BS EN 16785-1:2015

BSI Standards Publication

Bio-based products — Bio-based content

Part 1: Determination of the bio-based content using the radiocarbon analysis and elemental analysis

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National foreword

This British Standard is the UK implementation of EN 16785-1:2015.

The UK participation in its preparation was entrusted to Technical Committee MI/2, Bio-based products.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Biobasierte Produkte - Biobasierter Gehalt - Teil 1: Bestimmung des biobasierten Gehalts unter Verwendung der Radiokarbon- und Elementaranalyse

This European Standard was approved by CEN on 10 October 2015.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 16785-1:2015) has been prepared by Technical Committee CEN/TC 411 “Bio-based products”, the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2016, and conflicting national standards shall be withdrawn at the latest by June 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

EN 16785 consists of the following parts:

— EN 16785-1, *Bio-based products — Bio-based content — Part 1: Determination of the bio-based content using the radiocarbon analysis and elemental analysis (the present document)*

— EN 16785-2, *Bio-based products — Bio-based content — Part 2: Determination of the bio-based content using the material balance method*

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Bio-based products from forestry and agriculture have a long history of application, such as paper, board and various chemicals and materials. The last decades have seen the emergence of new bio-based products in the market. Some of the reasons for the increased interest lie in the bio-based products' benefits in relation to the depletion of fossil resources and climate change. Bio-based products may also provide additional product functionalities. This has triggered a wave of innovation with the development of knowledge and technologies allowing new transformation processes and product development.

Acknowledging the need for common standards for bio-based products, the European Commission issued Mandate M/492 [1)], resulting in a series of standards developed by CEN/TC 411, with a focus on bio-based products other than food, feed and biomass for energy applications.

The standards of CEN/TC 411 "Bio-based products" provide a common basis on the following aspects:

— Common terminology;

— Bio-based content determination;

— Life Cycle Assessment (LCA);

— Sustainability aspects;

— Declaration tools.

It is important to understand what the term bio-based product covers and how it is being used. The term 'bio-based' means 'derived from biomass'. Bio-based products (bottles, insulation materials, wood and wood products, paper solvents, chemical intermediates, composite materials, etc.) are products which are wholly or partly derived from biomass. It is essential to characterize the amount of biomass contained in the product by, for instance, its bio-based content or bio-based carbon content.

The bio-based content of a product does not provide information on its environmental impact or sustainability, which may be assessed through LCA and sustainability criteria. In addition, transparent and unambiguous communication within bio-based value chains is facilitated by a harmonized framework for certification and declaration.

The purpose of this European Standard is to provide a method of determining the bio-based content of solid, liquid and gaseous products using the radiocarbon analysis and elemental analysis.

Element carbon, C, has an isotope, ^{14}C, which allows for a clear distinction between carbon based substances in present living organisms and carbon based substances from fossil sources. Due to its radioactive decay, it is almost absent from fossil products older than 20 000 years to 30 000 years. Consequently, if the ^{14}C is present in chemicals, then it originates from recent atmospheric CO_2.The ^{14}C content may thus be considered as a tracer of chemicals recently synthesized from atmospheric CO_2 particularly of recently produced products, and it is used in CEN/TS 16640 for determining the bio-based carbon content.

The applied approach for carbon to determine the bio-based content of a sample based on isotopic measurements, cannot be used for other elements, such as oxygen, nitrogen or hydrogen.

However the content of each element can be determined by an elemental analysis which leads to the total content of each element. It does not differentiate the element according to its origin from bio-

1) A mandate is a standardization task embedded in European trade laws. Mandate M/492 is addressed to the European Standardization bodies, CEN, CENELEC and ETSI, for the development of horizontal European Standards for bio-based products.

based resources or fossil resources. Therefore, the combination of the ^{14}C content determination and an elemental analysis does not give the bio-based content of a sample. To circumvent this difficulty, the method as given in this European Standard is proposed consisting in a statement from the manufacturer, whose values have to be validated by the combined results of the radiocarbon and the elemental analysis.

