BS ISO 16620-3:2015

BSI Standards Publication

Plastics — Biobased content

Part 3: Determination of biobased synthetic polymer content

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National foreword

This British Standard is the UK implementation of ISO 16620-3:2015.

The UK participation in its preparation was entrusted to Technical Committee PRI/21, Testing of plastics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2015

ISBN 978 0 580 84623 6
ICS 83.080.01

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2015.

Amendments/corrigenda issued since publication

Date	Text affected

BS ISO 16620-3:2015

INTERNATIONAL STANDARD

ISO 16620-3

First edition
2015-04-01

Plastics — Biobased content —

Part 3: Determination of biobased synthetic polymer content

Plastiques — Teneur biosourcée —

Partie 3: Détermination de la teneur en polymère synthétique biosourcé

Reference number
ISO 16620-3:2015(E)

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Published in Switzerland

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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 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.

INTERNATIONAL STANDARD **ISO 16620-3:2015(E)**

Plastics — Biobased content —

Part 3: Determination of biobased synthetic polymer content

WARNING — The use of this part of ISO 16620 can involve hazardous materials, operations, and equipment. This part of ISO 16620 does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this part of ISO 16620 to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1 Scope

This part of ISO 16620 specifies the method of determining the amounts of biobased part in the biobased synthetic polymer in plastics products. This calculation method for biobased synthetic polymer content is based on the mass of biobased synthetic polymer in the plastics 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 16620-1, *Plastics — Biobased content — Part 1: General principles*

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

3 Terms, definitions, and symbols

3.1 Terms and definitions

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

3.2 Symbols

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

W_{n} mass composition of n constituent of the product;

$m_{\mathrm{BSP,n}}$ biobased synthetic polymer content of n constituent of the product;

$x_{\mathrm{B,n}}$ biobased carbon content of n constituent of the product.

4 Principle

The indication of biomass used in plastic products is a practical way to assess efforts to develop wholly or partly biobased synthetic polymers. It also helps consumers to understand and compare relative contributions to environmental protection.

This part of ISO 16620 provides a method for the measurement of the biobased synthetic polymer content, derived from biomass resources.

The biobased synthetic polymer content of a plastic item can be calculated from the composition of the plastic, stated as a list of constituents with their percentage by mass, and from the biobased synthetic polymer content of said constituents (see, for examples, Annex A, Table A.1, and Table A.2).

Only synthetic polymers are eligible to be considered in this calculation, when they are wholly or partly biobased. Natural polymers and any biobased additive are not included in the biobased synthetic polymer content.

5 Procedure

The compositions of biobased synthetic polymers provided by a manufacturer can be used to determine the biobased synthetic polymer content of plastic products.

6 Calculation and expression of results

6.1 Biobased carbon content

The biobased carbon content of each biobased synthetic polymer constituent of a product shall be calculated from the C^{14} analysis as described in ISO 16620-2.

6.2 Biobased synthetic polymer content

The biobased synthetic polymer content of a constituent A, $m_{BSP,A}$ is 100 %, where this constituent is a wholly biobased synthetic polymer. If the constituent is a partly biobased synthetic polymer, $m_{BSP,A}$ is the mass fraction of the biobased unit which is wholly biobased in this constituent (see Annex A). The $m_{BSP,n}$ is 0 %, where the constituent is an additive, native natural polymer, or fossil-based polymer.

Compositions and biobased synthetic polymer contents are shown in Table 1.

Table 1 — Composition, biobased synthetic polymer content in a product

Constituent	Dry mass fraction %	Biobased synthetic polymer content %	Biobased carbon content %
Biobased synthetic polymer	W_A	$m_{BSP,A}$	$x_{B,A}$
Fossil-based synthetic polymer	W_B	0	0
Natural polymer	W_C	0	100
Biobased additive	W_D	0	$x_{B,D}$
Fossil-based additive	W_E	0	0
Inorganic additive	W_F	0	0
Product (total)	100	m_{BSP}	x_B^{TOC}

The biobased synthetic polymer content in a product shall be calculated using Formula (1) (see Annex A).

The biobased synthetic polymer content is expressed as a percentage of mass.

$$m_{\mathrm{BSP}} = \frac{W_{\mathrm{A}} \times m_{\mathrm{BSP,A}}}{100} \quad (1)$$

where

W_{A} is the % by mass of constituent A, "biobased synthetic polymer", used in the product;

$m_{\mathrm{BSP,A}}$ is the biobased synthetic polymer content of constituent A.

7 Test Report

The test report shall provide all pertinent information, and specifically the following:

a) a reference to this International Standard, i.e. ISO 16620-3:2015;

b) a report on the experimentally determined biobased carbon content for each of the biobased synthetic polymer;

c) a report on the formula/composition (elemental analysis) of each constituent in the biobased synthetic polymer;

d) a calculation of the biobased synthetic polymer content, expressed as a percentage of total mass of the product.

Annex A
(informative)

Example of calculations of biobased synthetic polymer content

Biobased synthetic polymers include biobased carbon atoms instead of fossil carbon atoms. Sometimes, it is convenient for customers to define the biobased content in products as a percentage of mass. Examples of the calculation of biobased synthetic polymer content for a composite and a copolymer are shown in Table A.1 and Table A.2. The composite consists of polylactic acid (PLA) as a biobased synthetic polymer, polypropylene as a fossil-based synthetic polymer, starch as a biobased additive, dibutyl phthalate, and calcium carbonate.

