INTERNATIONAL STANDARD

ISO 17827-2

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Solid biofuels — Determination of particle size distribution for uncompressed fuels —

Part 2: Vibrating screen method using sieves with aperture of 3,15 mm and below

Biocombustibles solides — Détermination de la distribution granulométrique des combustibles non comprimés —

Partie 2: Méthode au tamis vibrant d'ouverture de maille inférieure ou égale à 3,15 mm

Reference number
ISO 17827-2:2016(E)

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Foreword

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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*.

ISO 17827 consists of the following parts, under the general title *Solid biofuels — Determination of particle size distribution for uncompressed fuels*:

— *Part 1: Oscillating screen method using sieves with apertures of 3,15 mm and above*

— *Part 2: Vibrating screen method using sieves with apertures of 3,15 mm and below*

Part 2 can also be used for round hole sieves with apertures of 4,0 and 5,6 mm.

Solid biofuels — Determination of particle size distribution for uncompressed fuels —

Part 2:
Vibrating screen method using sieves with aperture of 3,15 mm and below

1 Scope

This part of ISO 17827 specifies a method for the determination of the size distribution of particulate biofuels by the vibrating screen method. The method described is meant for particulate biofuels only, namely, materials that either have been reduced in size, such as most wood fuels, or are physically in a particulate form. This part of ISO 17827 applies to particulate uncompressed fuels with a nominal top size of 3,15 mm and below (e.g. sawdust).

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 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

ISO 3310-2, *Test sieves — Technical requirements and testing — Part 2: Test sieves of perforated metal plate*

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

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

ISO 17225-1, *Solid biofuels — Fuel specifications and classes — Part 1: General requirements*

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 method*

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

3 Terms and definitions

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

4 Principle

A laboratory sample is subjected to sieving through vibrating sieves, sorting the particles in decreasing size classes by mechanical means.

NOTE Manual sieving is excluded due to the fact that small sieve holes could easily be clogged by particles.

1) To be published.

5 Apparatus

5.1 Sieves

For the test, an appropriate number of either circular or rectangular sieves with a minimum effective sieve area of 250 cm^2 is required. For laboratory samples with a top size below 3,15 mm, the sieves shall have an aperture geometry in accordance with ISO 3310-1 (metal wire cloth) and for test materials with a top size 3,15 mm or above, the sieves shall have round perforated holes in metal plate in accordance with ISO 3310-2 (perforated metal plate). The frame of the sieves shall have a height that enables the sieves to contain the samples and allows a free movement of the sample during the sieving process.

The number of sieves and the aperture sizes of the sieves shall be chosen with the size specification for the actual laboratory sample material in accordance with ISO 17225-1. For sawdust and similar fine grade materials, the following set of sieves is recommended:

— 3,15 mm round holes;

— 2,8 mm metal wire cloth;

— 2,0 mm metal wire cloth;

— 1,4 mm metal wire cloth;

— 1,0 mm metal wire cloth;

— 0,5 mm metal wire cloth;

— 0,25 mm metal wire cloth.

NOTE If further classification of larger particles is required, sieves with round holes with an aperture of 4,0 mm and 5,6 mm can be applied.

5.2 Collecting pan

For collection of material passing through the sieves, a collecting pan of adequate size is required.

5.3 Weighing containers

The weighing of the sieved particle fractions can be performed either by weighing the remaining material directly on the tarred weighed sieves or by collecting and weighing the material in weighing containers. For this purpose, an adequate number of weighing containers are required.

