DD CEN/TS 15401:2010

BSI Standards Publication

Solid recovered fuels — Determination of bulk density

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National foreword

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This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature. It should be applied on this provisional basis, so that information and experience of its practical application can be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the international organization responsible for its conversion to an international standard. A review of this publication will be initiated not later than 3 years after its publication by the international organization so that a decision can be taken on its status. Notification of the start of the review period will be made in an announcement in the appropriate issue of *Update Standards.*

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into an international Standard, to extend the life of the Technical Specification or to withdraw it. Comments should be sent to the Secretary of the responsible BSI Technical Committee at British Standards House, 389 Chiswick High Road, London W4 4AL.

The UK participation in its preparation was entrusted to Technical Committee PTI/17, Solid biofuels.

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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Compliance with a British Standard cannot confer immunity from legal obligations.

This Draft for Development was published under the authority of the Standards Policy and Strategy Committee on 31 August 2010.

Amendments issued since publication

Date	Text affected

TECHNICAL SPECIFICATION

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English Version

Solid recovered fuels - Determination of bulk density

Combustibles solides de récupération - Méthode de détermination de la densité apparente

Feste Sekundärbrennstoffe - Bestimmung der Schüttdichte

This Technical Specification (CEN/TS) was approved by CEN on 27 March 2010 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

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Contents

Foreword

This document (CEN/TS 15401:2010) has been prepared by Technical Committee CEN/TC 343 “Solid recovered fuels”, the secretariat of which is held by SFS.

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 15401:2006 mainly as follows:

a) results of interlaboratory tests supplemented as an informative Annex A;

b) whole document editorially revised.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this Technical Specification: 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 the United Kingdom.

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Introduction

Bulk density is one of the main quality parameters of solid recovered fuels (SRF). It is needed e.g. in a sampling process (volume of sampling tools, volume primary sample), in assessing transport capacity or storage space required or energy density (MWh/m^3) of SRF. Bulk density is not an absolute value, therefore conditions for its determination should be standardised in order to gain comparative measuring results. This Technical Specification specifies the determination of bulk density of solid recovered fuels which can be conveyed in a continuous material flow.

For practical reasons, two standard measuring containers with a volume of 5 l or 50 l are selectable for the determination.

The method specified in this Technical Specification is based on EN 15103 [1].

1 Scope

This Technical Specification specifies a method for the determination of bulk density of solid recovered fuels using a standard measuring container. This method is applicable to all solid recovered fuels with a nominal top size of maximal 100 mm.

NOTE 1 The reason for the limitation to maximal 100 mm is the practical maximum volume of a measurement container and thus dimensions of the aperture of the container. Particle dimension should not exceed 1/3 of this value.

NOTE 2 Bulk density of solid recovered fuels is subject to variation due to several impacts such as vibration, shock, pressure, biodegradation, drying and wetting. Measured bulk density can therefore deviate from practice conditions during transportation, storage or transhipment.

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.

prEN 15357:2008, *Solid recovered fuels — Terminology, definitions and descriptions*

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

prEN 15443, *Solid recovered fuels — Methods for laboratory sample preparation*

CEN/TS 15414-2, *Solid recovered fuels — Determination of moisture content using the oven dry method — Part 2: Determination of total moisture by a simplified method*

CEN/TS 15415, *Solid recovered fuels — Determination of particle size distribution by screen method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 15357:2008 apply.

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4 Symbols and units

The symbols and units used in this Technical Specification are listed in Table 1.

Table 1 — Symbols and units used in this Technical Specification

Symbol	Designation	Unit
m_1	Mass of the empty container	kg
m_2	Mass of the filled container	kg
M_{ar}	Mass fraction of moisture as received (wet basis)	%
V	Net volume of the measuring cylinder	m^3
ρ_{ar}	Bulk density of the sample as received at M_{ar}	kg/m^3
ρ_{dm}	Bulk density of the dry matter at M_{ar}	kg/m^3

5 Principle

The test portion is filled into a standard container of a given size and shape and weighed afterwards. Bulk density is calculated from the net weight per standard volume and reported for the measured moisture content.

6 Apparatus

6.1 Measuring container

6.1.1 General

The container shall be cylindrically shaped and manufactured of a shock resistant, smooth-surfaced material. It shall be waterproof and resistant to deformation in order to prevent any variation of shape and volume. Grips may externally be fixed for easier handling. The height-diameter-ratio shall be in the range from 1,25 to 1,50.

