
Plastics — Biobased content —

**Part 1:
General principles**

Plastiques — Teneur biosourcée —

Partie 1: Principes généraux



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: [Foreword — Supplementary information](#).

The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 5, *Physical-chemical properties*.

ISO 16620 consists of the following parts, under the general title *Plastics — Biobased content*:

- *Part 1: General principles*
- *Part 2: Determination of biobased carbon content*
- *Part 3: Determination of biobased synthetic polymer content*

The following parts are under preparation:

- *Part 4: Determination of the biobased mass content*
- *Part 5: Declaration of biobased carbon content, biobased synthetic polymer content and biobased mass content*

Introduction

Increased use of biomass resources for manufacturing plastic products is 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.

In this series of International Standards, the biobased content of biobased plastics refers to the amount of the biobased carbon content, the amount of the biobased synthetic polymer content, or the amount of the biobased mass content only.

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Plastics — Biobased content —

Part 1: General principles

1 Scope

This part of ISO 16620 specifies the general principles and the calculation methods for determining the amount of biobased content in plastic products. These calculation methods are based on the carbon mass or mass of each constituent present in the plastic products.

This part of ISO 16620 is applicable to plastic products and plastic materials, polymer resins, monomers, or additives, which are made from biobased or fossil-based constituents.

Knowing the biobased content of plastic products is useful when evaluating their environmental impact.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 16620-2, *Plastics — Biobased content — Part 2: Determination of the biobased carbon content*

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

ISO 16620-4¹⁾, *Plastics — Biobased content — Part 4: Determination of the biobased mass content*

3 Terms, definitions, and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following apply.

3.1.1

biobased carbon content

amount of carbon derived from biomass present in the product

Note 1 to entry: The biobased carbon content is expressed by a fraction of sample mass, as a fraction of the total carbon content, or as a fraction of the total organic carbon content.

3.1.2

biomass

material of biological origin excluding material embedded in geological formations and/or fossilised

3.1.3

synthetic polymer

polymer obtained through chemical and/or biological industrial processes

1) To be published.

3.1.4

biobased synthetic polymer

polymer obtained through chemical and/or biological industrial process(es), wholly or partly from biomass resources

Note 1 to entry: Natural polymers are not classified as biobased synthetic polymers [see 3.1.7].

3.1.5

biobased synthetic polymer content

m_{BSP}

amount of biobased synthetic polymer present in the product

Note 1 to entry: The amount of biobased synthetic polymer in the product is expressed as a fraction or percent of the mass of biobased synthetic polymer to the total mass of the product.

3.1.6

carbon content

amount of carbon in the constituent, material, or product as a percent of the weight (mass)

3.1.7

natural polymer

polymer obtained from biomass, in which the polymer retains the original chemical structure and composition present in biomass

EXAMPLE Starch, cellulose, lignin, or lignocellulose.

3.1.8

product

resins, material, or objects/articles resulting from a production process

Note 1 to entry: Product can be a material, semi-finished, or final product, for example, polyethylene resin derived from petroleum or biomass, bioPE film, PET resins, PET bottles, monomers, plasticisers.

3.1.9

total carbon

TC

quantity of carbon present in a sample in the form of organic, inorganic, and elemental carbon

3.1.10

total organic carbon

TOC

quantity of carbon that is converted into carbon dioxide by combustion and which is not liberated as carbon dioxide by acid treatment

3.1.11

biobased mass content

m_{B}

total amount of biobased synthetic polymer, natural polymer, and biobased additives in a product

Note 1 to entry: The total biobased mass content in a product is expressed as a fraction or percentage of the sum of the biobased synthetic polymer, natural polymer, and biobased additives to the total mass of the product.

3.2 Symbols

x_B^{TC}	biobased carbon content by total carbon content, expressed as a percentage of the total carbon content
x_B^{TOC}	biobased carbon content by total organic carbon content, expressed as a percentage of the total organic carbon content
M_x	mass of carbon of constituent x
W_x	mass of constituent x

4 Principle

A plastic product is typically composed of the following six constituents, as shown in [Figure 1 a](#)):

- synthetic polymer(s) composed of biobased synthetic polymer(s) (constituent A) and fossil-based synthetic polymer(s) (constituent B);
- natural polymer(s) (constituent C);
- additive(s) composed of biobased organic and/or inorganic additive(s) (constituent D), fossil-based organic additive(s) (constituent E), and inorganic additive(s) (constituent F).

For the purposes of ISO 16620, additives also include fillers.