1 Scope

This part of EN 16785 specifies a method of determining the bio-based content in products, based on the radiocarbon analysis and elemental analysis.

As a direct analytical determination is not feasible, this method consists in requiring from the producer or his representative some data given in a statement, and comparing these data with the results of the radiocarbon and elemental analysis.

This European Standard is applicable to any solid, liquid and gaseous product containing carbon, provided that a statement is available about the elemental composition and the bio-based content of the product(s).

This method is not needed for the determination of the bio-based content in natural products wholly derived from biomass.

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.

EN 16575:2014, *Bio-based products —Vocabulary*

CEN/TS 16640:2014, *Bio-based products — Determination of the bio based carbon content of products using the radiocarbon method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16575:2014 and CEN/TS 16640:2014 apply.

4 Symbols and abbreviations

4.1 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
m_B	bio-based content, expressed as a percentage of the total mass of sample
x_B	bio-based 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

4.2 Abbreviations

CL confidence level

TC total carbon

TH total hydrogen

TN total nitrogen

TO total oxygen

5 Principle

5.1 Product groups

For the purpose of this European Standard, two groups of products are distinguished depending on whether they are obtained by chemical synthesis (Group I) or without chemical synthesis (Group II).

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 products (5.4) can be used to produce Group I products or as constituent(s) of Group II products.

5.2 Group I products

This method, supported by rules described in Clause 6, consists in:

a) the determination of the bio-based carbon content and elemental composition of the product by using the radiocarbon analysis and elemental analysis respectively (7.3), and

b) the comparison between:

   1) the data of the statement (7.1) comprising the composition and the origin (bio-based and/or fossil resources) of the product, and

   2) the data resulting from the radiocarbon analysis and elemental analysis of the product (7.3).

5.3 Group II products

This method consists in:

a) the determination of the bio-based carbon content of the product by using the radiocarbon analysis (8.3), and

b) the comparison between:

   1) the data of the statement (8.1) comprising the composition and the origin (bio-based and/or fossil resources) of the product, and

   2) the data resulting from the radiocarbon analysis of the product (8.3).

NOTE The “statement” in the sense of this document is not to be confused with the “declaration” of the bio-based content resulting of this method.

5.4 Natural products

It is not needed to apply this method for the determination of the bio-based content in natural products wholly derived from biomass [e.g. wood (including pulp), flax, hemp, bamboo, sisal, coconut, rice].

The bio-based content of a natural product/constituent of a product is equal to 100 %.

The bio-based carbon content of a natural product/constituent of a product, expressed as a percentage of the total carbon content is equal to 100 %.

6 Rules for allocation of elements

NOTE 1 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 synthesis (Group I), the following rule shall be applied:

a) if the reactants are exclusively derived from biomass, the bio-based content of the product/constituent of the product is 100 %;

b) if none of the reactants is derived from biomass, the bio-based content of the product/constituent of the product is 0 %, and

c) if the reactants are derived from both biomass and non-biomass, the following convention applies:

   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 bio-based content.

   NOTE 2 Element(s) other than C, H, O and N elements are not considered in this European Standard.

7 Group I products

7.1 Statement

The statement to be provided with the product as an input for the determination of its bio-based content shall include:

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

b) a complete elemental composition of the product ($x^{TC}{}_1$, $x^{TH}{}_1$, $x^{TO}{}_1$ and $x^{TN}{}_1$), and

c) the bio-based carbon content (x_{B1}), and bio-based content (m_{B1}), of the product, obtained by calculation, following the rules defined in Clause 6.

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

EXAMPLE Bio-ethyl acetate obtained by esterification between bio-ethanol from fermentation of sugar and acetic acid from fossil resources. See Table 1.

