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BSI Standards Publication

Solid biofuels — Determination of particle size distribution of disintegrated pellets

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National foreword

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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.

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Solid biofuels - Determination of particle size distribution of disintegrated pellets

Biocombustibles solides - Détermination de la distribution granulométrique des granulés désintégrés

Feste Biobrennstoffe - Bestimmung der Partikelgrößenverteilung von Pellet-Ausgangsmaterial

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Foreword

This document (EN 16126:2012) 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of an identical text or by endorsement, at the latest by August 2012, and conflicting national standards shall be withdrawn at the latest by August 2012.

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Introduction

In coal power plants with powder fuel burners for energy production, rebuilt to use biomass powder from biofuel pellets, the operators need information on the particle size distribution in the fuel for optimising of e.g. efficiency and emission levels. The grinders used for producing fuel powder within these plants grinds the biomass pellets into the individual internal particles in the pellets. The method described in this document aims to estimate the internal particle size distribution of the material comprised in fuel pellets.

For the time being, this method is based on experience of pellets made from sawdust, wood shavings and milled wood or straw as raw material. The method may also be applicable for pellets produced from other biofuel materials.

1 Scope

This European Standard aims at defining the requirements and method used to determine the particle size distribution of disintegrated pellets. It is applicable for pellets, which disintegrate in hot water at a temperature below 100 °C. It is intended for persons and organisations that manufacture, plan, sell, erect or use machinery, equipment, tools and entire plants related to fuel pellets, and to all persons and organisations involved in producing, purchasing, selling and utilising fuel pellets.

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.

EN 14588, *Solid biofuels — Terminology, definitions and descriptions*

EN 14774-1, *Solid biofuels — Determination of moisture content — Oven dry method — Part 1: Total moisture — Reference procedure*

EN 14774-2, *Solid biofuels — Determination of moisture content — Oven dry method — Part 2: Total moisture — Simplified procedure*

EN 14778, *Solid biofuels — Sampling*

EN 14780, *Solid biofuels — Sample preparation*

EN 15149-2, *Solid biofuels — Determination of particle size distribution. — Part 2: Vibrating screen method using sieve apertures of 3,15 mm and below*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in EN 14588 apply.

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. The determination is performed by sieving according to EN 15149-2.

5 Reagents

Deionised water shall be used.

6 Apparatus

6.1 Disintegration container

Water-proof container made of a material capable of withstanding a temperature of 100 °C, e.g. stainless steel, with a capacity of at least 3 000 ml.

When filled with the water and the test portion, sufficient space for thorough stirring without loosing any sample material shall be available.

A lid or a cover, e.g. aluminium folia shall be provided for the container.

6.2 Electric kettle or other suitable equipment for water heating

The electric kettle shall have a capacity of heating at least 2 000 ml of water.

6.3 Water measuring glass/glasses

The measuring capacity shall be at least 2 000 ml altogether (for example, 1 000 ml + 1 000 ml).

6.4 Drying cabinet/cabinets

The drying cabinets shall be capable of being controlled at a temperature within the range of 35 °C to 60 °C (± 5 °C) and at 105 °C (± 2 °C) for moisture determination purpose. Alternatively, two cabinets, one for each temperature, can be used. The air atmosphere change shall be between 3 times and 5 times per hour. The air velocity shall be such that the sample particles are not dislodged from the drying container.

6.5 Drying containers

The drying containers shall consist of non-corrodible and heat-resistant material e.g. metal trays or glass- or porcelain dishes.

6.6 Sample reduction equipment

The sample reduction equipment as specified in EN 14780, e.g. a riffle divider shall be used.

6.7 Balance

The balance shall be capable of reading to the nearest 0,01 g.

6.8 Sieves

The set of sieves described in EN 15149-2 shall be used.

6.9 Weighing containers

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. For this purpose an adequate number of weighing containers are required.

6.10 Spoon

The spoon shall be made of non-corrodible material, for stirring the disintegration slurry.

