INTERNATIONAL STANDARD

ISO 8486-2

First edition
1996-08-15

Bonded abrasives — Determination and designation of grain size distribution —

Part 2:
Microgrits F230 to F1200

Abrasifs agglomérés — Détermination et désignation de la distribution granulométrique —

Partie 2: Micrograins F230 à F1200

Reference number
ISO 8486-2:1996(E)

Contents

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Annexes

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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.

International Standard ISO 8486-2 was prepared by Technical Committee ISO/TC 29, *Small tools*, Subcommittee SC 5, *Grinding wheels and abrasives*.

ISO 8486 consists of the following parts, under the general title *Bonded abrasives — Determination and designation of grain size distribution*:

— *Part 1: Macrogrits F4 to F220*

— *Part 2: Microgrits F230 to F1200*

Annexes A, B and C of this part of ISO 8486 are for information only.

Bonded abrasives — Determination and designation of grain size distribution —

Part 2:
Microgrits F230 to F1200

1 Scope

This part of ISO 8486 sets forth a method for determining or checking the size distribution of microgrits from F230 to F1200 in fused aluminium oxide and silicon carbide.

It specifies the grit designation for the testing of those grits used in the manufacture of bonded abrasive products and general industrial applications and those removed from bonded products as well as loose grits used in polishing.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 8486. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8486 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8486-1:1996, *Bonded abrasives — Determination and designation of grain size distribution — Part 1: Macrogrits F4 to F220.*

3 Definitions

For the purposes of this part of ISO 8486 the definitions given in ISO 8486-1 as well as the following apply.

3.1 microgrits: Grits with grain size distributions which are determined by sedimentation.

4 Method of checking grain size distribution

4.1 Grain size distribution

The grain size distribution of microgrits F230 to F1200 is determined according to the following criteria:

a) the grain size (theoretical grain diameter) must not exceed the maximum permissible d_{s3} value at the 3 % point of the grain size distribution curve;

b) the median grain size (theoretical grain diameter) must be within the specified tolerances of the d_{s50} value at the 50 % point of the grain size distribution curve;

c) the grain size (theoretical grain diameter) must attain at least the $d_{s94/95}$ value at the 94/95 % point of the grain size distribution curve.

These three criteria must be met. The values are specified in table 1 for the photosedimentometer (94 %) and in table 2 for the US sedimentometer (95 %).

Testing of microgrits F230 to F1200 is carried out by sedimentation according to clause 5 of this standard.

4.2 Grading

The "F" microgrit-series is a graduated series of eleven microgrits starting at a median particle size of 53 µm and ending at 3 µm determined by photosedimentometer. This series follows on from the finest grain in the "F" series macrogrits F220 (63 µm) and uses the same ratio as that series, i.e. $\sqrt[4]{2}$.

The calculation of the individual grain size values (see table 3) has been made as follows:

a) the ratio of the median grain sizes F230 and F240 is $\sqrt[4]{2} \cdot f^0$ i.e. it corresponds approximately to the progressive ratio of the test sieves for macrogrits;

b) the ratio of the median grain sizes of the following grits F240 and F280 is $\sqrt[4]{2} \cdot f^1$;

c) the ratio of the succeeding grain sizes is $\sqrt[4]{2} \cdot f^n$

where n = 1, 2, 3, 4, 5, 6, 7, 8, 9 and where the following equation applies to the factor "f"

$$53 = 3\left(\sqrt[4]{2}\right)^{10} \cdot f^{(0+1+2+3+\ldots\ldots+9)}$$

$$f = \sqrt[45]{\frac{53}{3\left(\sqrt[4]{2}\right)^{10}}} = 1{,}025\,7$$

This produces a series of ratios starting at 1,189 and ending at 1,495.

Table 1 — Grain size distribution of microgrits F230 to F1200 (photosedimentometer)

Grit designation	d_{s3} value max. µm	Median grain size d_{s50} value µm	d_{s94} value min. µm
F230	82	53 ± 3	34
F240	70	44,5 ± 2	28
F280	59	36,5 ± 1,5	22
F320	49	29,2 ± 1,5	16,5
F360	40	22,8 ± 1,5	12
F400	32	17,3 ± 1	8
F500	25	12,8 ± 1	5
F600	19	9,3 ± 1	3
F800	14	6,5 ± 1	2
F1000	10	4,5 ± 0,8	1
F1200	7	3 ± 0,5	1 (at 80 %)

Table 2 — Grain size distribution of microgrits F230 to F1200 (US sedimentometer)

Grit designation	d_{s3} value max. µm	Median grain size d_{s50} value µm	d_{s95} value min. µm
F230	77	55,7 ± 3	38
F240	68	47,5 ± 2	32
F280	60	39,9 ± 1,5	25
F320	52	32,8 ± 1,5	19
F360	46	26,7 ± 1,5	14
F400	39	21,4 ± 1	10
F500	34	17,1 ± 1	7
F600	30	13,7 ± 1	4,6
F800	26	11 ± 1	3,5
F1000	23	9,1 ± 0,8	2,4
F1200	20	7,6 ± 0,5	2,4 (at 80 %)

NOTE — These values were calculated by the following algorithms, based on ISO round-robin tests. Factors for conversion from Eppendorf photosedimentometer (x) to US sedimentometer (y) are:

d_{s3} value	$y = 0{,}760x + 15{,}1$	k[1] = 0,999 7
d_{s50} value	$y = 0{,}961x + 4{,}8$	k = 0,999 2
$d_{s94/95}$ value	$y = 1{,}090x + 1{,}3$	k = 0,999 7

1) k is the correlation factor via which the confidence interval limits for linear relationships were verified.

