DRAFT INTERNATIONAL STANDARD
ISO/DIS 17828

ISO/TC **238** Secretariat: **SIS**

Voting begins on: **2013-09-12** Voting terminates on: **2014-02-12**

Solid biofuels — Determination of bulk density

Titre manque

ICS: 75.160.10;27.190

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Reference number
ISO/DIS 17828:2013(E)

Date: 2013-05-22

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 17828 Standard was prepared by Technical Committee ISO/TC 238, *Solid biofuels*, Working Group WG 4, Physical and Mechanical Test Methods

Introduction

Bulk density is an important parameter for fuel deliveries on volume basis and together with the net calorific value it determines the energy density. It also facilitates the estimation of space requirements for transport and storage. This document describes the determination of the bulk density of pourable solid biofuels which can be conveyed in a continuous material flow.

For practical reasons two standard measuring containers with a volume of 5 litres or 50 litres were chosen for the determination. Due to the limited volume of these containers, some fuels are therefore excluded from the scope of this document. This, for example, applies for chunk wood, non-comminuted bark or for baled material and larger briquettes. The bulk density of such fuels can be calculated from their mass and the volume of the container or lorry used to transport them.

To decide on the actual storage volume requirement of a solid biofuel the different storage conditions (e.g. height of heap, moisture content), which usually differ largely from the sample volume of the standard measuring container, also have to be taken into account.

The here described method includes a defined shock exposure to the bulk material. The decision for this procedure was based on several reasons. It leads to a certain volume reduction which accounts for compaction effects occurring during the production chain. These compaction effects are mainly due the fact, that the fuel is usually transported and/or stored in containers or silos that are much larger than the measuring container as chosen for the here described method. Thus, in practice the higher mass load leads to an increased load pressure and to fuel settling, which can also be additionally enhanced by the vibrations during transportation. Furthermore, filling or unloading operations in practise usually apply a higher falling depth than the one chosen for the here performed test. This will also result in a respectively higher compaction due to the increased kinetic energy of the particles falling. A procedure which applies a controlled shock to the sample was thus believed to reflect the practically prevailing bulk density in a better way than a method without shock. This is particularly true when the mass of a delivered fuel has to be estimated from the volume load of a transporting vehicle, which is a common procedure in many countries. For a rough estimation on how susceptible the different solid biofuels are towards the shock exposure some research data are given in Annex A. The data show a compaction effect between 6 and 18% for biomass fuels.

Date: 2013-05-22

Solid biofuels — Determination of bulk density

1 Scope

This document describes a method of determining bulk density of solid biofuels by the use of a standard measuring container. This method is applicable to all solid biofuels with a nominal top size of maximum 100 mm.

Bulk density is not an absolute value, therefore conditions for its determination have to be standardised in order to gain comparative measuring results.

Note 1: The nominal top size is defined as the aperture size of the sieve where at least 95 % by mass of the material passes (ISO DIS 16559 (14588))

Note 2: Bulk density of solid biofuels is subject to variation due to several factors such as vibration, shock, pressure, biodegradation, drying and wetting. Measured bulk density can therefore deviate from actual 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.

ISO DIS 16559 (14588), *Solid biofuels – Terminology, definitions and descriptions*

ISO DIS 18134-1 (14774-1), *Solid biofuels – Methods for the determination of moisture content – Oven dry method, Part 1: Total moisture – Reference method*

ISO DIS 18134-2 (14774-2), *Solid biofuels – Methods for the determination of moisture content – Oven dry method, Part 2: Total moisture – Simplified procedure*

ISO WD XXXXX (14778), *Solid biofuels – Sampling*

ISO WD XXXXX (14780), *Solid biofuels - Methods for sample preparation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO DIS 16559 (14588) shall apply.

The term "*Basic bulk density"* is defined as the ratio of the sample mass on dry basis and the bulk volume on green basis.