Table 1 — Example of calculation for bio-ethyl acetate

Fraction	C %	H %	O %	Total %
Fossil fraction (from acetic acid)	27,3	3,4	18,2	48,9
Bio-based fraction (from ethanol)	27,2	5,7	18,2	51,1
Total	54,5	9,1	36,4	100,0
x^{TC}_{1} = 54,5 % x^{TH}_{1} = 9,1 % x^{TO}_{1} = 36,4 %		x_{B1} = 27,2 % m_{B1} = 51,1 %		

7.2 Sampling

The samples shall be representative of the product under consideration.

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

A list of suitable standardized sampling methods is given in Annex A.

7.3 Determination of the bio-based carbon content and elemental composition

7.3.1 Procedure

Determine the bio-based carbon content of the sample according to CEN/TS 16640.

Express the bio-based carbon content (x_{B2}), as a percentage of the total mass of the sample.

Determine the contents of total carbon (x^{TC}_{2}), hydrogen (x^{TH}_{2}), oxygen (x^{TO}_{2}) and/or nitrogen (x^{TN}_{2}) 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, test methods as described in ISO 10694 [1], ISO 8245 [2], EN 13137 [3], EN 16449 [4], ISO 17247 [5], ISO 15350 [6], ISO 609 [7], ASTM D5291-02 [8] or ASTM E1019-11 [9] 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^{TC}_{2}), hydrogen (x^{TH}_{2}), oxygen (x^{TO}_{2}) and/or nitrogen (x^{TN}_{2}) as percentages of the total mass of the sample.

For the validation (7.4), use the test results expressed by mass of dry matter.

7.3.2 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, and

c) the analytical methods are also a source of uncertainty, as follows:

1) ± 3 % of the measured value for the bio-based carbon content;

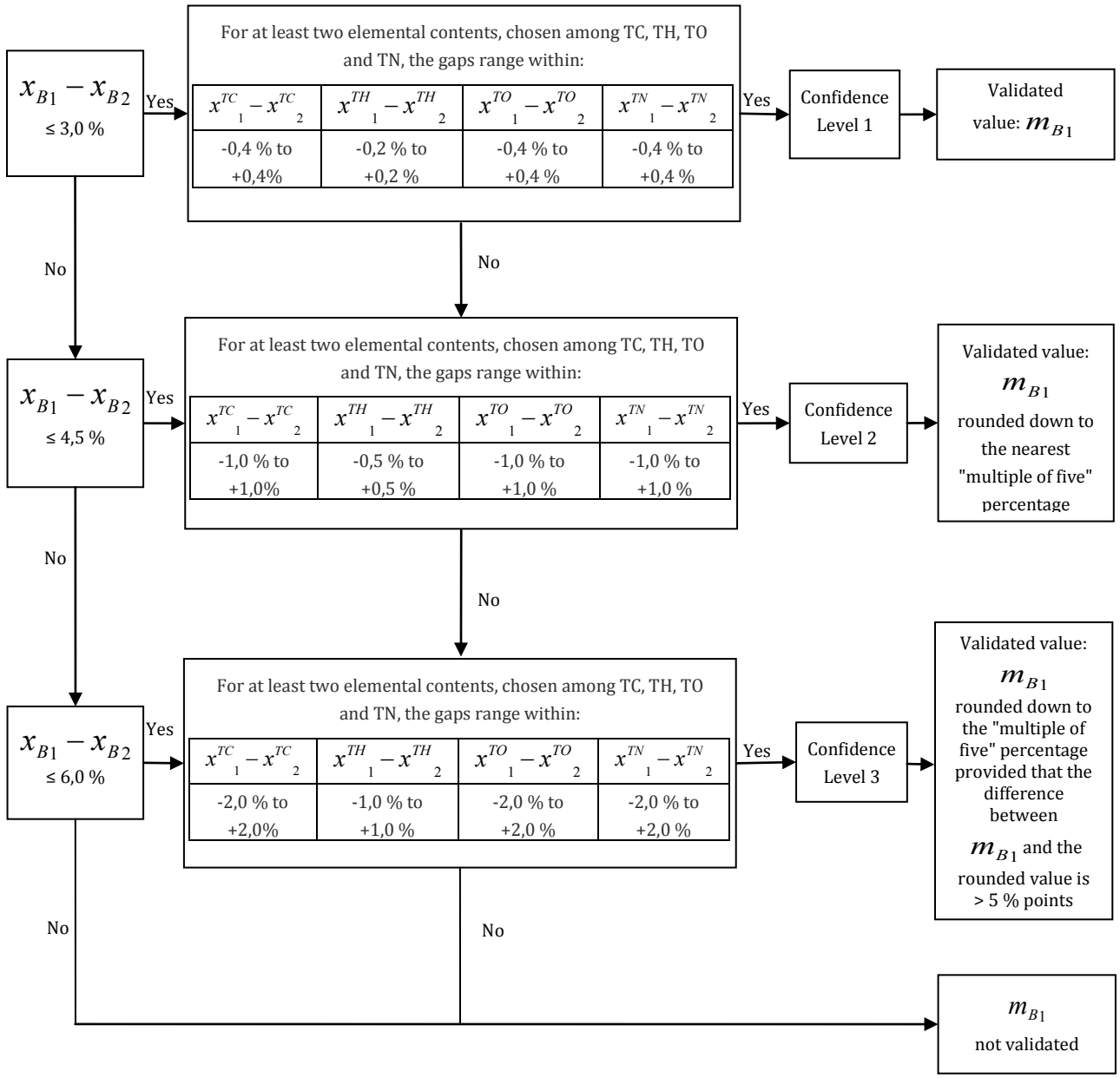
2) ± 0,4 % of the measured value for the total carbon, total oxygen or total nitrogen content, and

