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Solid biofuels — Determination of bulk density

Biocombustibles solides — Détermination de la masse volumique apparente

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 238, *Solid biofuels*.

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 International Standard 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 l or 50 l were chosen for the determination. Due to the limited volume of these containers, some fuels are therefore excluded from the scope of this International Standard. This, for example, applies for chunk wood, non-comminuted bark, 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 for transportation.

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

The described method herein includes a defined shock exposure of the bulk material for several reasons. A shock 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 described method. Thus, in practice, the higher mass load leads to an increased load pressure and to settling of the material, which can also be additionally enhanced by the vibrations during transportation. Furthermore, filling or unloading operations in practice usually apply a higher falling depth than the one chosen for the 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.

Solid biofuels — Determination of bulk density

1 Scope

This International Standard defines a method of determining bulk density of solid biofuels by the use of a standard measuring container. This method is applicable to all pourable 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 standardized in order to gain comparative measuring results.

NOTE 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 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.

ISO 14780, *Solid biofuels — Sample preparation*[1)]

ISO 16559, *Solid biofuels — Terminology, definitions and descriptions*

ISO 18134-1, *Solid biofuels — Determination of moisture content — Oven dry method, Part 1: Total moisture — Reference method*

ISO 18134-2, *Solid biofuels — Determination of moisture content — Oven dry method, Part 2: Total moisture — Simplified procedure*

ISO 18135, *Solid biofuels — Sampling*[1)]

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16559 apply.

4 Principle

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

5 Apparatus

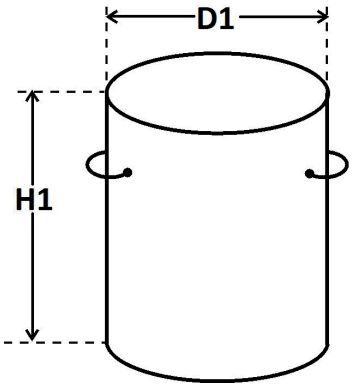
5.1 Measuring containers

5.1.1 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

1) In preparation.

and volume. The container has to be waterproof. For easier handling, grips can be fixed externally. The height-diameter-ratio shall be within 1,25 and 1,50.

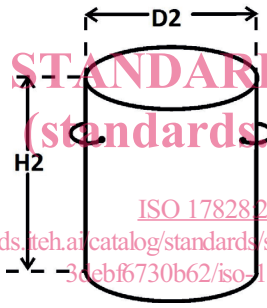


Key

D1 = 360 mm

H1 = 491 mm

Figure 1 — Large measuring container



Key

D2 = 167 mm

H2 = 228 mm

Figure 2 — Small measuring container

5.1.2 Large container

The large measuring container (see Figure 1) has a filling volume of 50 l (0,05 m^3) volume. The volume can deviate by 1 l (= 2 %). It shall have an effective (inner) diameter of 360 mm and an effective (inner) height of 491 mm (see Figure 1). Deviations from these dimensions are tolerable, if the height-diameter-ratio remains as given in 5.1.1.

5.1.3 Small container

The small measuring container (see Figure 2) has a filling volume of 5 l (0,005 m^3) volume. The volume can deviate by 0,1 l (= 2 %). It shall have an effective (inner) diameter of 167 mm and an effective (inner) height of 228 mm (see Figure 2). Deviations from these dimensions are tolerable, if the height-diameter-ratio remains as given in 5.1.1.

5.2 Balances

5.2.1 Balance 1

A balance shall be capable of reading to the nearest 10 g. This balance shall be used for measurements with the large container.

5.2.2 Balance 2

A balance shall be capable of reading to the nearest 1 g. This balance shall be used for measurements with the small container.

5.3 Scantlings

A rigid scantling with a length exceeding the diameter of the container in 5.1.1 shall be used for levelling the material in the measuring container by lateral movements of the scantling across the rim of the measuring container.

NOTE It is advisable to use a second scantling or other device for spacing the dropping height of 150 mm between the measuring container and the wooden board in 5.4.

5.4 Wooden board

A flat wooden board [e.g. oriented strand board (OSB)] with a thickness of approximately 15 mm and sufficient in size for dropping the container during shock exposure.

6 Sample preparation

Sampling shall be carried out in accordance with ISO 18135. If necessary, the sample can be divided in to test portions in accordance with ISO 14780. The test portion volume shall exceed the volume of the container measures by minimum of 30 %.

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

7 Procedure

7.1 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 (5.2.1 or 5.2.2). 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 °C and 20 °C. 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 0,01 l (0,000 01 m^3) for the large container or 0,001 l (0,000 001 m^3) for the small container.

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

NOTE 2 The container should be cleaned regularly and its volume should be checked regularly.

7.2 Container selection

The large container (5.2.1) can be used for larger materials within the scope of this International Standard. For materials with a nominal top size up to 12 mm and for pellets with a diameter equal or below 12 mm the small container (5.2.2) can be used (optional).

7.3 Measurement procedure