6.1.2 Large container with a filling volume of (50 ± 1) l, an effective (inner) diameter of 360 mm and an effective (inner) height of 491 mm (see Figure 1) where deviations from these dimensions are acceptable provided that the ratio of height to diameter remains as given in 6.1.1.

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Dimensions in millimetres

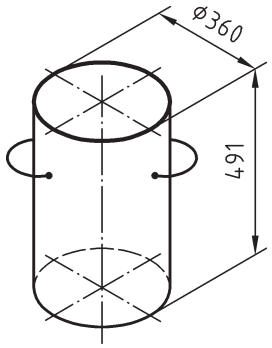

Figure 1 — Measuring container, large

6.1.3 Small container with a filling volume of $(5 \pm 0{,}1)$ l, an effective (inner) diameter of 167 mm and an effective (inner) height of 228 mm (see Figure 2) where deviations from these dimensions are acceptable provided that the ratio of height to diameter remains as given in 6.1.1.

Dimensions in millimetres

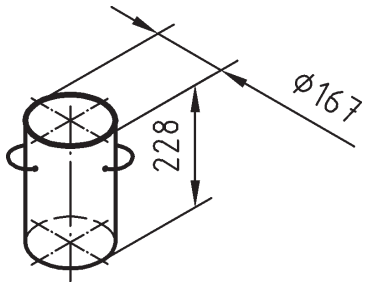

Figure 2 — Measuring container, small

6.2 Balances

6.2.1 Balance 1, capable of weighing the sample and the large container (6.1.2) to the nearest 10 g.

6.2.2 Balance 2, capable of weighing the sample and the small container (6.1.3) to the nearest 1 g.

6.3 Scantling with a length of about 600 mm and a cross section of about 50 mm $\times$ 50 mm, preferably made of hard wood.

NOTE Preferably, the height of the scantling should be 150 mm.

6.4 Wooden board, flat, e.g. an oriented strand board (OSB), with a thickness of about 15 mm and a sufficient size for the container to be dropped onto for shock exposure.

7 Sampling and sample preparation

The sample shall be taken and prepared in accordance with prEN 15442 and prEN 15443. The sample volume should exceed the measuring container volume by 30 %.

NOTE Precautions should be taken to ensure that the moisture is evenly distributed within the sample. Care should be taken that the moisture content remains constant.

8 Procedure

8.1 Determination of the container volume

Before use, determine the mass and filling volume of the measuring container (6.1). Weigh the empty, clean and dry container on the balance. Then fill the container with water and a few drops of wetting agent (e.g. liquid soap) until maximum capacity; then weigh it again. The water temperature shall be in the range from 10 °C to 20 °C. Calculate the volume of the container from the net mass of water and the density of the water (1 000 kg/m^3) and record the result rounded to the nearest 0,000 01 m^3 for the large container (6.1.2) or to the nearest 0,000 001 m^3 for the small container (6.1.3).

NOTE 1 The effect of temperature on the density of water is here neglected.

NOTE 2 The container volume should be checked regularly.

8.2 Container selection

All fuels with a nominal top size less than or equal to 100 mm may be used in the large container (6.1.2). For fuels with a nominal top size less than or equal to 12 mm and for pellets with a diameter less than or equal to 12 mm, the small container (6.1.3) may be used. The determination of the particle size shall be performed in accordance with CEN/TS 15415.

NOTE Larger container gave systematically higher values for bulk density than smaller container in tests [2]. Therefore, larger container (50 l) should be used for SRF bulk density measurements, whenever possible.

8.3 Measurement procedure

The measurement procedure shall be carried out as follows:

a) fill the container by pouring the sample material from a height of 200 mm to 300 mm above the upper rim until a cone of maximum possible height is formed. Make sure that the container is dry and clean before being (re)filled;

b) the filled container is then shock exposed to allow settling. For that purpose drop it freely from 150 mm height onto a wooden board (6.4) which is lying on an even, horizontal and hard floor. Ensure that the board and the floor are in full contact. Before shock exposure, remove particles on the wooden plate within the dropping area. Make sure that the container hits the ground in a vertical position. Repeat the shock exposure at least four times but not more often than five times. Then refill the resulting empty space in the container according to 8.3 a);

