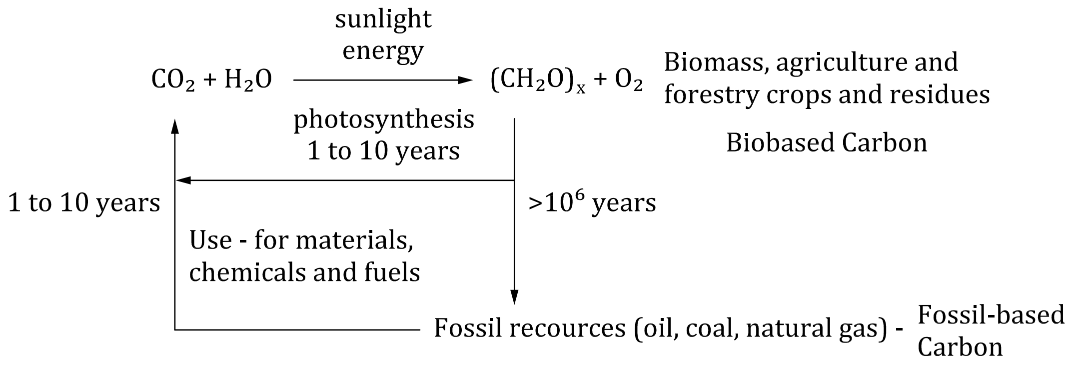
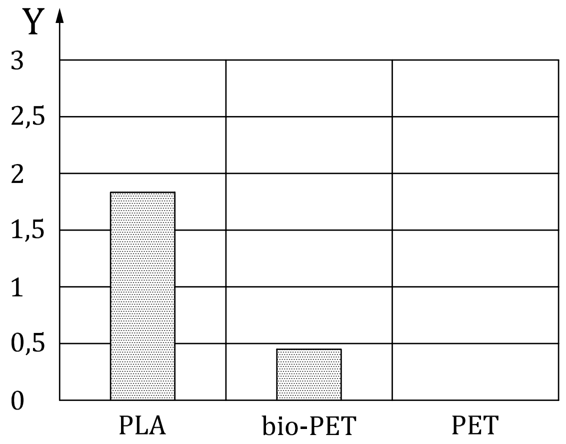


Figure 1 — Biological carbon cycle-value proposition for using biorenewable carbon instead of fossil-based carbon feedstock

Increasing levels of CO_2 and other greenhouse gas emissions to the atmosphere traps more of the sun's heat, thereby raising the average temperature of the planet. While one might debate the severity of the effects associated with this or any other target level of CO_2, there can be no disagreement that an uncontrolled, continued increase in levels of CO_2 in the atmosphere will result in a slow perceptible rise of the earth's temperature, global warming, and with it an associated severity of effects that will affect life on this planet as well known.

It is therefore prudent and necessary to try and maintain current CO_2 levels — the "zero carbon" approach. This can best be done by using renewable biomass crops to manufacture carbon-based products so that the CO_2 released at the end-of life of the product was that originally captured by the crops, so that no extra CO_2 is added to the atmosphere. Specifically, the rate of CO_2 release to the environment at end-of-life equals the rate of photosynthetic CO_2 fixation by the original crops planted — a zero material carbon footprint, in case of total oxidation into CO_2 of the feedstock. In the case of fossil feedstock, the rate of carbon fixation is measured in millions of years, while the end-of-life release rate into the air is in 1 to 10 years. The math is simple, and this is not sustainable. It causes more CO_2 release than fixation, resulting in an increased carbon footprint and, with it, attendant global warming and climate change problems.

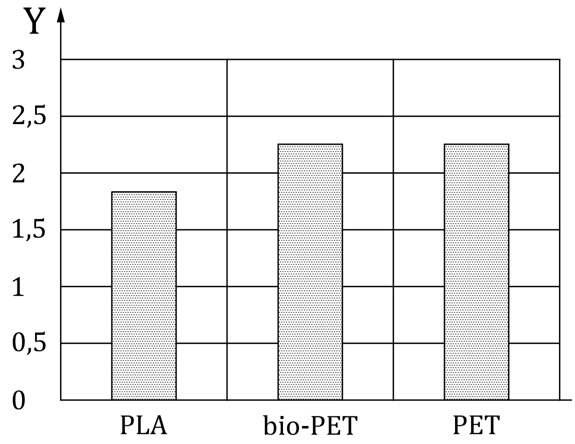
Based on the previous carbon cycle discussion and using basic stoichiometry, it was calculated that for every 100 kg of polyolefin (polyethylene, PE; polypropylene, PP) manufactured, a net 314 kg CO_2 is released into the air at its end-of-life (100 kg of PE contains 85,7 % kg carbon and upon combustion will yield 314 kg of CO_2 (44/12) × 85,7). Similarly, PET (polyethylene terephthalate) contains 62,5 % carbon and would result in 229 kg of CO_2 released into the air at end-of life. However, if the carbon in the polyester or polyolefin comes from a biological feedstock, the net release of CO_2 into the air is zero, because the CO_2 released is fixed in a short time period by the next crop or biomass plantation (see Figures 2, 3 and 4). This is the intrinsic zero material carbon footprint for using a bio/renewable feedstock.