6.11 Mechanical sieving equipment

The mechanical sieving equipment shall be made as defined by EN 15149-2.

6.12 Flat brush

The flat brush is used for separating agglomerated particles after sieving.

7 Sample preparation

The sample used for the determination of particle size of disintegrated pellets shall be taken according to EN 14778. From this sample, extract a test portion of (300 ± 25) g by division according to EN 14780.

8 Procedure

8.1 Disintegration

The (300 ± 25) g test portion of pellets is transferred into the disintegration container.

Approximately 2 000 ml of deionised water is heated to boiling point and poured over the pellets.

For highly swelling pellets (e.g. straw pellets) the sample weight can be reduced and/or the water volume can be increased.

Using a spoon, the slurry is carefully stirred from the bottom to the top until a smooth mush is obtained.

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

The lid is placed on the container and it is left for 24 hours.

8.2 Drying

The disintegrated slurry is mixed well and transferred to an adequate number of drying containers.

The disintegration container shall be rinsed carefully with deionised water into the last drying container. As an alternative, the disintegration container can be dried at 35 °C to 60 °C, where the remaining material is then transferred to the drying container with the help of a flat brush.

Dry at 35 °C to 60 °C depending on the raw material and the laboratory conditions in a drying cabinet until a moisture content between 5 % to 15 % is reached.

Woody material shall preferably be dried at the lower temperature. For material with high absorption of water e.g. straw pellets, it is recommended to dry at the higher temperature.

NOTE 1 The moisture content can be checked by periodic weighing.

After drying, the drying container is placed in room atmosphere in order to get equilibrium with the room atmosphere for at least 24 hours.

NOTE 2 If the pellets agglutinates during drying, then gently disintegrate the crust before division.

The equilibrated test portion is divided into two sub portions according to EN 14780 of approximately 150 g each and marked with sub portion “A” and “B”.

8.3 Control of the moisture content

Ensure that the moisture content of the equilibrated test portion prepared for determination of the particle size distribution is within the interval of 5 % to 15 %.

Determine the moisture content in sub portion “A” at 105 °C (± 2 °C) according to EN 14774-1 or EN 14774-2 with an exception for the prescribed minimum sample size.

NOTE If the moisture content is below 5 %, absorption of air moisture might occur and above 15 %, the risk of particle agglomeration increases which will influence the test result.

8.4 Sieving

Divide sub portion “B” into two sieve portions of approximately 75 g each.

NOTE 1 To avoid overloading of the sieves further dividing of the test portions may be necessary before sieving.

Each portion or sub portion is sieved separately in accordance with EN 15149-2.

NOTE 2 If agglomerated particles are observed on a sieve, separate these gently using e.g. a flat brush. Continue the sieving for 15 min for this sieve and the sieves below in the stack. If separation of all particles is not possible, a complete disintegration of the tested pellet sample has not been achieved and the internal particle size distribution cannot be determined according to Clause 1.

9 Calculation

For all of the sieved sub portions the obtained mass of each sieving fraction are summed up. Calculate the mass of each sieving fraction as a percentage of the total mass of all the sieved sub samples. Record the percentages to the nearest 0,1 w-% both fractionally and cumulatively. The procedure is demonstrated in Table 1.

The cumulative weight percentages is calculated by recording the percentage result from the collecting pan into the line for the 7^{th} sieve in the cumulative w-% column. This result is added to the result for the 7^{th} sieve where after the sum is recorded on the line for the 6^{th} sieve etc.

Table 1 — Results of the size distribution analysis.

