SLOVENSKI STANDARD
SIST EN 15440:2011

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Nadomešča:
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Trdna alternativna goriva - Metoda za določevanje biomase

Solid recovered fuels - Method of the determination of biomass content

Feste Sekundärbrennstoffe - Verfahren zur Bestimmung des Gehaltes an Biomasse

Combustibles solides de récupération - Méthode de détermination de la teneur en biomasse

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English Version

Solid recovered fuels - Methods for the determination of biomass content

Combustibles solides de récupération - Méthode de détermination de la teneur en biomasse

Feste Sekundärbrennstoffe - Verfahren zur Bestimmung des Gehaltes an Biomasse

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Foreword

This document (EN 15440:2011) has been prepared by Technical Committee CEN/TC 343 “Solid recovered fuels”, the secretariat of which is held by SFS.

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of an identical text or by endorsement, at the latest by September 2011, and conflicting national standards shall be withdrawn at the latest by September 2011.

This document supersedes CEN/TS 15440:2006 and CEN/TS 15747:2008.

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.

This document differs from CEN/TS 15440:2006 mainly as follows:

a) the method based on ^{14}C and presented earlier in CEN/TS 15747:2008 is added to the standard;

b) results of interlaboratory tests supplemented as an informative Annex F;

c) whole document editorially revised.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This European Standard specifies the methods for the determination of biomass content in solid recovered fuels. This European Standard specifies three normative methods that are: the method of selective dissolution, the manual sorting method and the method based on the ^{14}C content.

The method of selective dissolution is based on the reaction of biomass material with a mixture of sulphuric acid and hydrogen peroxide. The manual sorting method is based on the separation of different fractions by visual inspection. The determination of the biomass content using the ^{14}C method is based on the well established analytical procedures that are used for the determination of the age of carbon containing objects.

With this European Standard the fraction of biomass is expressed:

— by weight;

— by energy content (gross or net calorific value);

— by carbon content.

This European Standard is primarily geared toward laboratories, producers, suppliers and purchasers of solid recovered fuels, but is also useful for the authorities and inspection organizations.

1 Scope

This European Standard specifies three normative methods for the determination of the biomass fraction in solid recovered fuel, and when to use each method. The methods are the selective dissolution in a hydrogen peroxide/sulphuric acid mixture, the manual sorting method and the method based on the ^{14}C content.

2 Normative references

The following referenced documents are indispensable for the application 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.

EN 15357:2011, *Solid recovered fuels — Terminology, definitions and descriptions*

EN 15400, *Solid recovered fuels — Determination of calorific value*

EN 15403, *Solid recovered fuels — Determination of ash content*

EN 15407[1)], *Solid recovered fuels — Methods for the determination of carbon (C), hydrogen (H) and nitrogen (N) content*

EN 15413[1)], *Solid recovered fuels — Methods for the preparation of the test sample from the laboratory sample*

EN 15442, *Solid recovered fuels — Methods for sampling*

EN 15443, *Solid recovered fuels — Methods for the preparation of the laboratory sample*

CEN/TS 15414-1:2010, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 1: Determination of total moisture by a reference method*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 15357:2011 and the following apply.

3.1
ash content
inorganic mass remaining after complete combustion of a solid recovered fuel under specified conditions expressed as a percentage of the mass of the dry matter in the solid recovered fuel

3.2
biodegradable
material capable of undergoing biological anaerobic or aerobic decomposition under conditions naturally occurring in the biosphere

NOTE (Council Directive 1999/31/EC on the landfill of biodegradable waste; any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and paperboard.)

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1) To be published.

3.3
biogenic
produced in natural processes by living organisms but not fossilized or derived from fossil resources

3.4
biomass[2)]
NOTE 1 This term is defined in several Directives and Decisions. For the purpose of this European Standard the following are relevant:

a) Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market: 'biomass' shall mean the biodegradable fraction of products, waste and residues from agriculture (including vegetable and animal substances) forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.

b) COMMISSION DECISION (2007/589/EC) of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council, as: 'biomass' means non-fossilised and biodegradable organic material originating from plants, animals and micro-organisms, including products, by-products, residues and waste from agriculture, forestry and related This term is defined in Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.

NOTE 2 Also see CEN/TR 14980.

3.5
calorific value
energy amount per unit mass or volume released on complete combustion

3.6
gross calorific value
measured value of the specific energy of combustion for unit mass of a solid recovered fuel burned in oxygen in calorimetric bomb under the conditions specified

NOTE 1 The results of combustion are assumed to consist of gaseous oxygen, nitrogen, carbon dioxide and sulphur dioxide, of liquid water (in equilibrium with its vapour) saturated with carbon dioxide under conditions of the bomb reaction, and of solid ash, all at the reference temperature and at constant volume.