3) ± 0,2 % of the measured value for the total hydrogen content.

7.4 Validation criteria of the bio-based content

Determine the gaps between the values given in the statement (7.1) and values resulting from testing (7.3.1) for the bio-based carbon content, total carbon content, total hydrogen content, total oxygen content and/or total nitrogen content, as relevant.

For the validation of the bio-based content apply the decision scheme according to Figure 1.



Key

x_{B1} stated value for bio-based carbon content

x_{B2} measured value for bio-based carbon content

Figure 1 — Decision scheme for Group I products

EXAMPLE 1 For confidence level 2, 52 % is rounded down to 50 %, 57 % is rounded down to 55 %.

EXAMPLE 2 For confidence level 3, 48 % is rounded down to 40 %, 42 % is rounded down to 35 %.

If nitrogen and/or oxygen element(s) is(are) not present in the molecule, it(they) is(are) not taken into account.

EXAMPLE 3 In case of bio-ethyl acetate (see EXAMPLE in 7.1), N is not present in the molecule; therefore N cannot be taken into account. The validation is done by comparing the values of the bio-based carbon content as well as the TC content and the TH content. The TO content may also be considered instead of the TC content or TH content.

7.5 Examples of application of the decision scheme

Table 2 — Example 1

	Bio-based carbon content %	Total carbon %	Total hydrogen %	Total oxygen %	Bio-based content %
Stated values	25,0	50,0	5,6	44,4	56
Measured values	25,9	49,8	5,7	44,6	
	$x_{B1} - x_{B2}$ −0,9	$x^{TC}{}_1 - x^{TC}{}_2$ 0,2	$x^{TH}{}_1 - x^{TH}{}_2$ −0,1	$x^{TO}{}_1 - x^{TO}{}_2$ −0,2	
Criteria for CL 1	≤ 3	±0,4	±0,2	±0,4	
Criteria satisfied	Yes	Yes	Yes	Yes	
Validated value for the bio-based content: 56 %.					