Key

Y	kg CO_2/kg disposed resin
PLA	Polylactic Acid
bio-PET	bio-PolyEthylene Terephthalate
PET	PolyEthylene Terephthalate

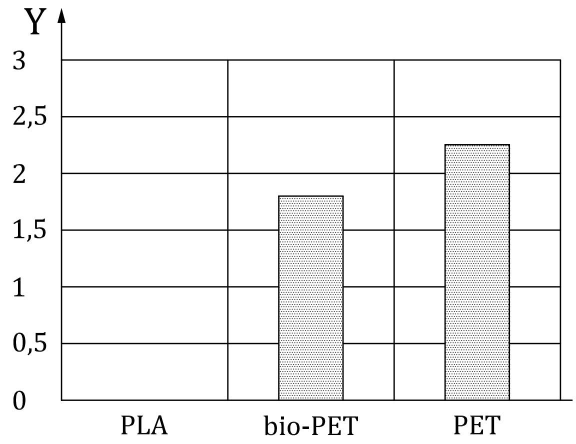
Figure 2 — Amount (mass) of CO_2 removed from the air per 1 kg production of resin (A) — Material carbon footprint



Key

Y	kg CO_2/kg disposed resin
PLA	Polylactic Acid
bio-PET	bio-PolyEthylene Terephthalate
PET	PolyEthylene Terephthalate

Figure 3 — Amount (mass) of CO_2 released to the air per 1 kg disposal of resin (B)



Key

Y	kg CO_2/kg disposed resin
PLA	Polylactic Acid
bio-PET	bio-PolyEthylene Terephthalate
PET	PolyEthylene Terephthalate

Figure 4 — Amount (mass) of CO_2 released to the air per 1 kg production and disposal of resin (B-A)

5.3 Process carbon footprint

Carbon footprint from the conversion of feedstock to product – cradle to factory gate scenario and total environmental footprint should be calculated using life cycle assessment methodology of ISO 14040.

B2B value chain analysis or cradle to factory gate analysis should be clarified. Practitioners and users of life cycle assessment need to be careful in comparative analysis of products because of the boundary conditions selected and quality of data used. Life cycle assessment should primarily be used for improvements in environmental impact from base line and not as a marketing tool to show comparative analysis using partial skewed system boundaries.

The descriptions in the process carbon footprint of the biobased plastics are in line with ISO 14067.

5.4 Environmental (total) footprint (life cycle assessment)

Material carbon footprint and process carbon footprint do not solely provide information on its environmental impact, which should be also assessed through life cycle analysis, including not only carbon footprint but also other relevant impact categories. In addition, transparent and unambiguous communication within biobased value chains is facilitated by a harmonized framework for certification and declaration.

This document aims to provide specific life cycle assessment requirements and guidance for biobased products, excluding food, feed and energy, in accordance with ISO 14040 and ISO 14044.

This document informs and guides life cycle assessment and applications, including for example product category rules (PCR) development for biobased products.

The life cycle assessment of a bio-based product shall cover the whole product, not only the biobased parts. However, the focus of document is on how to handle the specificities of the biobased parts.

5.5 System boundaries of the ISO 22526 series

System boundaries of total scheme of the carbon and environmental footprint of biobased plastics are depicted in Figure 5.

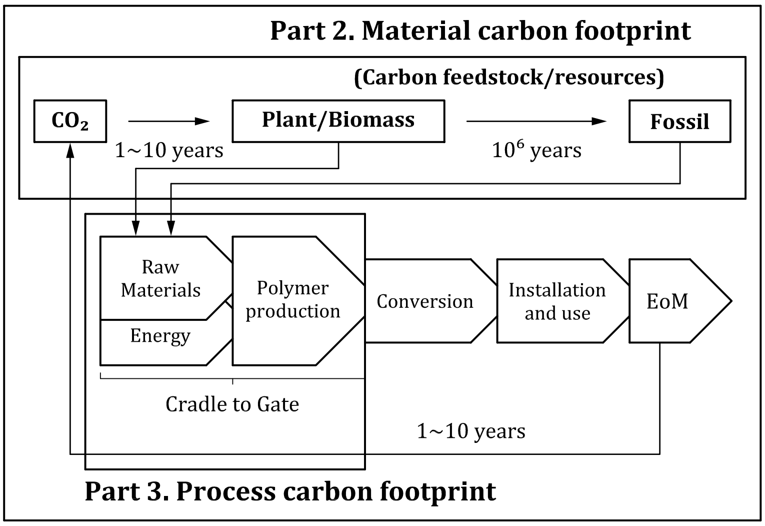


Figure 5 — System boundaries of total scheme of the carbon and environmental footprint of biobased plastics

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[4] NARAYAN R., Biobased & Biodegradable Polymer Materials: Rationale, Drivers, and Technology Exemplars; ACS (an American Chemical Society publication) Symposium Ser. 1114, Chapter 2, pg 13 – 31, 2012

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International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 16620-4 Plastics — Biobased content — Part 4: Determination of the biobased mass content	IS 17948 (Part 4) : 2022/ISO 16620-4 : 2016 Plastics — Biobased content: Part 4 Determination of the biobased mass content	Identical with ISO 16620-4 : 2016
ISO 16620-5 Plastics — Biobased content — Part 5: Declaration of biobased carbon content, biobased synthetic polymer content and biobased mass content	IS 17948 (Part 5) : 2022/ISO 16620-5 : 2017 Plastics — Biobased content: Part 5 Declaration of biobased carbon content, biobased synthetic polymer content and biobased mass content	Identical with /ISO 16620-5 : 2017

The technical committee has reviewed the provisions of the following International Standard referred in this adopted standard and has decided that it is acceptable for use in conjunction with this standard:

International/Other standard no.	*Title*
ISO 14067	Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’.

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: PCD 27 (19553).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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