NOTE 2 The old term for gross calorific value is higher heating value.

3.7
increment
portion of solid recovered fuel extracted in a single operation of the sampling device

3.8
isotope abundance
fraction of atoms of a particular isotope of an element

3.9
laboratory sample
sample sent to or received by the laboratory

NOTE 1 When the laboratory sample is further prepared (reduced) by subdividing, mixing, grinding, or by combinations of these operations, the result is the test sample. When no preparation of the laboratory sample is required, the laboratory sample is the test sample. A test portion is removed from the test sample for the performance of the test or for analysis.

NOTE 2 The laboratory sample is the final sample from the point of view of sample collection but it is the initial sample from the point of view of the laboratory.

[2)] No definition.

NOTE 3 Several laboratory samples may be prepared and sent to different laboratories or to the same laboratory for different purposes. When sent to the same laboratory, the set is generally considered as a single laboratory sample and is documented as a single sample.

3.10
total moisture
moisture in a solid recovered fuel removable under specific conditions

NOTE The old term for total moisture is moisture content.

3.11
net calorific value
calculated value of the specific energy of combustion for unit mass of a solid recovered fuel burned in oxygen in calorimetric bomb under such conditions that all the water remains as water vapor at 0,1 MPa

NOTE The old term for net calorific value is lower heating value.

3.12
nominal minimum size
aperture size of the sieve used for determining the particle size distribution of solid recovered fuels through which no more than 5 % by mass of the material passes

3.13
nominal top size
aperture size of the sieve used for determining the particle size distribution of solid recovered fuels through which at least 95 % by mass of the material passes

3.14
percentage modern Carbon (pmC)
percent modern carbon relative to the NIST Oxalic acid standard reference material SRM4990B

NOTE 1 The internationally accepted radiocarbon dating reference value is 95 percent of the activity, in AD 1950, of this NBS oxalic acid SRM4990B.

NOTE 2 In 2008 the value of 100 % biogenic carbon is set at 107 pmC.

3.15
sample
quantity of material, representative of a larger quantity for which the property is to be determined

3.16
sample preparation
all actions taken to obtain representative analyses samples or test portions from the original sample

3.17
sub-sample
sample obtained by procedures in which the items of interest are randomly distributed in parts of equal or unequal size

NOTE 1 A sub-sample can be:

d) a portion of the sample obtained by selection or division;

e) the final sample of multistage sample-preparation.

NOTE 2 The definition for sub-sample is adopted from CEN/TC 292.

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

C	Symbol for element carbon
D	Diameter (mm)
^{14}C	Carbon isotope with an atomic mass of 14
MS	Manual sorting method
RES-E	Directive 2001/77/EC of the European parliament and council of 27 September 2001
RSD	Relative standard deviation
SDM	Selective dissolution method
SRF	Solid recovered fuel
TC	Total carbon content
X	Fraction expressed as a percentage by weight.

Expressions to different bases employed in this document are given with the suffixes: $_{(ad)}$ for air-dried: $_{(ar)}$ for as received: $_{(d)}$ for dry: $_{(daf)}$ for dry and ash free, where appropriate.

Example; $x^{cal}_{NB(d)}$ means the fraction of energy content in the non-biomass fraction, on dry basis

5 Principle

The determination of the biomass content is based on selective dissolution, manual sorting or ^{14}C measurement of biomass in solid recovered fuel. The choice for the method to be used is described in the next clause. The biomass content gives an estimation of the content of the biodegradable/biogenic fraction in solid recovered fuel.

6 Determination of biomass content

6.1 Sampling

Sampling, transport, storage of the solid recovered fuel and sample preparation in the field shall be conducted according to EN 15442 and EN 15443. Preparation of the test sample shall be conducted according to EN 15413.

6.2 Applicable methods

For the determination of biomass content three methods are available:

1) the determination of the biomass content based on the selective dissolution method (SDM) (see Annex A). The determination of the biomass content based on the selective dissolution method is based on the property of biomass that it can be dissolved in a sulphuric acid / hydrogen peroxide mixture;

2) the determination of the biomass content based on the manual sorting method (MS). This method is suitable for samples with a particle size > 10 mm (see Annex B);

3) the determination of the biomass content based on the ^{14}C method. This method is suitable for samples of all types of fuel (see Annex C).

The selective dissolution method can give false results which may be caused by the following components in SRF. In case that these components are present in an amount defined below, the selective dissolution method is not applicable.

