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**Plastics — Biobased content —**  
**Part 4:**  
**Determination of biobased mass**  
**content**

*Plastiques — Teneur biosourcée —*

*Partie 4: Détermination de la teneur en masse biosourcée*

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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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

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

A list of all parts in the ISO 16620 series can be found on the ISO website.

## Introduction

Increased use of biomass resources for manufacturing plastics products is effective in reducing global warming and the depletion of fossil resources.

Current plastics 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 ISO 16620 series, 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.

This document is harmonized with EN 16785-1:2015<sup>[12]</sup>.

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# Plastics — Biobased content —

## Part 4: Determination of biobased mass content

### 1 Scope

This document specifies a method of determining the biobased mass content in plastics products, based on the radiocarbon analysis and elemental analysis.

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

This method is applicable, provided that the plastic product contains carbon element and that a statement giving its elemental composition and its biobased mass content is available.

### 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 16620-2:2015, *Plastics — Biobased content — Part 2: Determination of biobased carbon content*  
ISO 16620-4:2016

### 3 Terms, definitions, symbols and abbreviated terms

#### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16620-1 apply.

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

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

#### 3.2 Symbols

$^{14}\text{C}$	carbon isotope with an atomic mass of 14
C	symbol for element carbon
H	symbol for element hydrogen
N	symbol for element nitrogen
O	symbol for element oxygen
$m_{\text{B}}$	biobased mass content, expressed as a percentage of the total mass of sample
$x_{\text{B}}$	biobased carbon content, expressed as a percentage of the total mass of the sample

$x^{TC}$	total carbon content, expressed as a percentage of the total mass of the sample
$x^{TH}$	total hydrogen content, expressed as a percentage of the total mass of the sample
$x^{TN}$	total nitrogen content, expressed as a percentage of the total mass of the sample
$x^{TO}$	total oxygen content, expressed as a percentage of the total mass of the sample
$W$	mass of a sample, expressed in grams

### 3.3 Abbreviated terms

CL	confidence level
TC	total carbon
TH	total hydrogen
TN	total nitrogen
TO	total oxygen

## 4 Principle

### 4.1 Product groups

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For the purpose of this document, two groups of products are distinguished as follows:

- Group I products are obtained by chemical or biological reaction(s);
- Group II products are obtained by mixing Group I products without chemical or biological reaction.

Natural constituents (4.4) can be used to produce Group I products or as constituent(s) of Group II products.

### 4.2 Group I products

This method, supported by rules described in [Clause 6](#), consists in

- the determination of the biobased carbon content and elemental composition of the product by using the radiocarbon analysis and elemental analysis respectively (6.3), and
- the comparison between
  - the data of the statement (6.1) comprising the composition and the origin (biobased and/or fossil resources) of the product, and
  - the data resulting from the radiocarbon analysis and elemental analysis of the product (6.3).

NOTE The “statement” in the sense of this document is to be distinguished from the “declaration” of the biobased mass content resulting of this method, which is in the scope of ISO 16620-5<sup>1)</sup>.

### 4.3 Group II products

This method consists in

- the determination of the biobased carbon content of the product by using the radiocarbon analysis (7.3), and

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1) To be published.



- b) the comparison between
- 1) the data of the statement (7.1) comprising the composition and the origin (biobased and/or fossil resources) of the product, and
  - 2) the data resulting from the radiocarbon analysis of the product (7.3).

NOTE The “statement” in the sense of this document is to be distinguished from the “declaration” of the biobased mass content resulting of this method, which is in the scope of ISO 16620-5<sup>1)</sup>.

#### 4.4 Natural constituents

This method is not needed for the determination of the biobased mass content in natural constituents (e.g. natural polymers) wholly derived from biomass.

The biobased mass content of a natural constituent is equal to 100 %.

The biobased carbon content of a natural constituent, expressed as a percentage of the total carbon content, is equal to 100 %.

NOTE This differentiates the calculation of the biobased mass content according to this document from the calculation of the biobased synthetic polymer content according to ISO 16620-3, where the biobased synthetic polymer content of a natural constituent is 0 % (see ISO 16620-1:2015, Clause 4).

#### 4.5 Monomers and additives

In case of monomers and additives for which the composition and raw material(s)/chemical(s) from which they are made are known, and whose chemical identification is unequivocal, the method may consist only in a determination of the biobased carbon content. The biobased mass content may be validated by applying the validation criteria (6.4), considering only the biobased carbon content.

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### 5 Rules for allocation of elements

NOTE According to the current state of the art, it is not possible by isotopic measurements to establish a distinction between elements originating from biomass and elements originating from non-biomass for elements such as oxygen, hydrogen or nitrogen.