The biobased content of plastic products can be divided as follows:

- Biobased carbon content [see [Figure 1 b1](#)) and b2) and [5.1](#) for the calculation method]. Part 2 — Biobased carbon content can be reported as the ratio of biobased carbon to total organic carbon x_B^{TOC} or ratio of biobased carbon to total carbon x_B^{TC} on a mass basis expressed as a percentage. In plastic products, inorganic compounds such as calcium carbonate are added from a cost-performance benefit. Therefore, biobased carbon content calculations, with and without inorganic carbon, have been included. When biobased synthetic polymer and biobased additive are wholly biobased, all carbons in these constituents are biobased carbons [see [Figure 1 b1](#)), [5.1.1.1](#), and [5.1.2.1](#)]. In the case that these are partly biobased, carbons in these constituents are biobased and fossil-based carbons [see [Figure 1 b2](#)), [5.1.1.2](#), and [5.1.2.2](#)].
- Biobased synthetic polymer content [see [Figure 1 c1](#)) and c2) and [5.2](#) for the calculation method]. Part 3 — This reporting method takes into account the mass of the constituents rather than only the carbon. The biobased synthetic polymer content is calculated as the ratio of the biobased mass in the biobased synthetic polymer to total mass of the product expressed as a percentage. The total mass of product shall also include the mass of inorganic carbon constituents. Manufacturers routinely use the mass content for production purposes and can readily calculate this value. When a biobased synthetic polymer is wholly biobased, the total mass of this constituent is biobased [see [Figure 1 c1](#)) and [5.2.1](#)]. When this is partly biobased, part of the mass of this constituent is biobased [see [Figure 1 c2](#)) and [5.2.2](#)].
- Biobased mass content [see [Figure 1 d1](#)) and d2) and [5.3](#) for the calculation method]. Part 4 — This reporting method identifies natural polymer constituents, in addition to biobased synthetic polymer constituents and biobased additives. The biobased mass content is then the ratio of the sum of the mass of natural polymer constituent + biobased synthetic polymer + biobased additives to the total mass of the product. The total mass of the product shall also include the mass of inorganic carbon constituents present in the product. When biobased synthetic polymer and biobased additive are wholly biobased, the total mass of these constituents is biobased [see [Figure 1 d1](#)) and [5.3.1](#)]. When these are partly biobased, parts of the mass in these are biobased [see [Figure 1 d2](#)) and [5.3.2](#)].

