SLOVENSKI STANDARD
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Trdna biogoriva - Preračun analiz na različne osnove

Solid biofuels - Conversion of analytical results from one basis to another

Feste Biobrennstoffe - Umwandlung von Analysenergebnissen einer Bezugsbasis in Ergebnisse mit anderer Bezugsbasis

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Biocombustibles solides - Conversion de résultats analytiques d'une base en une autre base

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75.160.10	Trda goriva	Solid fuels

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Solid biofuels - Conversion of analytical results from one basis to another

Biocombustibles solides - Conversion de résultats analytiques d'une base en une autre base

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Foreword

This document (EN 15296:2011) has been prepared by Technical Committee CEN/TC 335 “Solid biofuels”, the secretariat of which is held by SIS.

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of an identical text or by endorsement, at the latest by August 2011, and conflicting national standards shall be withdrawn at the latest by August 2011.

This document supersedes CEN/TS 15296:2006.

In the pre-normative project BIONORM I&II a robustness test has been performed to find out if all critical parameters in the standard were addressed. Based on the results of that test it has been concluded that all critical parameters were covered. Only minor technical changes were necessary which have been implemented in the revised text. The revision also includes a change of deliverable from Technical Specification to European Standard and updated normative references.

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Introduction

In the CEN Standards covering the analysis of solid biofuels it is generally specified that the determination should be carried out on the air-dried or in air equilibrated general analysis test sample, prepared according to FprEN 14780 [1]. However, in making use of these analyses, it is necessary to express the results on dry basis and sometimes also on some other basis. The bases in common use for solid biofuels are “air-dried” (sometimes stated as “as determined”), “as received” (sometimes stated “as sampled” or “as delivered”), “dry” and “dry, ash free”.

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1 Scope

This European Standard gives equations, which allow analytical data relating to solid biofuels to be expressed on the different bases in common use. Consideration is given to corrections that may be applied to certain determined values for solid biofuels prior to their calculation to other bases.

In the informative Annex A tools for integrity checks of analytical results are given. In the informative Annex B conversion factors for calculation into other units are given. The informative Annex C is a guideline for the use of validation parameters as can be found in analytical standards of CEN/TC 335.

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 14774 (all parts), *Solid biofuels — Determination of moisture content — Oven dry method*

EN 14775, *Solid biofuels — Determination of ash content*

EN 14918, *Solid biofuels — Determination of calorific value*

EN 14961-1, *Solid biofuels — Fuel specifications and classes — Part 1: General requirements*

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EN 15104:2011, *Solid biofuels — Determination of total content of carbon, hydrogen and nitrogen — Instrumental methods*

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EN 15289, *Solid biofuels — Determination of total content of sulfur and chlorine*

3 Symbols

The symbols employed in the subsequent clauses are as follows, with the indices "ad" (air-dried), "ar" (as received), "d" (dry), "daf" (dry, ash free) where appropriate:

— *A* ash (percentage by mass) according to EN 14775;

— *C* total carbon content (percentage by mass) according to EN 15104;

— *Cl* total chlorine content (percentage by mass) according to EN 15289;

— $q_{p,net}$ net calorific value at constant pressure (J/g) according to EN 14918 or (MJ/kg) according to EN 14961-1;

— *H* total hydrogen content (percentage by mass) according to EN 15104;

— *M* moisture content (percentage by mass) according to EN 14774 (all parts);

— *N* total nitrogen content (percentage by mass) according to EN 15104;

— *O* total oxygen content (percentage by mass);

— *S* total sulfur content (percentage by mass) according to EN 15289.

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4 Principle

In order to convert an analytical result expressed as one basis to another basis, it is multiplied by a factor calculated from the appropriate equations (see Table 1) after insertion of the requisite numerical values into the equations in question.

5 Calculations for analyses of solid biofuels

5.1 General

Most analytical values on a particular basis may be converted to any other basis by multiplying it by a factor calculated from the appropriate equation given in Table 1, after insertion of the requisite numerical values into the equation in question. However, for some parameters there is a direct involvement of the moisture content. In these cases a correction as specified in 5.2 of the air-dried result shall be carried out before calculation to dry basis or dry, ash free basis. Also, if a result for these parameters expressed on a dry or a dry, ash free basis is to be recalculated to a moist basis, the corrections stated in 5.2 shall be added back to the actual moist basis after applying the appropriate equation from the table.