List of components giving false results:

— solid fossil fuels like hard coal, coke, brown coal, lignite and peat;

— charcoal;

— biodegradable plastics of fossil origin;

— non-biodegradable plastics of biogenic origin;

— oil or fat present as a constituent of biomass;

— natural and/or synthetic rubber residues;

— wool;

— viscose;

— nylon, polyurethane or other polymers containing molecular amino groups;

— silicon rubber.

If components in this list are expected to be present with an amount of less than 10 % by weight (for natural and/or synthetic rubber residues) or 5 % by weight (for the other mentioned components), an assessment is not necessary. If the components in this list are expected to be present in the sample with a higher amount, an assessment shall be made of the estimated influence of the presence of these components and the results of that assessment shall be mutually agreed between the parties involved. In case of conflicts the ^{14}C method shall be used to confirm the results of that assessment.

NOTE 1 In typical municipal and similar waste, the content of nylon, polyurethane, biodegradable plastics of fossil origin, wool, viscose, non-biodegradable plastics of biogenic origin and oil/fat present is rather small and the error is negligible.

NOTE 2 As the contribution of biobased products is expected to increase, the effect should be evaluated during the next revision of this European Standard. The limitations of the ^{14}C Method can be found in Annex D.

6.3 Selection of methods for the determination of the biomass content

Three different dimensions are used to express the biomass content:

a) biomass in percent by weight (x_B).

b) biomass in percent by calorific value (x_B^{cal}).

c) biomass in percent by carbon content (x_B^{TC}).

For the selection of the method the following aspects shall be considered:

1) what is the purpose of the biomass content determination? If the results are used for the Directive 2001/77/EC (RES-E) then biomass content by weight and / or calorific value needs to be determined. If the results are used for greenhouse gas reduction related issues (CO_2 trading) then the biomass content by carbon and/or calorific value has to be determined;

2) are the measurements parts of a regular routine control check for RES-E issues? In that case the SDM / MS shall be used, provided that there is no restriction due to false results as described in 6.2. The SDM and MS measurements are regarded as preferred methods as they can be performed in a typical laboratory by proficient analysis using simple standard equipment. Results can be available within 1 to 2 days and if the nature of the SRF is well known and constant, the SRF and MS measurements are the most efficient options;

3) are the measurements intended for CO_2 trading matters or accounting biomass content in CO_2 - emissions? In that case the ^{14}C method or the SDM may be used. Validation studies show that there is a good agreement in the determination of the biomass content by carbon between the ^{14}C method and the SDM / MS method in SRF materials.

Table 1 — Method selection

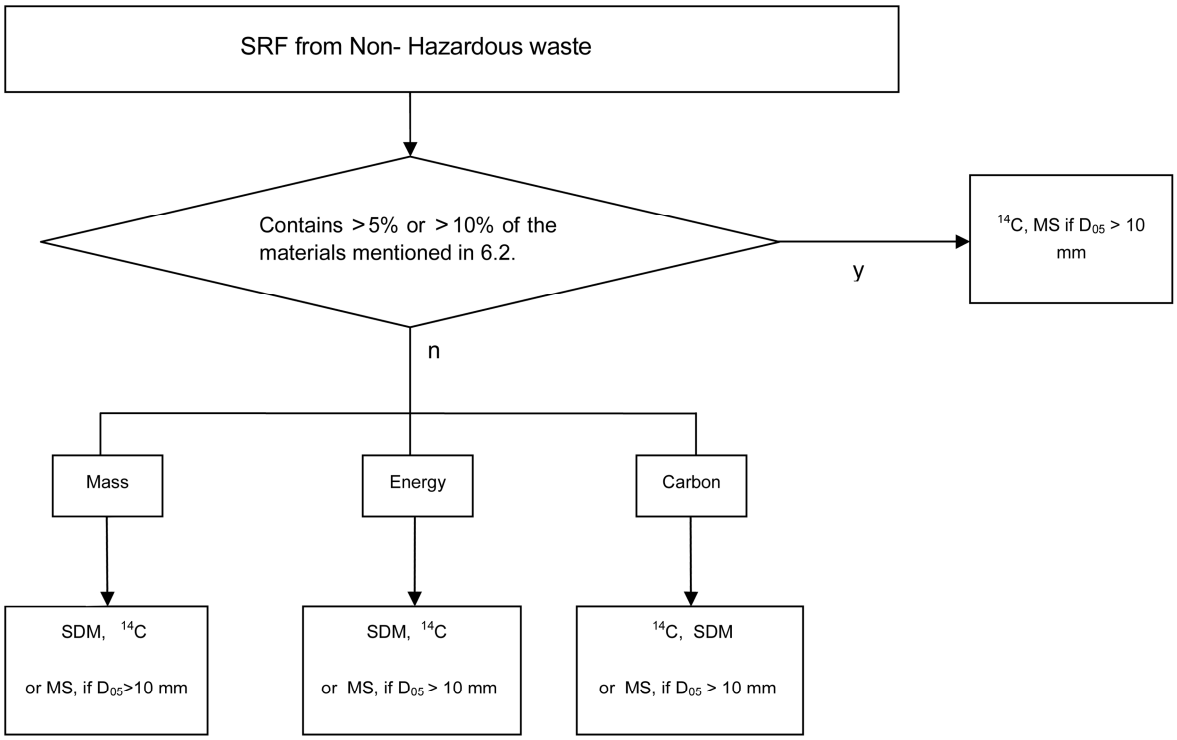
	[RES-E]	[CO_2 trading]
x_B	SDM / MS	
x_B^{cal}	SDM / MS	^{14}C / SDM
x_B^{TC}		^{14}C / SDM