Table 3 — Example 2

	Bio-based carbon content %	Total carbon %	Total hydrogen %	Total oxygen %	Bio-based content %
Stated values	40,8	53,0	9,0	24,2	52
Measured values	40,1	52,1	8,8	22,5	
	$x_{B1} - x_{B2}$ +0,7	$x^{TC}{}_1 - x^{TC}{}_2$ +0,9	$x^{TH}{}_1 - x^{TH}{}_2$ +0,2	$x^{TO}{}_1 - x^{TO}{}_2$ +1,7	
Criteria for CL 2	≤ 4,5	±1,0	±0,5	±1,0	
Criteria satisfied	Yes	Yes	Yes	No	
Validated value for the bio-based content: 50 %.					

Table 4 — Example 3

	Bio-based carbon content %	Total carbon %	Total hydrogen %	Total oxygen %	Bio-based content %
Stated values	47,2	50,2	7,2	42,6	67
Measured values	42,2 ± 6	47,5 ± 2	7,9	40,8	-
	$x_{B1} - x_{B2}$ +5	$x^{TC}{}_1 - x^{TC}{}_2$ +2,7	$x^{TH}{}_1 - x^{TH}{}_2$ −0,7	$x^{TO}{}_1 - x^{TO}{}_2$ +1,8	
Criteria for CL 3	≤ 6	±2	±1	±2	
Criteria satisfied	Yes	No	Yes	Yes	
Validated value for the bio-based content: 60 %.					

7.6 Test report

The test report shall include at least the following information:

a) a reference to this European Standard (i.e. EN 16785-1);

b) all information necessary for complete identification of the product under consideration;

c) the group of the product: Group I;

d) the statement, as defined in 7.1 (m_{B1} x_{B1}, $x^{TC}{}_1$, $x^{TH}{}_1$, $x^{TO}{}_1$, $x^{TN}{}_1$), expressed as a percentage of total mass of the sample;

e) method used for the determination of the bio-based carbon content (i.e. CEN/TS 16640:2014, Method C);

f) the value resulting from testing of the bio-based carbon content (x_{B2}), expressed as a percentage of the total mass of the sample;

g) analytical methods used for the determination of the elemental composition;

h) the measured values for each present element C, H, O and/or N ($x^{TC}{}_2$, $x^{TH}{}_2$, $x^{TO}{}_2$, $x^{TN}{}_2$), expressed as a percentage, of the total mass of the sample;

i) the validated value for the bio-based content (m_B), expressed as a percentage of total mass of the dried sample matter;

j) any additional information, including details of any deviations from the test methods and any operations not specified in this document which could have had an influence on the results;

k) identification of the laboratory performing the test, and

l) date of the test.

Annex B gives an example of a format for reporting the results for Group I products.

8 Group II products

8.1 Statement

This method is applicable provided that each of the constituents of the product, except the constituent(s) made from natural product(s) (5.4), if any, have been first analysed according to Clause 7 and the statement giving the bio-based content of each constituent has been validated.

The statement to be provided with the product as an input for the determination of its bio-based content shall include:

a) information related to the production process and the raw materials/chemicals from which the product is made;

b) the validated bio-based carbon content ($x_{B,i}$) and bio-based content ($m_{B,i}$) of each of the bio-based constituents of the product;

c) the bio-based carbon content (x_{B1}) and the bio-based content (m_{B1}) of the product, obtained by calculation according to Annex C.

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

8.2 Sampling

The samples shall be representative of the product under consideration.

If available, product sampling procedures for the determination of the bio-based carbon content shall be used and the details shall be documented.

A list of suitable standardized sampling methods is given in Annex A.

8.3 Determination of the bio based carbon content

8.3.1 Procedure

Determine the bio-based carbon content of the sample according to CEN/TS 16640.

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

For the validation (8.4), use the test results expressed by mass of dry matter.