5.4 Brush

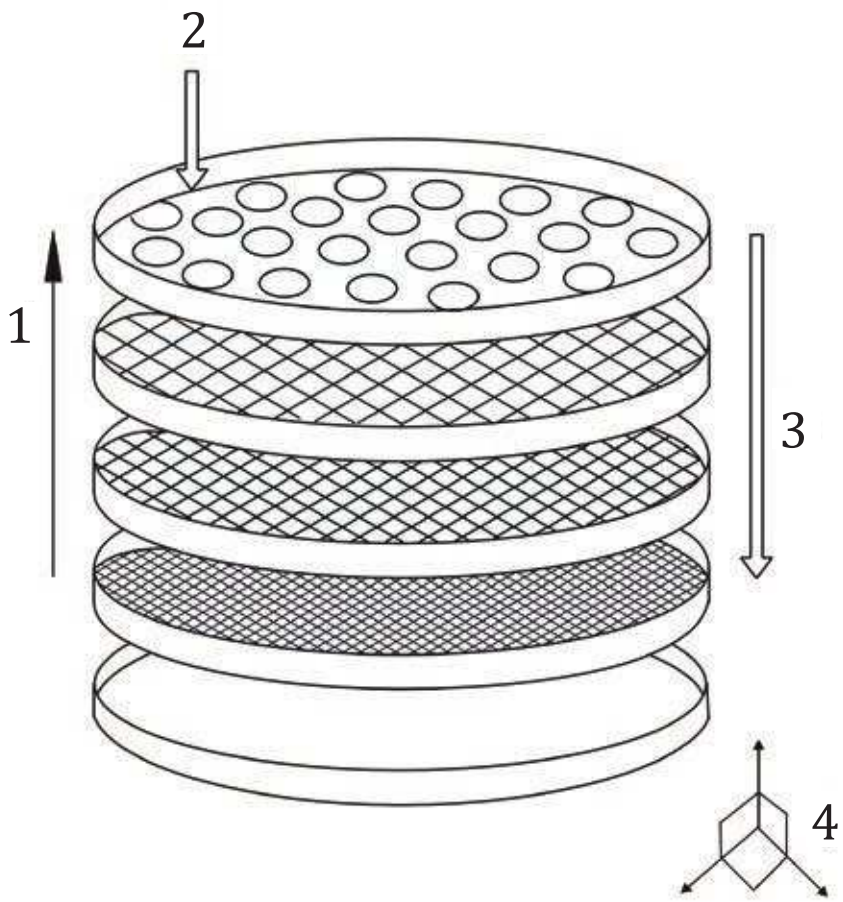
For cleaning the sieves, a brush is required.

5.5 Mechanical sieving equipment

The mechanical device (sieving machine) shall apply a vibration on the sieves. Some sieving machines have adjustable parameters. The results of the sieving may differ depending on how adjustable parameters are controlled. It is therefore important for comparative purposes to report how adjustable parameters have been used in terms of frequency, amplitude, duration, etc. If machines have adjustable, dimensionless settings, an estimate of the adjustable degree shall be recorded to the best of the ability of the operator.

For a principle drawing of the sieving operation, see Figure 1.

NOTE Be aware that vibrating at an amplitude that is too low might lead to incomplete particle segregation. The minimum amplitude can be determined by pre-tests.



Key

1 increasing hole diameter
2 material addition
3 material flow direction
4 vibration direction

Figure 1 — Principle of the sieving operation

5.6 Balance

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

6 Sample preparation

6.1 Sample size

The laboratory sample shall be obtained in accordance with ISO 18135 and a test sample of minimum 50 g shall be extracted using volume reduction methods in accordance with ISO 14780. To prevent overloading of the sieves, the height of the layer of material on the upper sieve shall never exceed 2 cm. If the material height does exceed 2 cm, then the test sample shall be divided into test portions, which

are processed in sequential sieving operations. The results of the separate determinations of the test portions shall be combined in accordance with Clause 8.

The laboratory sample shall include sufficient material for determination of size distribution and moisture content.

6.2 Moisture conditioning

The test sample shall be sieved at a moisture content below 20 w-% wet basis, thus preventing the particles from sticking together or losing significant amount of moisture during the sieving process. If necessary, the test sample shall be pre-dried. Drying is done in accordance with ISO 14780.

NOTE By pre-drying, as described in ISO 14780, the laboratory sample is brought into equilibrium with the humidity of the surrounding atmosphere.

Determine the moisture content of the material to be sieved on a separate test portion by following the procedure given in ISO 18134-1 or ISO 18134-2. The moisture content shall be determined and reported concurrently with the particle size distribution determination.

7 Procedure

The test sample to be used for sieving shall be weighed to the nearest 0,01 g.

Assemble and operate the mechanical shaking device with the appropriate sieves with decreasing aperture, ending with the collecting pan at the bottom. If the size of the test sample is significantly larger than the minimum 50 g proposed in 6.1, the test sample shall be divided into two or more test portions, which are to be processed subsequently.

Spread the material in an even layer on the top sieve and start the sieving operation. As a pre-test, a sieving operation shall be continued until the mass changes between two sequential sieves do not exceed a maximum of 0,3 % of the sample mass under test per 1 min time of sieving operation. As an alternative to the pre-test, a 30 min duration of the sieving operation is recommended.

The required minimum sieving time shall be determined for each equipment and type of fuel in separate pre-tests. Avoid losing any particles when determining individual weight differences during such pre-tests.

NOTE 1 If shorter sieving time is applied for the purpose of decreasing the abrasion, the results could be affected by machine characteristics.

During the sieving operation, particles may stick on the edge of the sieves due to static electricity generated during the shaking of the material. Any tendency of such problem should be observed during pre-testing and remediated by means of earthing the sieves using copper wires or braids.

NOTE 2 Be aware that an excessive sieving time might cause abrasion and a higher portion of fine fraction.

NOTE 3 If it is observed that the sample under test is not evenly distributed on each of the sieves, turn each of the sieves approximately 180° after approximately half of the sieve time has elapsed and complete the sieving operation.