Table A.1 — Example of calculation of the biobased synthetic polymer content of a product

Constituent	Chemical formula	Dry mass fraction %	Biobased synthetic polymer content m_{BSP} %
PLA[a]	$C_3H_4O_2$	30	100
PP[b]	C_3H_6	30	0
Starch	$C_6H_{10}O_5$	20	0
DBP[c]	$C_{16}H_{22}O_4$	5	0
Calcium carbonate	$CaCO_3$	15	0
Product (Total)		100	30

[a] Poly(lactic acid).
[b] Polypropylene.
[c] Dibutyl phtalate.

The biobased synthetic polymer content is defined as the mass percent of the biobased synthetic polymer in a product. In Table A.1, the biobased synthetic polymer is only PLA; therefore, the mass percent of PLA, 30%, is the biobased synthetic polymer content.

An example of a partly biobased synthetic polymer of poly(ethylene terephthalate) in which the ethylene glycol unit of the polymer is biobased and the terephthalate unit is fossil-based is shown in Table A.2.

Table A.2 — Example of calculation of the biobased synthetic polymer content of a copolymer

Monomer unit	Chemical formula	Molecular weight g	Dry mass fraction %	Biobased synthetic polymer content m_{BSP} %
ethylene glycol	$C_2H_4O_2$	60	31,25	100
Terephthalate	$C_8H_4O_2$	132	68,75	0
Copolymer (Total)		192	100	31,25
Poly(ethylene terephthalate): $\{(O\text{-}CH_2\text{-}CH_2\text{-}O)(CO\text{-}C_6H_4\text{-}CO)\}_n$				

An example of the biobased synthetic polymer of product including PLA, bio-PET as shown in Table A.2, PP, starch, DBP, and calcium carbonate is shown in Table A.3.

Table A.3 — Example of calculation of the biobased synthetic polymer content of a product

Constituent	Chemical formula	Dry mass fraction %	Biobased synthetic polymer content m_{BSP} %
PLA[a]	$C_3H_4O_2$	30	100
Bio-PET	-[d]	20	31,25[e]
PP[b]	C_3H_6	10	0
Starch	$C_6H_{10}O_5$	20	0
DBP[c]	$C_{16}H_{22}O_4$	5	0
Calcium carbonate	$CaCO_3$	15	0
Product (Total)		100	36,25[f]

[a] Poly(lactic acid).

[b] Polypropylene.

[c] Dibutyl phtalate.

[d] Bio-PET [Poly(ethylene terephthalate)]: $\{\{O\text{-}CH_2\text{-}CH_2\text{-}O\}\{CO\text{-}C_6H_4\text{-}CO\}\}_n$.

[e] This value was calculated based on Table A.2.

[f] The biobased synthetic polymer content = 30 + (20 × 31,25) / 100 (%).

Annex B
(informative)

Example of calculations for biobased synthetic polymer content using biobased carbon content

Where the biobased synthetic polymer content of sample is 100%, its biobased carbon content which can be measured on the basis of ISO 16620-2 is 100%.

For a partly biobased synthetic polymer of polyethylene terephthalate (bio-PET) in which the ethylene glycol unit (EG) of the polymer is biobased and the terephthalate unit (TA) is fossil-based, the method for the calculation of biobased carbon content from biobased synthetic polymer content and carbon fraction (content) is shown in Table B.1. The biobased synthetic polymer content of bio-PET is 31,25% (see Table A.2).

Table B.1 — Example of calculation of the biobased carbon content from the biobased synthetic polymer content of partly biobased synthetic copolymer

	Bio-PET	
	EG	TA
Composition, %	31,25	68,75
Chemical formula of unit	$-OC_2H_4O-$	$-OC_8H_4O-$
Molecular weight of unit (Carbon weight of unit)	60 (24)	132 (96)
Carbon fraction	0,4	0,727
Relative carbon mass in copolymer	31,2 × 0,4 = 12,5	68,75 × 0,727 = 49,98
Biobased carbon content in copolymer (%)	[12,5 / (12,5 + 49,98)] × 100 = 20,01	

The carbon fraction can be calculated from its chemical formula or be measured by elemental analysis of each constituent. The relative mass of biobased and fossil-based carbon in a copolymer can be calculated. From these values, the biobased carbon content of the copolymer can be calculated and compare the measured value based on ISO 16620-2.

An example for a blend of bio-PET and PE (85/15 mass) is shown in Table B.2. The biobased synthetic polymer content shall be calculated using Formula (B.1).

$$m_{BSP} = \frac{W_A \times m_{BSP,A}}{100} = (85 \times 31{,}25) / 100 = 26{,}56\ (\%) \qquad \text{(B.1)}$$

Table B.2 — Example of calculation of the biobased carbon content from the biobased synthetic polymer content of bio-PET/PE (85/15) blend

	Bio-PET		**PE**
	EG	TA	
Composition, %	85		15
Composition, %	26,56	58,44	15
Chemical formula of unit	$-OC_2H_4O-$	$-OC_8H_4O-$	$-C_2H_4-$
Molecular weight of unit	60	132	28
(Carbon weight of unit)	(24)	(96)	(24)
Carbon fraction	0,4	0,727	0,857
Relative carbon mass in copolymer	26,56 × 0,4 = 10,62	58,44 × 0,727 = 42,49	15 × 0,857 = 12,86
Biobased carbon content in blend (%)	[10,62 / (10,62 + 42,49 + 12,86)] × 100 = 16,10		

ICS 83.080.01
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