8.3.2 Variability of test results

The results obtained by the radiocarbon method can differ from the stated values for the following reasons:

a) the composition of the product can present variability due to its natural origin;

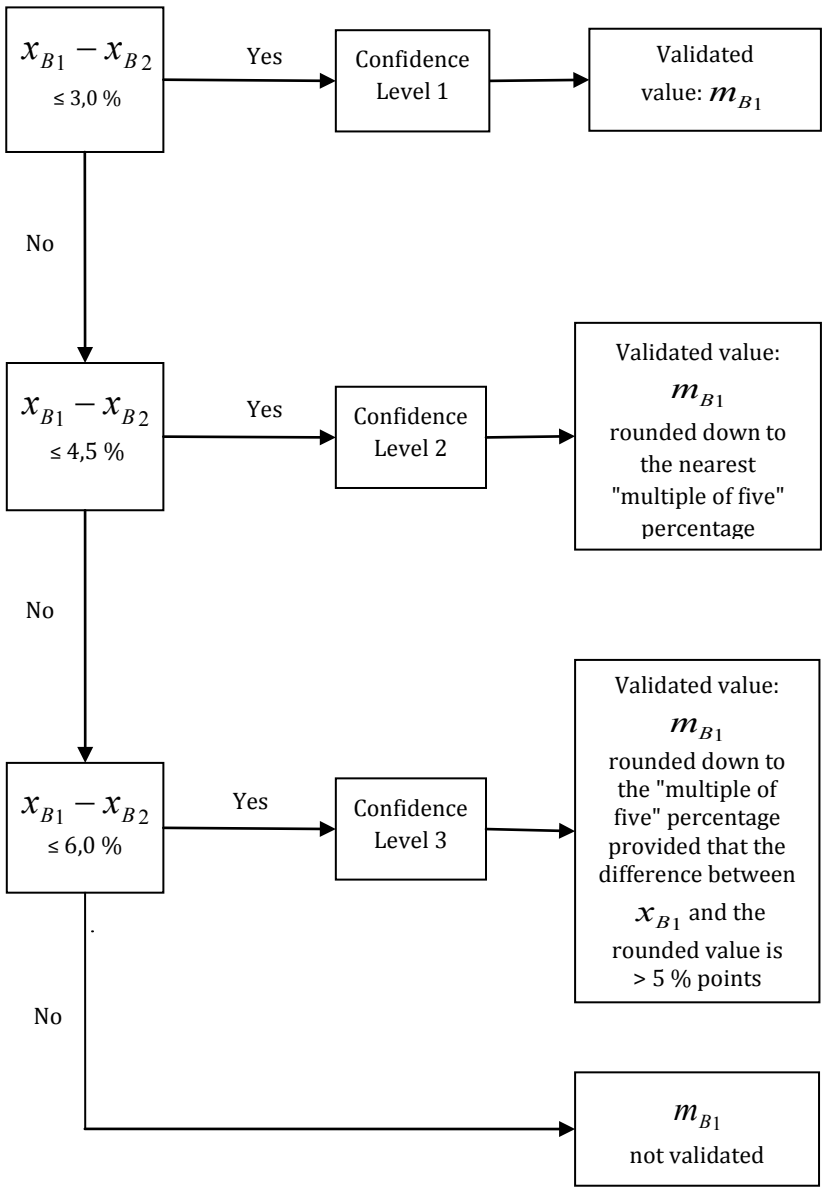
b) the production process can be, to a certain extent, a cause of variability of the composition of the final product, and

c) the radiocarbon method is also a source of uncertainty: ± 3 % of the measured value.

8.4 Validation criteria of the bio-based content

Determine the gap between the value given in the statement (8.1) and value resulting from testing (8.3.1) for the bio-based carbon content.

For the validation of the bio-based content apply the decision scheme according to Figure 2.