In size classification by sieving, thin particles, which are longer than the diameter of a hole in the sieve, may pass through the sieve and mix with the particles in the smaller size fractions. In such case, these particles shall remain part of the fraction where they are retained.

Weigh the material in each sieve and in the collecting pan to an accuracy of 0,01 g and record each mass in a scheme equal to Table 1. If a particle gets stuck in a hole of a sieve, it shall be removed and added to the mass of the fraction retained on that sieve (as if it did not pass the hole).

8 Calculation

The results of the particle size determination shall be expressed as percentages of the total mass of all fractions. If the test sample has been divided into two or more test portions, the mass of the respective fractions shall be added up before calculating the overall percentage of each size class. This procedure is illustrated in Table 1, assuming the test sample is divided in two test portions. The table provides guidance for how a table can be structured but has to be adjusted for the number of test portions to be analysed.

The obtained mass for each test portion shall be summed up vertically in columns 1 and 2, respectively (or additional columns as applicable) and recorded in grams.

The total mass of each sieve fraction shall be summed up horizontally in column 3 and recorded to the nearest 0,01 g and expressed in column 4 as percent of the sum of all mass fractions. The cumulative w-% passing through is summed up in column 5. Annexes A and B provide research data for comparison.

The moisture content of the test sample shall be recorded in the lower section of Table 1 and expressed as w-%.

The difference between the mass of the test sample and the sum of the mass of all sieve fractions in column 3 of 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 not practical or the result still deviates by more than 2 %, then it shall be noted in the Test Report.

If an assessment of the performance characteristics is required (see Clause 9), the sieving operation shall be repeated using another test sample of the laboratory sample material. If sufficient sample material is not available, the fractions from the first determination may be re-mixed and used for the second determination.

Table 1 — Results of the particle size distribution analysis

Sieve name	**Fraction** mm	(1) **Mass of fraction in test portion 1** g	(2) **Mass of fraction in test portion 2** g (add more columns if necessary)	(3) **Total mass of fractions in columns 1 + 2 or more** g	(4) **Percentage mass fraction, based on the total mass of all fractions in column 3**	(5) **Cumulative w-% passing through (summing up the mass fraction percentages in column 4)**
First sieve (3,15 mm)	above 3,15					
Second sieve (2,8 mm)	2,8 to 3,15					
Third sieve (2,0mm)	2,0 to 2,8					
Fourth sieve (1,4 mm)	1,4 to 2,0					
Fifth sieve (1,0 mm)	1,0 to 1,4					
Sixth sieve (0,5 mm)	0,5 to 1,0					
Seventh sieve (0,25 mm)	0,25 to 0,5					
Collecting pan	below 0,25					
Total mass of all fractions	all				100 %	

Other recordings:	
Mass of the test sample in g	
Difference between the mass of the test sample and the total mass of all sieve fractions (column 3) expressed in percent of the mass of the test sample	
Moisture content of the sieved sample, in w-%	

9 Performance characteristics

No general precision data can be given for the method. For guidance, some relevant research data is presented in Annex B.

10 Test report

The Test Report shall include at least the following information:

a) an identification of the laboratory performing the test and the date of the test;

b) an identification of product (or sample) tested;

c) a reference to this part of ISO 17827, i.e. ISO 17827-2:2016;

d) a recording of all adjustable machine settings

e) the results of the test as illustrated in Table 1 and the moisture content at which the sample was sieved at;

f) if the 2 w-% difference between the mass of the test portion and the total mass of all fractions in percent of the mass of the test portion has been exceeded, it shall be clearly stated;

g) any unusual features noted during the determination, which may affect the result;

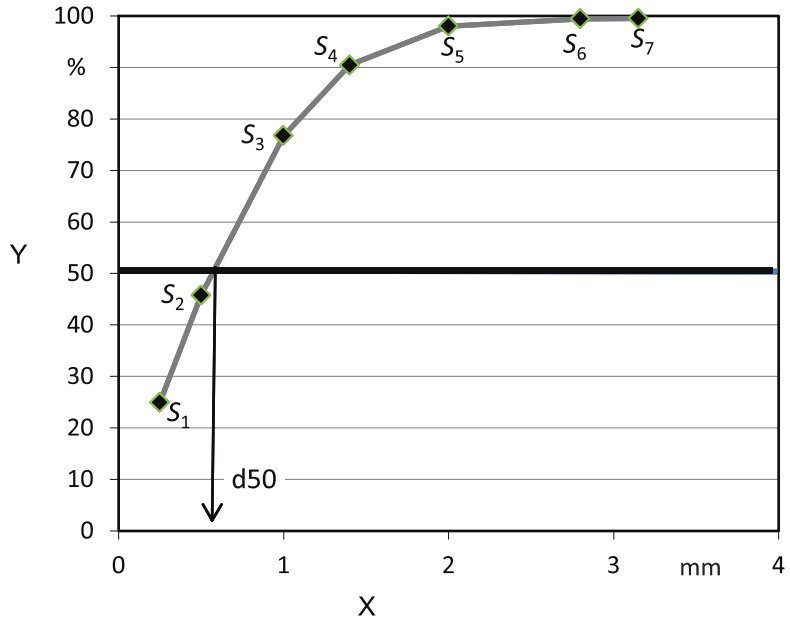
h) any deviation from this part of ISO 17827, or operations regarded as optional.