For a product/constituent of a product obtained by chemical or biological reaction(s) (Group I), the following rules shall apply:

- a) if the reactants are exclusively derived from biomass, the biobased mass content of the product/constituent of the product is 100 %;
- b) if none of the reactants is derived from biomass, the biobased mass content of the product/constituent of the product is 0 %;
- c) if the reactants are derived from both biomass and non-biomass, the following conventions apply:
  - 1) if oxygen (O) and/or hydrogen (H) and/or nitrogen (N) element(s) is(are) bound to a carbon structure derived from biomass, its(their) fraction is(are) considered to be part(s) of the biobased mass content;
  - 2) element(s) other than C, H, O and N elements are not considered in this document.

EXAMPLE Esters derived from the condensation of an acid with a primary alcohol keep the O element coming from the alcohol.

## 6 Group I products

### 6.1 Statement

The statement to be provided with the product under consideration shall include

- information related to the relevant chemical or biological reaction(s) and the raw materials/chemicals from which the product is made,
- a complete elemental composition of the product ( $x_1^{TC}$ ,  $x_1^{TH}$ ,  $x_1^{TO}$  and  $x_1^{TN}$ ), and
- the biobased carbon content ( $x_{B1}$ ) and biobased mass content ( $m_{B1}$ ), of the product, obtained by calculation, following the rules defined in [Clause 5](#).

NOTE 1 The biobased carbon content can be expressed on the basis of total organic carbon (TOC) or total carbon (TC) or total mass.

NOTE 2 In this document, “biobased carbon content” refers to “biobased carbon content by mass, expressed as a percentage of the total mass”.

For products which contain water, the biobased mass content ( $m_{B1}$ ) is expressed by mass of dry matter.

EXAMPLE Poly(ethylene terephthalate) obtained by polycondensation of terephthalic acid from fossil resources with biobased ethylene glycol (see [Table 1](#)).

**Table 1 — Example of calculation for poly(ethylene terephthalate)**

Fraction	C %	H %	O %	Total %
Fossil fraction (from terephthalic acid)	50,0	2,1	16,6	68,7
Biobased fraction (from ethylene glycol)	12,5	2,1	16,6	31,2
Total	62,5	4,2	33,3	100,0
$x_1^{TC} = 62,5 \%$ $x_1^{TH} = 4,2 \%$ $x_1^{TO} = 33,3 \%$		$x_{B1} = 12,5 \%$ $m_{B1} = 31,2 \%$		

### 6.2 Sampling

The samples shall be representative of the product under consideration.

If available, product sampling procedures for the determination of the biobased carbon content and elemental composition shall be used and the details shall be documented.

### 6.3 Determination of the biobased carbon content and elemental composition

#### 6.3.1 Procedure

Determine the biobased carbon content of the sample according to ISO 16620-2.

Express the biobased carbon content ( $x_{B2}$ ) as a percentage of the total mass of the sample.

Determine the contents of total carbon ( $x_2^{TC}$ ), hydrogen ( $x_2^{TH}$ ), oxygen ( $x_2^{TO}$ ) and/or nitrogen ( $x_2^{TN}$ ) of the sample according to suitable standard analytical methods. If other element(s) is(are) present, its(their) content(s) may be also determined.

For determining the total carbon content and organic carbon content, test methods as described in ISO 609, ISO 8245, ISO 10694, ISO 15350, ISO 17247, ASTM D5291-02, ASTM E1019-11 or EN 13137 may be used, as applicable.

The oxygen content shall be obtained by analysis and not by calculation [i.e. by subtraction of the C, H and N contents from the total content (100 %)].

Express the contents of total carbon ( $x_2^{TC}$ ), hydrogen ( $x_2^{TH}$ ), oxygen ( $x_2^{TO}$ ) and/or nitrogen ( $x_2^{TN}$ ) as percentages of the total mass of the sample.

For the validation (6.4), use the test results, expressed by mass of dry matter.

### 6.3.2 Variability of test results

The results obtained by the analytical methods can differ from the stated values for the following reasons:

- a) the composition of the product can present variability due to its natural origin;  
EXAMPLE Natural fatty acids used in the production of fatty acid esters.
- b) the production process can be, to a certain extent, a cause of variability of the composition of the final product;
- c) the analytical methods are also a source of uncertainty, as follows:
  - 1)  $\pm 3$  % of the measured value for the biobased carbon content;
  - 2)  $\pm 0,4$  % of the measured value for the total carbon, total oxygen or total nitrogen content;
  - 3)  $\pm 0,2$  % of the measured value for the total hydrogen content.

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### 6.4 Validation criteria of the biobased mass content

Determine the gaps between the values given in the statement (6.1) and values resulting from testing (6.3.1) for the biobased carbon content, total carbon content, total hydrogen content, total oxygen content and/or total nitrogen content, as relevant.

For the validation of the biobased mass content, apply the decision scheme according to [Figure 1](#).

For monomers and additives, see also [4.5](#).