4 Symbols and abbreviations

Abbreviations used in this document:

BD_{ar}	bulk density as received in kg/m³
BD_{d}	bulk density of the sample mass on dry basis in kg/m³
M_{ar}	the moisture content, as received, as percentage by mass (wet basis)
m_1	the mass of the empty container in kg

m_2	the mass of the filled container in kg
V	the net volume of the measuring container in m³

5 Principle

A standard container is filled with the test portion of a given size and shape and weighed afterwards. The bulk density is calculated from the net weight per standard volume and reported with the determined moisture content.

6 Apparatus

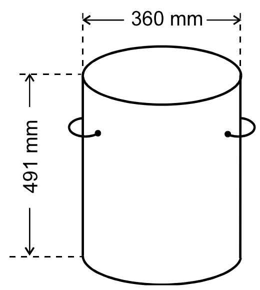
6.1 Measuring containers

6.1.1 General

The container shall be cylindrically shaped and manufactured of a shock resistant, smooth-surfaced material. The container shall be resistant to deformation in order to prevent any variation in shape and volume. The container has to be waterproof. For easier handling grips may be fixed externally. The height-diameter-ratio shall be within 1,25 and 1,50.

6.1.2 Large container

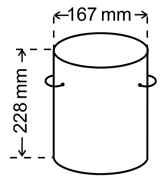
The large measuring container has a filling volume of 50 litres (0,05 m³) volume. The volume may deviate by 1 litre (= 2 percent). It shall have an effective (inner) diameter of 360 mm and an effective (inner) height of 491 mm (see figure on right side). Deviations from these dimensions are tolerable, if the height-diameter-ratio remains as given in 6.1.1



measuring container, large

6.1.3 Small container

The small measuring container has a filling volume of 5 litres (0,005 m³) volume. The volume may deviate by 0,1 litre (= 2 percent). It shall have an effective (inner) diameter of 167 mm and an effective (inner) height of 228 mm (see figure on right side). Deviations from these dimensions are tolerable, if the height-diameter-ratio remains as given in 6.1.1



measuring container, small

6.2 Balances

6.2.1 Balance 1

A balance, having sufficient accuracy to enable the sample and container to be weighed to the nearest 10 g. This balance shall be used for measurements with the large container.

6.2.2 Balance 2

A balance, having sufficient accuracy to enable the sample and container to be weighed to the nearest 1 g. This balance shall be used for measurements with the small container.

6.3 Scantlings

A small scantling, preferably made of hard wood, approximately 600 mm long and having a cross section of about 50 x 50 mm

Advisable: A strong scantling, preferably made of wood, of 150 mm height, to indicate the falling height in the shock exposure

6.4 Wooden board

A flat wooden board (e.g. oriented strand board (OSB)) with a thickness of approximately 15 mm and sufficient in size for the container to be dropped onto for shock exposure.

7 Sample preparation

Sampling shall be carried out in accordance with ISO WD XXXXX (14778). If necessary the sample may be divided in mass in accordance with ISO WD XXXXX (14780). The sample volume should exceed the measuring container volume by minimum of 30%.

Note 3: Precautions should be taken to ensure that the moisture is evenly distributed within the sample.

8 Procedure

8.1 Determination of the container volume

Before use, the mass and filling volume of the container shall be determined. Weigh the empty, clean and dry container on the balance (6.2.1 or 6.2.2). 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 should be at a temperature between 10 and 20 degrees Celsius. Calculate the volume (V) of the container from the net weight of water and the density of the water (1 kg/dm^3) and record the result rounded to the nearest 0.010 litre (0,00001 m^3) for the large container or 0.001 litre (0,000001 m^3) for the small container.

Note 4: The effect of temperature on the density of water is negligible.

Note 5: The container volume should be checked regularly.

8.2 Container selection

All fuels that are within the scope of this document can be used in the large container (6.2.1). For fuels with a nominal top size up to 12 mm and for pellets with a diameter equal or below 12 mm the small container (6.2.2) may be used (optional).

8.3 Measurement procedure

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.

Note 6: Make sure that the container is dry and clean before being (re)filled.

b) The filled container is then shock exposed to allow settling. This is done by dropping it freely from 150 mm height onto a wooden board (6.4). Before shock exposure remove particles from the wooden board