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Solid biofuels — Particle size distribution of disintegrated pellets

Biocombustibles solides — Distribution granulométrique des granulés désintégrés

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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 document 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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This document was prepared by Technical Committee *238, Solid biofuels,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 335, *Solid biofuels,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 17830:2016), which has been technically revised.

The main changes are as follows:

— set of suggested sieves has been modified to better reflect industry practice and to be consistent with ISO 17827-2;

— a specific table for the results of size distribution analysis for quality control of pellets for industrial use has been added. The order of sieves was reversed to align with other standards;

— a figure has been added to show the sample division;

— details have been added to clarify the procedure and to improve the accuracy;

— normative references have been updated and amended;

— editorial changes have been made.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In power plants with powder fuel burners for energy production, operators need information about the particle size distribution of the fuel for optimising particle burnout during combustion. Fuel preparation equipment, such as pulverisers, are used for crushing pellets into the original particle sizes before the material is pressed into pellets. The method described in this document is intended to characterize particle size distribution of the material contained within fuel pellets and also allows for a relative comparison of pellets of different manufacturing.

This method is based on experience with pellets made from sawdust, wood shavings and milled wood, as well as straw. The method may also be applicable for pellets produced from other solid biofuel materials provided that they can be disintegrated into its constituents in water.

Pellets that are engineered to resist water, e.g. pellets from materials which have undergone some thermal treatments, cannot be characterised by this method.

Solid biofuels — Particle size distribution of disintegrated pellets

1 Scope

This document specifies the requirements and method used to determine particle size distribution of disintegrated pellets. It is applicable for pellets that fully disintegrate in hot water.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 14780, *Solid biofuels — Sample preparation*

ISO 16559, *Solid biofuels — Vocabulary*

ISO 17827-2, *Solid biofuels — Determination of particle size distribution for uncompressed fuels — Part 2: Vibrating screen using sieves for classification of samples with apertures of 3,15 mm and below*

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

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

ISO 18135, *Solid Biofuels — Sampling*

ISO 21945, *Solid biofuels — Simplified sampling method for small scale applications*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
sieve fraction
mass fraction of test portion or sub-portion collected on a sieve after particle separation through the sieving process.

4 Principle

The particle size distribution is determined after the sample pellets have been disintegrated in hot deionised water and dried in a drying cabinet or oven. The determination is performed by sieving the dried material in accordance with ISO 17827-2.

5 Reagents

5.1 Deionised water.

6 Apparatus

6.1 Disintegration container, shall be a waterproof container made of material such as stainless steel capable of withstanding a temperature of 100 °C. The container shall have a minimum volume of 5 l in order that 2 l of deionised water and the entire test portion can be accommodated without spilling over during stirring.

A rigid lid should be used to cover the container to minimize evaporation, contamination and cooling during the disintegration of the pellets in water.

6.2 Electric kettle, or other suitable equipment for water heating shall be capable of heating at least 2 l of water.

6.3 Ventilated drying cabinet or ovens, shall be capable of maintaining a temperature of (60 ± 5) °C with fresh air ventilation which allows moderate air exchange. The air velocity shall be such that the test sample particles are not dislodged from the drying container(s).

6.4 Drying containers, shall consist of non-corrodible heat-resistant material such as metal, glass or porcelain and be able to hold sufficient volume to accommodate the slurry from the disintegration container.

6.5 Balance, shall be capable of reading to the nearest 0,01 g.

6.6 Sieves, set of sieves as described in ISO 17827-2 and as listed in Table 2 shall be considered the default sieve set. However, other sieve sets can be used based on the specific requirements as agreed upon by the interested parties.

6.7 Weighing containers, an adequate number of weighing containers is required.

The weighing of the sieved particle fractions can be performed either by weighing the remaining material directly on the tared weighed sieves or by collecting and weighing the material in weighing containers.

6.8 Spoon, which shall be made of non-corrodible material is used for stirring the disintegration slurry.

6.9 Mechanical sieving equipment, in accordance with ISO 17827-2 shall be used for determination of the particle size distribution of the disintegrated pellets and to break down agglomerates of particles formed during the drying of the slurry.

Some sieving machines have adjustable parameters. The results of the sieving might differ depending on how adjustable parameters are controlled. It is therefore important, for comparative purposes, to report how the adjustable parameters are set in terms of frequency, amplitude, duration, etc. For machines with adjustable dimensionless settings, an estimate of the degree of adjustment shall be recorded to the best of the ability of the operator.

6.10 Flat surfaced tool or a flat brush, shall be used for stirring the dried material and for separating agglomerated particles after drying and sieving.

7 Sample preparation

The laboratory sample used for the determination of particle size distribution of disintegrated pellets shall be obtained in accordance with ISO 18135 or ISO 21945 and a test portion shall be extracted using volume reduction methods in accordance with ISO 14780. The recommended size of the test portion is (300 ± 10) g.

If a larger test portion is used, the amount of water, container sizes, etc. needs to be adjusted accordingly.