Sieve size	**Fraction,**	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Mass fraction for each of the sieved sub portions cf. clause 8.4 (two or more sub portions depending on the loading of the material on the first sieve. In this example is used four sub portions)				**Total mass of the fraction** (sum of the masses in column 1 – 4)	**Percentage mass fraction** (based on the total mass in column (5))	**Cumulative oversize** (summing up of mass fractions in column (6))
	in mm	**in g**				**in g**	**in w-%**	**w-% >**
1. sieve (3,15 mm)	above 3,15							
2. sieve (2,8 mm)	2,8 - 3,15							
3. sieve (2,0mm)	2,0 - 2,8							
4. sieve (1,4 mm)	1,4 - 2,0							
5. sieve (1,0 mm)	1,0 - 1,4							
6. sieve (0,5 mm)	0,5 - 1,0							
7. sieve (0,25 mm)	0,25 - 0,5							
Collecting pan	below 0,25							
Total mass of all fractions	All						100 %	

Other recordings:

Difference between the total mass of test portion and the total mass of all fractions (column 5) as a percentage of the total test portion	
Moisture content of the sieved sample	

Report the result as the mean of the results from the two determinations. The percentage of each fraction shall be rounded to the nearest 0,1 %.

Report the cumulative results rounded to the nearest 0,1 %.

The difference between the total mass of the test portion and the total mass of all fractions as indicated in Table 1 shall be less than 2 %. Larger differences may 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 impossible or the result still deviates more than accepted, it shall be reported.

10 Precision and bias

It is currently impossible to give a complete precision statement (repeatability or reproducibility) for this test method.

For typical results of the method used, see informative Annex A.

11 Test report

The test report shall include at least the following information:

— identification of the laboratory and the testing date;

— identification of the product or sample tested (see normative reference EN 14778);

— a reference to this document;

— any deviation from this document;

— conditions and observations, e.g. unusual occurrences during the test procedure, which may affect the result;

— the test results as specified in Clause 9;

— if the 2 percent difference between the total mass of the test portion and the total mass of all fractions in percent of the total test portion as given in table 1, column 5, has been exceeded, it shall be clearly stated.

Annex A
(informative)

Characteristics of the determination of particle size distribution of disintegrated pellets

A.1 General

Two different Round Robin tests were carried out, each one with five European laboratories. The purpose of the examination was to test the method described in the present standard for wet disintegration of fuel pellets and to assess the quality of the method. The method was elaborated on the basis of the experiences obtained from PSO 5297 Round Robin, (Characterisation of Solid Biofuels 2004 – Development of Methods. PSO project no. 5297).

For the results obtained in the studies, the cumulative percentages of the material retained on each sieve were calculated for each set of results. For the cumulative distributions obtained, the 25 %, 50 % and the 75 % quantiles were used for a statistical evaluation of the performance of the method. The results of this evaluation appear in Table A.1 and Table A.2.

Table A.1 — Performance characteristics for the method calculated as repeatability and reproducibility, based on results from Round Robin test no. 1

Sample	Quantiles	*N*	*X* mm	s_r mm	s_R mm	S_r %	S_R %
Wood pellets, coniferous	25 %	5	0,46	0,018	0,039	3,94	8,53
	50 %	5	0,83	0,016	0,049	1,94	5,93
	75 %	5	1,28	0,018	0,063	1,40	4,92
Wood pellets, broad-leaf trees	25 %	5	0,33	0,0082	0,055	2,51	16,80
	50 %	5	0,72	0,016	0,089	2,22	12,36
	75 %	5	1,33	0,028	0,087	2,11	6,54
Straw pellets	25 %	3	0,46	0,025	0,056	5,46	12,23
	50 %	3	0,91	0,039	0,067	4,30	7,37
	75 %	3	1,44	0,057	0,092	3,96	6,31

A.2 Performance characteristics on disintegration of wood pellets

Table A.2 — Performance characteristics for the method calculated as repeatability and reproducibility of wood pellets, based on results from Round Robin test no. 2

Sample	Quantiles	*N*	*X mm*	s_r mm	s_R mm	S_r %	S_R %
Wood pellets	25 %	5	0,25	0,010	0,031	4,21	12,70
	50 %	5	0,42	0,007	0,020	1,57	4,77
	75 %	5	0,79	0,014	0,064	1,81	8,14

N *Number of values*

X *Mean value*

s_r *repeatability standard deviation*

S_r *relative repeatability standard deviation*

s_R *reproducibility standard deviation*

S_R *relative reproducibility standard deviation*

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