Annex A
(normative)

Determination of the median value of a particle size distribution

A.1 Definition

The median value of a particle size distribution (d50) as determined by screening operation is defined as the calculated particle size of a sample where 50 % of the particle mass is below and 50 % is above. Therefore, the cumulative size distribution is separated into two halves. Graphically, the median value is established by the intersection of the cumulative distribution curve with the 50-%-line (see example in Figure A.1).



Key:

X particle/hole size

Y accumulated percent of weight

NOTE See sample data from example in Table A.1.

Figure A.1 — Median value of the size distribution of a saw dust sample

A.2 Procedure (example)

Record the determined mass shares from each screen as shown in Table A.1. Calculate the cumulated particle share as shown in Table A.1, column 5. Identify the screen sizes which are below and above the 50 % cumulative share. In the example below, the median value will be found between S_2 and S_3, as shown in column 5 (see also Figure A.1). These are the size boundaries from which the median value can be calculated by linear interpolation.

Table A.1 — Example of a saw dust sample after size classification

(1)	(2)	(3)	(4)	(5)
Sieve class	**Sieve/Class size** C mm	**Sample mass** g	**Fraction** %	**Cumulated share** S %
0 to 0,25	C_1: 0,25	12,44	24,9	S_1: 24,9
>0,25 to 0,5	C_2: 0,50	10,39	20,8	S_2: 45,8
>0,5 to 1,0	C_3: 1,00	15,45	31,0	S_3: 76,8
>1,0 to 1,4	C_4: 1,40	6,84	13,7	S_4: 90,5
>1,4 to 2,0	C_5: 2,00	3,77	7,6	S_5: 98,0
>2,0 to 2,8	C_6: 2,80	0,70	1,4	S_6: 99,4
>2,8 to 3,15	C_7: 3,15	0,04	0,1	S_7: 99,5
>3,15		0,24	0,5	100,0
Total		49,87	100	

A.3 Calculation

For the given example in Table A.1, the linear interpolation can be made according to Formula (A.1):

$$d_{50} = C_2 + (50 - S_2) \cdot \frac{C_3 - C_2}{S_3 - S_2} = 0,5 + (50 - 45,8) \cdot \frac{1,0 - 0,5}{76,8 - 45,8} = 0,568 \text{ mm} \quad \text{(A.1)}$$

where

d_{50} is the median value of the size distribution (in mm);

C_2 is the hole diameter of sieve C_2 (in mm);

C_3 is the hole diameter of sieve C_3 (in mm);

S_2 is the cumulative particle share at size class C_2 (in mass %);

S_3 is the cumulative particle share at size class C_3 (in mass %).

Annex B
(informative)

Guidance data on performance characteristics

The performance data of the method stated in Table B.1 have been established in a Danish comparative study in 2007 (see Reference [2]) on two different samples of solid biofuels. For the obtained results in the study, the cumulative percentage of the material retained on each sieve was calculated for each set of results. For these obtained cumulative distributions, the 25 %, 50 % and the 75 % quartiles were used for a statistical evaluation of the performance of the method. The results of this evaluation appear in Table B.1.

Table B.1 — Performance characteristics of the method

Sample	Quantile	N	X mm	s_r mm	s_R mm	S_r %	S_R %
Saw dust	25 %	72	0,24	0,019	0,12	7,9	50
	50 %	72	0,51	0,029	0,16	5,7	31
	75 %	72	0,83	0,032	0,091	3,9	11
Straw dust	25 %	40	0,50	0,020	0,032	4,0	6,4
	50 %	40	0,91	0,046	0,021	5,1	2,3
	75 %	40	1,35	0,051	0,042	3,8	3,1

N is the number of values.

X is the mean value.

s_r is the estimate of the repeatability standard deviation.

S_r is the estimate of the relative repeatability standard deviation.

s_R is the estimate of the reproducibility standard deviation.

S_R is the estimate of the relative reproducibility standard deviation.

Bibliography

[1] ISO 17827-1, *Solid biofuels — Determination of particle size distribution for uncompressed fuels — Part 1: Oscillating screen using sieves with apertures of 3,15 mm and above*

[2] *Characterization of Solid Biofuels 2004 — Development of Methods. PSO project no. 5297. October 2008*

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