8 Procedure

8.1 Flowchart of the test procedure

Figure 1 gives an overview of the process steps for determination of particle size distribution of disintegrated pellets. The procedure includes the subdivision of the test portion after its disintegration and drying to get sub-portion A for control of the moisture content and sub-portion B for the sieving procedure. In a second step, sub-portion B is divided into sub-portion B1 and B2 to perform the sieving with them.

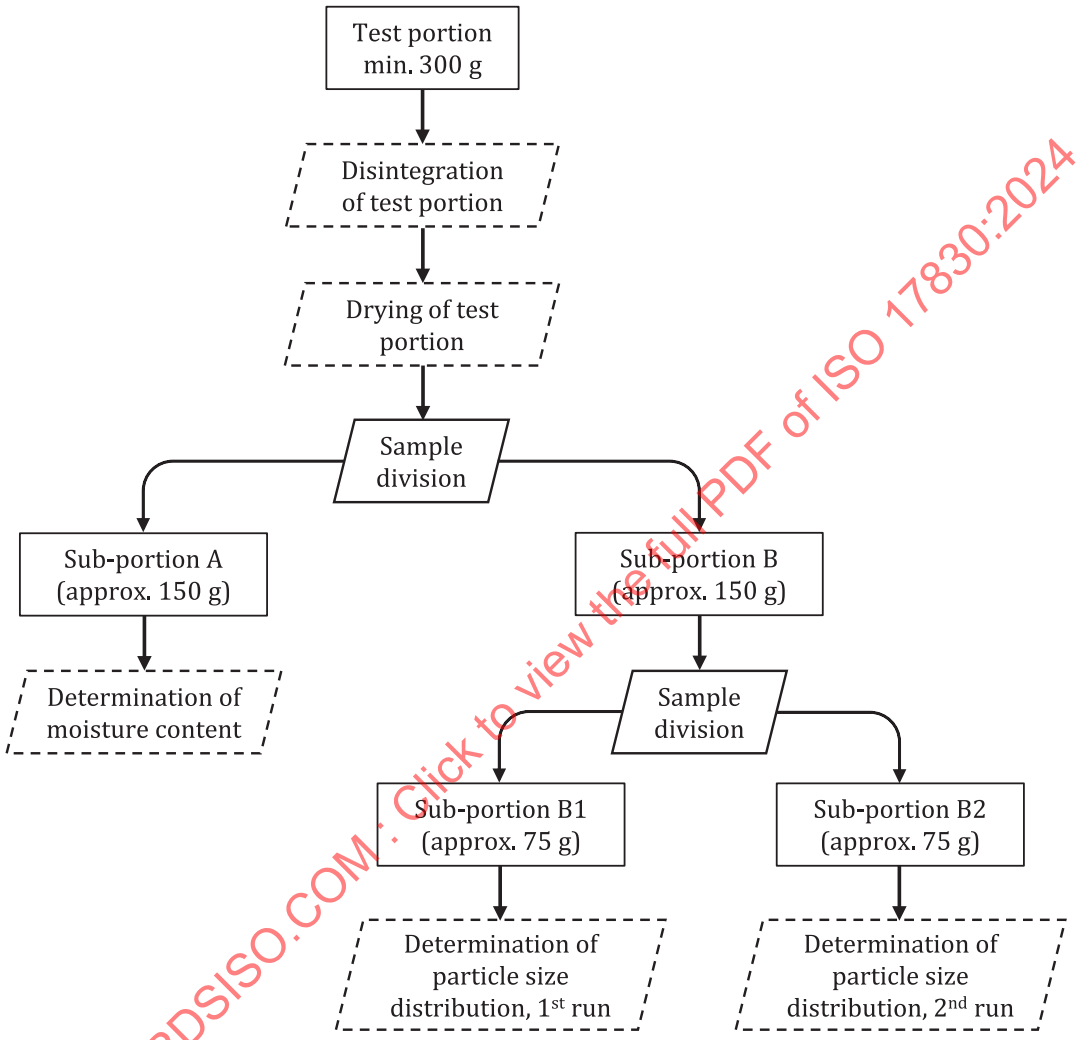

Figure 1 — Process steps of determination of particle size distribution of disintegrated pellets including the subdividing of the test portion

8.2 Disintegration

The test portion of pellets shall be transferred into the disintegration container.

Approximately 2 l of deionised water at the temperature just below the boiling point shall be poured over the pellets. To avoid chemical dissolving components of the material, the water temperature shall not be maintained when the pellets are disintegrating. The amount of water to be used shall be at least sufficient to provide the maximum amount of water that can be absorbed by the pellets. This is indicated by the presence of free water in the disintegration container after about 30 min.

For pellets with high swelling ratio, such as straw pellets, the test portion can be reduced and/or the water volume be increased.

Using a spoon, the slurry shall be carefully stirred from the bottom and up until particles are segregated from each other.

The spoon shall be rinsed with deionised water in the container ensuring that all particles remain in the slurry.

The container should be covered with a rigid lid to protect the slurry from contamination and prevent evaporation of water and is left for at least 30 min or as long as required to disintegrate the pellets. Some pellets can require a longer soak time for full disintegration.

NOTE Some pellets can take 16 h to 24 h or more to disintegrate.

