International Standard

ISO 16620-4

Second edition

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

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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 document 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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This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 14, *Environmental aspects*.

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This second edition cancels and replaces the first edition (ISO 16620-4:2016), which has been technically revised.

The main changes are as follows:

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— the Scope was editorially revised;

— the Normative references have been updated;

— 6.3.1 “Procedure” has been revised;

— the Bibliography has been updated.

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

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Increased use of biomass resources for manufacturing plastics products contributes to both reduction of global warming and conservation 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 the 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.

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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 and/or fossil-based constituents.

This method can be applied provided that the plastic product contains the element carbon and that a statement giving its elemental composition and its biobased carbon 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 16620-1, *Plastics — Biobased content — Part 1: General principles*

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

EN 17351, *Bio-based products — Determination of the oxygen content using an elemental analyser*

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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 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/

3.2 Symbols

^{14}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

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m_B biobased mass content, expressed as a percentage of the total mass of sample

x_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

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4.1 Product groups

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

a) Group I products are obtained by chemical, biochemical or biological reaction(s);

b) Group II products are obtained by mixing Group I products without chemical, biochemical or biological reaction.

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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

a) 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

b) the comparison between

   1) the data of the statement (6.1) comprising the composition and the origin (biobased and/or fossil resources) of the product, and

   2) 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 from this method, which is in the scope of ISO 16620-5.

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4.3 Group II products

This method consists in

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

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.

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).

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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.

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, biochemical 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.

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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

a) information related to the relevant chemical or biological reaction(s) and the raw materials/chemicals from which the product is made,

b) a complete elemental composition of the product (x_1^{TC}, x_1^{TH}, x_1^{TO} and x_1^{TN}), and

c) 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 in accordance with ISO 16620-2.

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

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.

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