Key

x_{B1} stated value for bio-based carbon content

x_{B2} measured value for bio-based carbon content

Figure 2 — Decision scheme for Group II products

EXAMPLE 1 For confidence level 2, 52 % is rounded down to 50 %, 57 % is rounded down to 55 %.
EXAMPLE 2 For confidence level 3, 48 % is rounded down to 40 %, 42 % is rounded down to 35 %.

8.5 Example of application of the decision scheme

EXAMPLE Stated value for the bio-based content: 53 %

Stated value for the bio-based carbon content: 48 %

Measured value for the bio-based carbon content: 44 %

Gap between stated value and measured value: 48 % - 44 % = 4 % (in confidence level 2)

Validated value for the bio-based content: 50 %

8.6 Test report

The test report shall include at least the following information:

a) a reference to this European Standard (i.e. EN 16785-1);

b) all information necessary for complete identification of the product under consideration;

c) the group of the product: Group II;

d) the statement, as defined in 8.1;

e) the calculated value of the bio-based carbon content (x_{B1}), expressed as a percentage of the total mass of the sample;

f) the calculated value of the bio-based content (m_B), expressed as a percentage of the total mass of the sample;

g) method used for the determination of the bio-based carbon content (e.g. CEN/TS 16640:2014, Method C);

h) the value resulting from testing of the bio-based carbon content (x_{B2}), expressed as a percentage of the total mass of the sample;

i) the validated value of the bio-based content, expressed as a percentage of the total mass of the dried sample matter;

j) any additional information, including details of any deviations from the test methods and any operations not specified in this document which could have had an influence on the results;

k) identification of the laboratory performing the test, and

l) date of the test.

Annex D gives an example of a format for reporting the results for Group II products.

Annex A
(informative)

Standardized sampling methods

Standardized sampling methods for solid, liquid and gaseous products are given in Table A.1.

If there is no specific sampling method for a solid product, then the procedure described in EN 15442 or EN 15443 should be used.

Table A.1 — Sampling methods

Products	Sampling methods
Solid products	
Plastics, polymers	ISO 10210 [10]
Fuels	EN 14780 [11], EN 14778 [12], EN 15442 [13], EN 15443 [14] ISO 13909 [15], ISO/NP 18135 [16], ISO 18283 [17], ISO 20904 [18], ASTM D7026–13 [19],
Ceramics, glass, concrete, cement, construction materials / waste	ASTM C172/C172M-10 [20], ASTM C224–78 [21] (2009), ASTM C322–09 [22], ASTM C1704/C1704M-09A [23], ASTM D3665–12 [24]
Rubber	ISO 1795 [25], ASTM D1485–07 [26] (2011), ASTM D6085–97 [27] (2011)
Paper	EN ISO 186 [28], ISO 7213 [29], ASTM D2915–10 [30]
Liquid products	
Solvents	ASTM D 268–01 [31] (2012), ASTM D802–01 [32] (2013), ASTM D3437–11 [33]
Fuels	EN ISO 3170 [34], EN ISO 3171 [35], EN ISO 4257 [36] ISO 8943 [37] ASTM D233–12 [38], ASTM D1265–11 [39], ASTM D4057–12 [40], ASTM D4177–95(2010) [41]
Gaseous products	EN ISO 13833 [42] ISO 10715 [43] ASTM D7459–08 [44]
Other methods	EN ISO 15528 [45] ASTM D460–91(2005) [46], ASTM D6866–12 [47], ASTM D7455–08 [48], ASTM D7718–11 [49], ASTM E300–03 [50] (2009) EPA 340/1–91–010 [51]

Annex B
(informative)