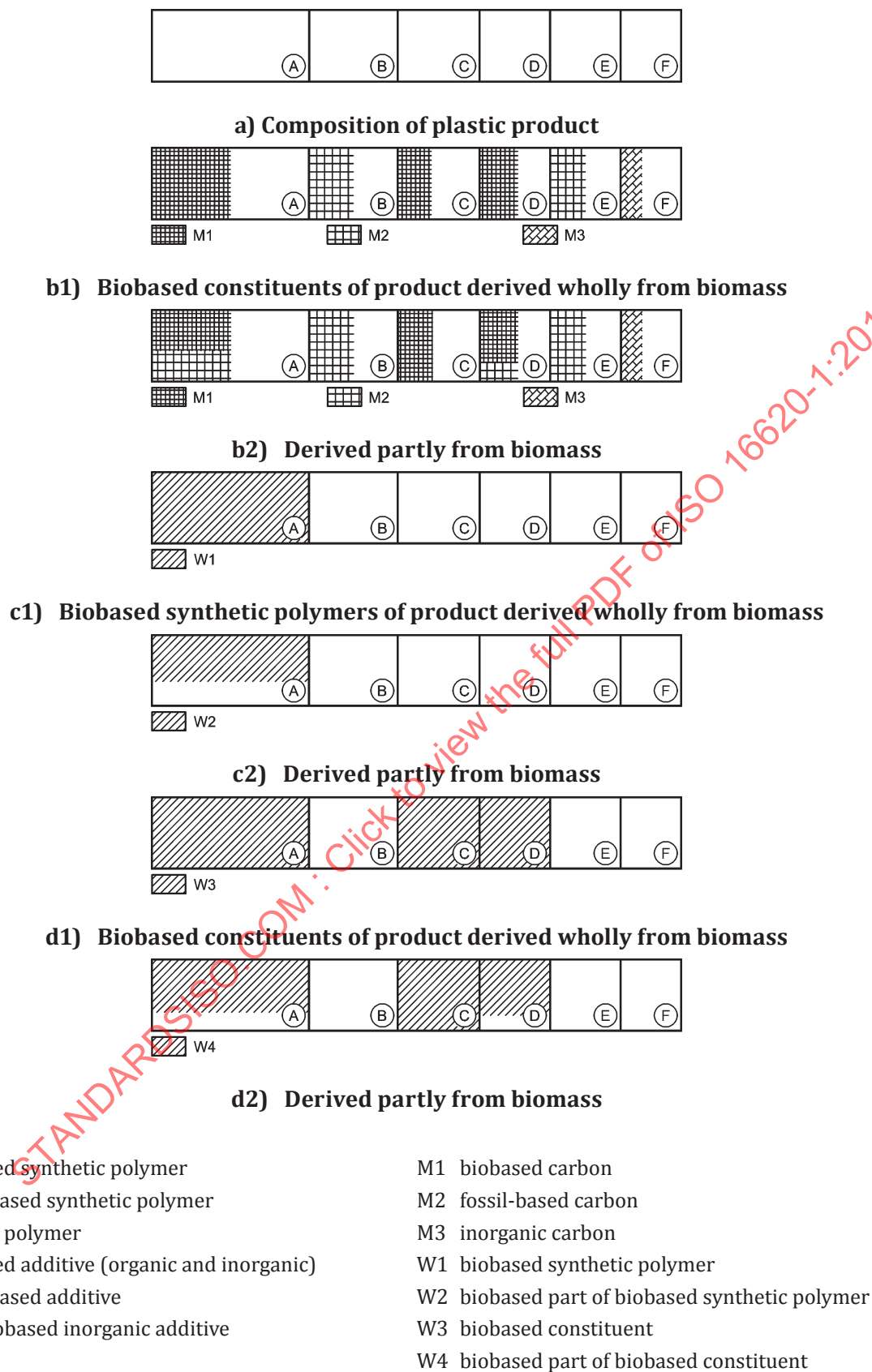


Figure 1 — Biobased content of a plastic product

5 Calculation methods for biobased content

5.1 Biobased carbon content — x_B^{TOC} and x_B^{TC}

5.1.1 Biobased carbon content expressed as a percentage of the total organic carbon

5.1.1.1 Biobased constituents of product derived wholly from biomass

The biobased carbon content, i.e. the amount of carbon of biomass origin [see [Figure 1](#) b1)], is expressed as a percentage of the total organic carbon and shall be calculated using Formula (1).

$$x_B^{\text{TOC}} = 100 \frac{M_A + M_C + M_D}{M_A + M_B + M_C + M_D + M_E} \quad (1)$$

where

M_A , M_B , M_C , M_D , and M_E are the carbon masses of the constituents A, B, C, D, and E, respectively.

The carbon mass of the inorganic additive M_F is not considered in Formula (1).

The method for determining the biobased carbon content of products comprising biobased constituents derived wholly from biomass is specified in ISO 16620-2.

5.1.1.2 Biobased constituents of product partly derived from biomass

If the biobased synthetic polymer and/or the biobased additive are partly biobased [see [Figure 1](#) b2)], then the biobased carbon content, expressed as a percentage of the total organic carbon, shall be calculated using Formula (2).

$$x_B^{\text{TOC}} = 100 \frac{M_{A1} + M_C + M_{D1}}{M_A + M_B + M_C + M_D + M_E} \quad (2)$$

where

M_{A1} and M_{D1} are the biobased carbon masses of the constituents A and D, respectively;

M_A , M_B , M_C , M_D , and M_E are the carbon masses of the constituents A, B, C, D, and E, respectively.

The method for determining the biobased carbon content of products comprising biobased constituents derived partly from biomass is specified in ISO 16620-2.

An example of this calculation is given in [Annex A](#).

5.1.2 Biobased carbon content expressed as a percentage of the total carbon

5.1.2.1 Biobased constituents of product derived wholly from biomass

The biobased carbon content, i.e. the amount of carbon of biomass origin [see [Figure 1](#) b1)] is expressed as a percentage of total carbon and shall be calculated using Formula (3).

$$x_B^{\text{TC}} = 100 \frac{M_A + M_C + M_D}{M_A + M_B + M_C + M_D + M_E + M_F} \quad (3)$$

where

M_A , M_B , M_C , M_D , M_E , and M_F are the carbon mass of constituents A, B, C, D, E and F, respectively.

The method for determining the biobased carbon content of products comprising biobased constituents wholly derived from biomass is specified in ISO 16620-2.

5.1.2.2 Biobased constituents of product partly derived from biomass

If the biobased synthetic polymer or the biobased additive is partly biobased [see [Figure 1 b2](#)], the biobased carbon content, expressed as a percentage of the total carbon, shall be calculated using Formula (4).

$$x_B^{TC} = 100 \frac{M_{A1} + M_C + M_{D1}}{M_A + M_B + M_C + M_D + M_E + M_F} \quad (4)$$

where

M_{A1} and M_{D1} are the biobased carbon mass of the constituents A and D, respectively;

$M_A, M_B, M_C, M_D, M_E,$ and M_F are the carbon mass of the constituents A, B, C, D, E, and F, respectively.

The method for determining the biobased carbon content is specified in ISO 16620-2.

An example of this calculation is given in [Annex A](#).