NOTE 1 The determination of the biomass fraction with ^{14}C expressed by energy content has not been validated.

NOTE 2 The MS combined with the CV determination or the TC determination of the biomass and the non-biomass fraction could be used for internal analyses.

In Table 1 [RES-E] refers to Directive 2001/77/EC of the European parliament and council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market and [CO_2 trading] refers to greenhouse gas reduction related issues.

Figure 1 gives a decision tree for finding the right method for the determination.



where

MS = Manual sorting

SDM = Selective dissolution method

^{14}C = Radiocarbon method

D_{05} = nominal minimum size

Figure 1 — Decision tree for the selection of determination method

NOTE 3 The MS combined with the CV determination or the TC determination of the biomass and the non-biomass fraction can be used for internal analyses.

NOTE 4 ^{14}C method is not validated for the determination of the energy related biomass content.

7 Calculation

Examples of method specific calculations are presented in the method specific Annexes A, B and C. When the biomass content by weight and biomass content by calorific value is to be determined by the ^{14}C method, the values are calculated from the biogenic carbon content. Examples of this calculation are given in C.7.5. If the origin of the biogenic constituents is unknown, then a good estimation can be obtained by assuming that cellulose is the primary source of the biogenic constituents, as cellulose is the main product of the photosynthesis carbon cycle.

8 Expression of results

8.1 Example for biomass carbon values

In this European Standard all biomass related values are expressed as fraction of the total (biomass + non-biomass) content. Table 2 gives 2 examples of the different terms used in this European Standard, with some common values for wood and SRF.

Table 2 — Examples of the relation between TC, Biogenic carbon content and x_B^{TC}

Fuel	**% TC**	**% Biogenic carbon**	x_B^{TC}
Wood	48	48	100
SRF	50	25	50
where			
% TC	is the Total Carbon content;		
% Biogenic carbon	is the amount of carbon with biogenic origin;		
x_B^{TC}	is the biomass content, expressed as a percentage by TC.		

8.2 Performance characteristics

In accordance with EN ISO 17025 and the actual vision on the presentation of the performance characteristics as is shown in recent ISO standards, no demands on performance characteristics are present in this European Standard. External data for the calculation of the expanded uncertainty of measurements are presented in Annex F where recent results of round robin and validation studies are summarized. These values should be used in combination with individual laboratory performance characteristics and a desired coverage factor to get the overall uncertainty that is demanded by the customer.

EXAMPLE Practical example of usage of the data from Annex F:

A laboratory wants to determine the expanded uncertainty of measurement of their SDM method (by mass).

The intra-laboratory reproducibility for the laboratory calculated from internal validations studies and control charts was determined to be 2,5 % (RSD).

The round robin results from the QUOVADIS study (Table F.2.1) give a RSD value of 3,4 % (at 70 % level).

$u_{c,rel} = \sqrt{(2{,}5^2 + 3{,}4^2)} = 4{,}2\ \%$

$U_{rel} = 2 \times u_{c,rel} = 8{,}4\ \%$

where $u_{c,rel}$ is the combined uncertainty of measurement and U_{rel} is the expanded uncertainty of measurement using a coverage factor of 2 (~ 95 % confidence interval).

9 Test report

The test report shall contain at least the following information:

a) identification of the laboratory performing the test;

b) date of the test;

c) identification of product (sample) tested;

d) sample preparation (e.g. method of size reduction, drying, subdivision);

e) storage conditions;

f) date of receipt of laboratory sample and dates of the test (beginning and end);

g) a reference to this European Standard (EN 15440);

h) in case of ^{14}C-method, the results of the test including the basis on which they are expressed and application of the isotope correction;

i) the biomass content expressed as a percentage by mass, calorific value and/or carbon content;

j) any operation not included in this European Standard, or regarded as optional;

k) any unusual features noted during the test procedure.