5.2 Extra calculations for hydrogen, oxygen and net calorific value

5.2.1 Hydrogen

The hydrogen content determined on the air-dried basis (H_{ad}, as analysed) includes both the hydrogen content of the combustible part of the solid biofuel as well as the hydrogen present in the sample as moisture (total hydrogen content). Before calculation to any other basis the determined hydrogen content, H_{ad}, shall be corrected of the moisture bound hydrogen by calculation to dry basis, H_d:

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$$H_d = (H_{ad} - M_{ad} / 8{,}937) \times \frac{100}{(100 - M_{ad})} \quad (1)$$

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This hydrogen content, related to the combustible part of the solid biofuel, may be converted to any other basis using the equations in Table 1.

5.2.2 Oxygen

The oxygen content related to the combustible part of the solid biofuel can be calculated by difference on the dry basis using the equation:

$$O_d = 100 - C_d - H_d - N_d - S_d - Cl_d - A_d \quad (2)$$

NOTE If high precision is required, the values of S_d and Cl_d should be corrected for eventual remaining contents of sulfur and chlorine in the ash (A_d).

5.2.3 Net calorific value

The net calorific value at constant pressure on a moist basis ($q_{p,net,M}$) includes a correction for the heat of vaporization concerning the actual moisture content, M (M being e.g. M_{ad} or M_{ar}). Before conversion to any other basis, using the equations in Table 1, this correction corresponding to 24,43 J/g per weight percent moisture (24,43 x M) shall be undone by adding 24,43 $\times$ M to the value of the net calorific value. After multiplying this sum with the appropriate equation from Table 1, the obtained value then is to be corrected for the heat of vaporization concerning the new moisture content, M^*, by subtracting the value 24,43 $\times$ M^*. These corrections are illustrated in Equation (3) concerning the conversion of the net calorific value for a moisture content M to the net calorific value for a moisture content M^*, both at constant pressure and in J/g:

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$$q_{p,net,M*} = \left[q_{p,net,M} + (24{,}43 x M)\right] x \frac{100 - M*}{100 - M} - (24{,}43 x M*) \quad (3)$$

For the conversion of e.g. the net calorific value on dry basis ($q_{p,net,d}$ in J/g) to the net calorific value on as received basis ($q_{p,net,ar}$ in J/g), Equation (3) can be simplified into:

$$q_{p,net,ar} = q_{p,net,d} \times \frac{100 - M_{ar}}{100} - 24{,}43 \times M_{ar} \quad (4)$$

as in this case, M = 0 and M* = M_{ar}

The net calorific value at a constant pressure for a dry sample ($q_{p,net,d}$) is derived from the corresponding gross calorific value at a constant volume according to EN 14918.

5.3 General equations for the conversion from one basis to another basis

After applying eventual corrections according to 5.2, analytical values on a particular basis may be converted to any other basis by multiplying it by a factor calculated from the appropriate equation given in Table 1, after insertion of the requisite numerical values into the equation in question.

Table 1 — Equations for calculating conversion factors to convert analytical results from one basis to another

Given	Wanted			
	As analysed (air dried) (ad)	**As received** [a] (ar)	**Dry** (d)	**Dry, ash free** (daf)
As analysed (air dried, ad)		$\frac{100 - M_{ar}}{100 - M_{ad}}$	$\frac{100}{100 - M_{ad}}$	$\frac{100}{100 - (M_{ad} + A_{ad})}$
As received (ar)	$\frac{100 - M_{ad}}{100 - M_{ar}}$		$\frac{100}{100 - M_{ar}}$	$\frac{100}{100 - (M_{ar} + A_{ar})}$
Dry (d)	$\frac{100 - M_{ad}}{100}$	$\frac{100 - M_{ar}}{100}$		$\frac{100}{100 - A_d}$
Dry, ash free (daf)	$\frac{100 - (M_{ad} + A_{ad})}{100}$	$\frac{100 - (M_{ar} + A_{ar})}{100}$	$\frac{100 - A_d}{100}$	

[a] Note that the equations given for calculating results to the "as received" basis may be used to calculate them to any other moisture bases.

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