5.2 Biobased synthetic polymer content of a product

5.2.1 Biobased synthetic polymers of product derived wholly from biomass

The biobased synthetic polymer content, i.e. the amount of the biobased synthetic polymer of biomass origin [see [Figure 1 c1](#)], is expressed as a fraction of the total product mass and shall be calculated using Formula (5).

$$m_{BSP} = 100 \frac{W_A}{W_A + W_B + W_C + W_D + W_E + W_F} \quad (5)$$

where

$W_A, W_B, W_C, W_D, W_E,$ and W_F are the masses of the constituents A, B, C, D, E, and F, respectively.

The method for determining the biobased synthetic polymer content is specified in ISO 16620-3.

An example of this calculation is given in [Annex B](#).

5.2.2 Biobased synthetic polymers of product derived partly from biomass

If the biobased synthetic polymer is partly biobased [see [Figure 1 c2](#)], the biobased synthetic polymer content, expressed as a fraction of the total product mass, shall be calculated using Formula (6).

$$m_{BSP} = 100 \frac{W_{A1}}{W_A + W_B + W_C + W_D + W_E + W_F} \quad (6)$$

where

W_{A1} is the biobased mass of the constituent A;

$W_A, W_B, W_C, W_D, W_E,$ and W_F are the masses of constituents A, B, C, D, E, and F, respectively.

An example of this calculation is given in [Annex B](#).

Today, there is no experimental method to determine the biobased synthetic polymer content. However, using the biobased carbon content and the structure formula/mass composition, the biobased synthetic polymer content, the biobased additive content, and the total biobased mass content can be calculated.

The method to determine the biobased synthetic polymer content of products is specified in ISO 16620-3.

5.3 Biobased mass content

5.3.1 Biobased constituents of product derived wholly from biomass

The biobased mass content of a plastics product, expressed as a percentage of the total mass of the product, shall be calculated using Formula (7) [see [Figure 1 d1](#)].

$$m_B = 100 \frac{W_A + W_C + W_D}{W_A + W_B + W_C + W_D + W_E + W_F} \quad (7)$$

where

W_A , W_B , W_C , W_D , W_E , and W_F are the masses of constituents A, B, C, D, E, and F, respectively.

An example of this calculation is given in [Annex B](#).

5.3.2 Biobased constituents of product derived partly from biomass

If the biobased synthetic polymer and biobased additive are partly biobased [see [Figure 1 d2](#)], the biobased mass content of a plastics product, expressed as a percentage of the total mass of the product, shall be calculated using Formula (8):

$$m_B = 100 \frac{W_{A1} + W_C + W_{D1}}{W_A + W_B + W_C + W_D + W_E + W_F} \quad (8)$$

where

W_{A1} and W_{D1} are the biobased masses of constituents A and D, respectively;

W_A , W_B , W_C , W_D , W_E , and W_F each are the mass of the constituents A, B, C, D, E, and F, respectively.

An example of this calculation is given in [Annex B](#).

Today, there is no experimental method to determine the biobased mass content. However, using the biobased carbon content and the structure formula/mass composition, one can calculate the biobased synthetic polymer content, the biobased additive content, and the total biobased mass content.

The method for determining the biobased mass content of products is specified in ISO 16620-4.

Annex A (informative)

Examples for calculation of biobased carbon content

Table A.1 gives a calculation example for a polymer composite with a biobased synthetic polymer (polylactic acid) (PLA) and a biobased additive (starch). Polypropylene (PP) and dibutyl phthalate (DBP) are, respectively, a fossil-based polymer and an additive. Calcium carbonate is an inorganic additive. This polymer composite is not a real commercial product, but a model composite for the purpose of explaining the biobased carbon content calculation.

Table A.1 — Examples of calculation of the biobased carbon contents of a product

Constituent	Chemical formula	Dry mass fraction %	Carbon content of constituent %	Carbon content in total %	Biobased carbon content by TC for each constituent x_B^{TC} %	Biobased carbon content by TOC for each constituent x_B^{TOC} %
PLA ^a (Constituent A)	C ₃ H ₄ O ₂	30	50	15	100	100
PP ^b (Constituent B)	C ₃ H ₆	30	85,7	25,7	0	0
Starch (Constituent C)	C ₆ H ₁₀ O ₅	20	44,4	8,8	100	100
DBP ^c (Constituent E)	C ₁₆ H ₂₂ O ₄	5	69,1	3,4	0	0
Calcium carbonate (Constituent F)	CaCO ₃	15	12	1,8	0	—
Product (Total)	—	100	—	54,7	43,5 ^d	45 ^e
^a Poly(lactic acid). ^b Polypropylene. ^c Dibutyl phthalate. ^d $x_B^{TC} = 100 \times (15 + 8,8) / 54,7$. ^e $x_B^{TOC} = 100 \times (15 + 8,8) / (54,7 - 1,8)$.						