8.3 Drying

The slurry is produced in a container with sufficient volume according to 6.1 and the slurry may remain in the same container throughout the drying process. This will prevent the potential of any loss of sample through transferring the slurry between containers. If it is not possible to dry the sample in the same container, the disintegrated slurry is transferred to an adequate number of drying containers according to 6.4. The disintegration container shall be rinsed carefully with deionised water and emptied into the drying containers.

Dry at a temperature not exceeding 60 °C in a drying cabinet or oven to reach a moisture content of between 5 % in mass and 15 % in mass.

NOTE The moisture content can be checked by periodic weighing provided that the exact weight of the empty drying container(s) and the exact weight and moisture content of the test sample are known.

8.4 Moisture conditioning

After drying is completed, stir the dried test portion with a flat surfaced tool to break up any agglomerates of particles or crust. The drying container(s) with the dried test portion are then placed in room atmosphere for at least 2 h in order that the material reaches moisture equilibrium with the room atmosphere.

The equilibrated test portion of the disintegrated pellets shall be thoroughly mixed and divided into two sub-portions of approximately 150 g each in accordance with ISO 14780 and marked with sub-portions “A” and “B”.

Use sub-portion “A” to verify that the moisture content of the equilibrated test portion is between 5 % in mass and 15 % in mass by conducting a moisture test in accordance with ISO 18134-1 or ISO 18134-2.

A single determination is sufficient.

8.5 Sieving

Weigh the sub-portion B to the nearest 0,01 g.

Mix sub-portion B and divide it into two sub-portions identified as “B1” and “B2”, each weighing approximately 75 g.

Regarding straw and other materials with low density, the sub- portions B1 and B2 shall be mixed and further divided into two equally sized sub-portions each (B1-1, B1-2 and B2-1, B2-2) before sieving to assure that none of the sieves becomes overloaded due to the size of the sub-portions.

Each sub-portion shall be sieved separately in accordance with ISO 17827-2. As described in 6.9, some sieving machines have adjustable parameters, and it is important to report how the adjustable parameters have been set during sieving.

If agglomerated particles are observed on a sieve, separate the agglomerated particles by gently using the flat surfaced tool or fingers. Continue the sieving if agglomerates are still found on the sieves.

If separation of all particles is not possible, the minimum requirement of this method has not been achieved and the test report shall state that the pellets could not be fully disintegrated.

NOTE It can be possible to break up agglomerated particles by controlling the frequency, amplitude, and duration functions of the sieving equipment (see ISO 17827-2).

9 Calculation

The following tables provide examples of recording the particle size distribution obtained from the method assuming that the sub-portions B1 and B2 are not further divided. Table 1 and Table 2 illustrate sieve set configurations used by industry for determination of particle size distribution. Table 1 illustrates the specific sieve set configuration used for quality control of particle size distribution in industrial pellets, e.g. as delivered under ISO 17225-2[1] (see also ISO 17827-2).

NOTE 1 Other sieve sizes can be selected as required and the reporting table can be adjusted accordingly.

NOTE 2 Alternative recording and automated calculation can be used as long as all relevant details are recorded.

The obtained mass for each sub-portion, B1 and B2, is summed up vertically in column A1 and A2, respectively.

The total mass of each sieve fraction is summed up horizontally in column B and recorded in g to the nearest 0,01 g and expressed in column C as percent of the sum of all mass fractions. The cumulative % in mass passing through is summed up in column D.

The moisture content of test portion A is recorded in the upper section of Table 1 or Table 2 and expressed as % in mass.

The difference between the mass of test portion B and the total mass of all the fractions in column B is recorded in the lower section of Table 1 or 2 and expressed in percent of the mass of test portion B and shall be smaller than 2 % in mass. Larger differences can occur due to lost or retained particles or due to changes in moisture content. In these cases, the causes for the deviation should be investigated and the measurement repeated. If this is not practical or the result still deviates by more than 2 % in mass, then it shall be noted in the test report.

If the test sample is divided into additional sub-portions, the tables can be expanded with additional columns.

Table 1 — Example of reporting results of a particle size distribution analysis using a sieve set configuration specifically used for quality control of pellets for industrial use delivered under ISO 17225-2[1]

Date of test:							
Analyst:							
Sample ID:							
Mass of sub-portion B (g):							
Moisture content of sub-portion A (% in mass):							
		A0	A1	A2	B	C	D
Sieve aperture size (mm)	Particle size fraction (mm)	Mass of empty sieves and collecting pan (g)	Mass of fraction in		Total mass fraction, (columns A1+A2)	Percentage of mass fraction, (based on the total mass of all fractions in column B)	Cumulative percent in mass of fractions passing through (summing up the mass fraction percentages in column C)
			Sub-portion B1 (g)	Sub-portion B2 (g)			
Collecting pan	< 1,0						
1,0	≥ 1,0 to < 2,0						
2,0	≥ 2,0 to < 3,15						
3,15	≥ 3,15						
Total mass of all fractions	All						
Difference between mass of test portion B and total mass of all sieve fractions					(g) (%)		