NOTE In order to estimate the falling height correctly, it is useful to place the filled container on a strong scantling with a height of 150 mm (see 6.3) before moving it to the side for dropping it freely.

c) remove surplus material by using a small scantling (see 6.3) which is shuffled over the edge of the container in oscillating movements. If the sample contains coarse material, remove by hand all particles preventing the free passage of the scantling. If the removal of larger particles tears bigger holes into the levelled surface, the cavities shall be refilled and the removal procedure repeated;

d) weigh the container;

e) unify the used sample with the unused sample material and repeat the procedure as given in 8.3 a) to 8.3 d) at least once in order to get two replications;

f) determine the moisture content of the sample as received in accordance with CEN/TS 15414-2 immediately after bulk density determination.

NOTE Dust can occur when handling SRF materials during the bulk density determination. Therefore, the use of respiratory protective equipment and protective clothing is recommended.

9 Calculation

9.1 Calculation of bulk density as received

Calculate the bulk density of the sample as received, ρ_{ar}, by Equation (1):

$$\rho_{ar} = \frac{m_2 - m_1}{V} \quad (1)$$

The result for each individual determination shall be calculated to one decimal place, and the mean value of the individual results shall be calculated and rounded to the nearest 10 kg/m^3. The mean value shall be recorded in the test report.

9.2 Calculation of bulk density of dry matter

Calculate the bulk density of the dry matter, ρ_{dm}, by Equation (2):

$$\rho_{dm} = \rho_{ar} \frac{100 - M_{ar}}{100} \quad (2)$$

NOTE Equation (2) disregards shrinkage or expansion which usually cause significant deviations if the sample is measured at different drying stages. A true comparison between fuel samples is therefore only possible if bulk density is measured at similar moisture contents.

The result for each individual determination shall be calculated to one decimal place, and the mean value of the individual results shall be calculated and rounded to the nearest 10 kg/m^3.

10 Precision

10.1 General

For definition of precision terms, see also ISO 5725-1 [3] and for determination of repeatability and reproducibility data, see ISO 5725-5 [4]. Precision data are given in Annex A.

10.2 Repeatability limit

The maximum difference to be expected between two independent single test results of one laboratory at a confidence level of 95 % will not exceed the repeatability limit in more than 5 % of cases when measuring the same measurand in the same medium, using the same facilities and fulfilling all requirements of the test method.

10.3 Reproducibility limit

The maximum difference to be expected between two independent single test results of different laboratories at a confidence level of 95 % will not exceed the reproducibility limit in more than 5 % of cases when measuring the same measurand in the same medium, each laboratory using their own facilities and fulfilling all requirements of the test method (interlaboratory testing).

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11 Test report

The test report shall include at least the following information:

a) name of the testing laboratory;

b) date of the test;

c) identification of the product or sample tested;

d) reference to this Technical Specification, i.e. CEN/TS 15401;

e) container size applied;

f) any deviation from this Technical Specification;

g) mean value of the individual test results at moisture content as received according to 9.1 and, if appropriate, mean value of bulk density of dry matter according to 9.2;

h) any unusual features observed during the test procedure which may have affected the test result.

Annex A
(informative)

Results of interlaboratory test

The interlaboratory test was performed by Quality management, organisation, validation of standards, developments and inquiries for SRF (QUOVADIS) [2] in 2007. The results of interlaboratory test were evaluated in accordance with ISO 5725-5 [4] (see Table A.1).

Table A.1 — Results of interlaboratory test

Designation	Pelletised SRF	Mixed SRF (1)	Wood containing SRF	Plastic containing SRF	Mixed SRF (2)
Number of participating laboratories	5	5	5	5	5
Number of accepted test results	20	20	20	20	20
Mean value of bulk density, in kg/m^3	343	151	170	109	149
Repeatability standard deviation, s_r, in kg/m^3	4	2	6	5	6
Reproducibility standard deviation, s_R, in kg/m^3	5	1	14	13	15

Bibliography

[1] EN 15103, *Solid biofuels — Determination of bulk density*

[2] Quality management, organisation, validation of standards, developments and inquiries for SRF (QUOVADIS): *Publishable results-oriented report*, Deliverable 1.9, December 2007

[3] ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

[4] ISO 5725-5, *Accuracy (trueness and precision) of measurement methods and results — Part 5: Alternative methods for the determination of the precision of a standard measurement method*

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