Example of format for reporting results for Group I products

Table B.1 — Example of format for reporting results

Sample:	%	CL	%
Stated biobased content, m_B (provided by the producer or his representative)			
Stated value for bio-based carbon content, x_{B1} (provided by the producer or his representative)			
Measured value for bio-based carbon content, x_{B2}			
Gap between the stated and measured value, $x_{B1} - x_{B2}$			
Confidence level for bio-based carbon (based on the gap: $x_{B1} - x_{B2}$)			
Stated value for total carbon content, $x^{TC}{}_1$ (provided by the producer or his representative)			
Measured value for total carbon content, $x^{TC}{}_2$			
Gap between the stated and the measured total carbon content, $x^{TC}{}_1 - x^{TC}{}_2$			
Confidence level for total carbon (based on the gap: $x^{TC}{}_1 - x^{TC}{}_2$)			
Stated value for the total hydrogen content, $x^{TH}{}_1$ (provided by the producer or his representative)			
Measured value for the total hydrogen content, $x^{TH}{}_2$			
Gap between the stated and measured total hydrogen content, $x^{TH}{}_1 - x^{TH}{}_2$			
Confidence level for total hydrogen (based on the gap: $x^{TH}{}_1 - x^{TH}{}_2$)			
Stated value for the total oxygen content, $x^{TO}{}_1$ (provided by the producer or his representative)			
Measured value for the total oxygen content, $x^{TO}{}_2$			
Gap between the stated and measured total oxygen content, $x^{TO}{}_1 - x^{TO}{}_2$			
Confidence level for total oxygen (based on the gap: $x^{TO}{}_1 - x^{TO}{}_2$)			
Stated value for the total nitrogen content, $x^{TN}{}_1$ (provided by the producer or his representative)			
Measured value for the total nitrogen content, $x^{TN}{}_2$			
Gap between the stated and measured total nitrogen content, $x^{TN}{}_1 - x^{TN}{}_2$			
Confidence level for total nitrogen (based on the gap: $x^{TN}{}_1 - x^{TN}{}_2$)			
Assigned final confidence level (Use defined confidence levels for ^{14}C and two best confidence levels out of the remaining 4 elements: C, H, N, O)			
Validated value of the bio-based content accordingly to assigned final confidence level (m_B, or m_B rounded down depending on the confidence level (7.4)			

Annex C
(normative)

Calculation of the bio-based carbon content and bio-based content for Group II products

C.1 Calculation of the bio-based carbon content

Calculate the bio-based carbon content, as a percentage of the total mass of the sample, using Formula (C.1):

$$x_B = \frac{\sum_{i=1}^{n} W_i \cdot x_{B,i}}{W} \quad \text{(C.1)}$$

where

x_B is the bio-based carbon content, expressed as a percentage of the total mass of the sample;

$x_{B,i}$ is the bio-based carbon content of the constituent (i), expressed as a percentage of the mass of the constituent (i);

W_i is the mass of the constituent (i), expressed in grams;

W is the total mass of the sample, expressed in grams;

n is the number of constituents of the sample.

C.2 Calculation of the bio-based content

Calculate the bio-based content using Formula (C.2):

$$m_B = \frac{\sum_{i=1}^{n} W_i \cdot m_{B,i}}{W} \quad \text{(C.2)}$$

where

m_B is the bio-based content of the product expressed as a percentage of the total mass of sample;

$m_{B,i}$ is the bio-based content of the constituent (i), expressed as a percentage of the mass of the constituent (i);

W_i is the mass of the constituent (i), expressed in grams;

W is the total mass of the sample, expressed in grams.

n is the number of constituents of the sample.

Annex D
(informative)

Example of format for reporting results for Group II products

Table D.1 — Example of format for reporting results

Sample:	%	CL	%
Stated biobased content, m_B (provided by the producer or his representative)			
Stated value for bio-based carbon content, x_{B1} (provided by the producer or his representative)			
Measured value for the bio-based carbon content, x_{B2}			
Gap between the stated and measured value, $x_{B1} - x_{B2}$			
Confidence level for bio-based carbon (based on the gap $x_{B1} - x_{B2}$)			
Validated value of the bio-based content accordingly to assigned final confidence level (m_B, or m_B rounded down depending on the confidence level (8.4)			

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