Table 3 — Calculation of the f^n factors (photosedimentation)

Grit designation	Median grain size µm	Formula
F230	53	Starting point
F240	45	$f^0 = 1 = \frac{53}{44,5} \cdot \frac{1}{\sqrt[4]{2}}$
F280	37	$f^1 = \frac{44,5}{36,5} \cdot \frac{1}{\sqrt[4]{2}}$
F320	29	$f^2 = \frac{36,5}{29,2} \cdot \frac{1}{\sqrt[4]{2}}$
F360	23	$f^3 = \frac{29,2}{22,8} \cdot \frac{1}{\sqrt[4]{2}}$
F400	17	$f^4 = \frac{22,8}{17,3} \cdot \frac{1}{\sqrt[4]{2}}$
F500	13	$f^5 = \frac{17,3}{12,8} \cdot \frac{1}{\sqrt[4]{2}}$
F600	9	$f^6 = \frac{12,8}{9,3} \cdot \frac{1}{\sqrt[4]{2}}$
F800	7	$f^7 = \frac{9,3}{6,5} \cdot \frac{1}{\sqrt[4]{2}}$
F1000	5	$f^8 = \frac{6,5}{4,5} \cdot \frac{1}{\sqrt[4]{2}}$
F1200	3	$f^9 = \frac{4,5}{3} \cdot \frac{1}{\sqrt[4]{2}}$

5 Testing of microgrits F230 to F1200

5.1 General

The testing of microgrits F230 to F1200 is carried out by sedimentation.

Criteria for the determination of the grain size distribution are

a) the theoretical grain size at the 3 % point of the grain size distribution curve (d_{s3} value),

b) the theoretical grain size at the 50 % point of the grain size distribution curve (d_{s50} value) and

c) the theoretical grain size at the 94/95 % point of the grain size distribution curve ($d_{s94/95}$ value).

The permissible values are given in tables 4 and 5.

Table 4 — Permissible deviations resulting from the variations due to the measuring technique (photosedimentometer)

Grit designation	Permissible deviations for the values d_{s3} µm	d_{s50} µm	d_{s94} µm
F230	+ 3,5	± 2,5	– 1,5
F240			
F280	+ 2,5	± 1,5	– 0,8
F320			
F360			
F400			
F500	+ 2	± 1	– 0,5
F600			
F800			
F1000	+ 1,5	± 0,5	– 0,4
F1200			

Table 5 — Permissible deviations resulting from the variations due to the measuring technique (US sedimentometer)

Grit designation	Permissible deviations for the values d_{s3} µm	d_{s50} µm	d_{s95} µm
F230	+ 1,5	± 1,5	– 1,5
F240			
F280	+ 1,5	± 1	– 1,5
F320			
F360			
F400			
F500	+ 1,5	± 0,8	– 1,5
F600			
F800			
F1000	+ 1,5	± 0,5	– 1,5
F1200			

5.2 Designation of the test method

The designation of the test method for microgrits F230 to F1200 shall include an indication of the measuring instrument used thus:

— test-MICRO F – Eppendorf photosedimentometer;
— test-MICRO F – Sedigraph series;
— test-MICRO F – US sedimentometer;
— test-MICRO F – "Others".

5.3 Test method

The test method is based on Micro-F-mastergrits[2].

2) Micro-F-mastergrits of fused aluminium oxide and silicon carbide can be obtained from Staatliche Materialprüfungsanstalt Darmstadt, Grafenstraße 2, D-64283 Darmstadt.
This information is given for the convenience of users of this part of ISO 8486 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Each Micro-F-mastergrit is accompanied by a certificate of the Staatliche Materialprüfungsanstalt Darmstadt (MPA) stating the value at the 50 % point determined by means of their Eppendorf photosedimentometer. The values measured shall be corrected on the basis of the mastergrit values.

The determination of grain sizes by use of different measuring instruments, e.g. with the Eppendorf photosedimentometer, with the different types of sedigraphs or with instruments using other principles of measurement may give deviating results.

5.4 Preparation of the sample

Prior to the test the sample shall be heated at a temperature of 600 °C ± 20 °C for at least 10 min. It is recommended that the sample be dispersed by means of ultrasonics for example.

5.5 Test procedure

The test shall be carried out in accordance with the instructions for the measuring instrument used.

5.6 Evaluation

5.6.1 Determination of grain size distribution

The principle upon which this method is based is the comparison of the median (50 %) size determined in a cooperative test on the Micro-F-mastergrits of MPA Darmstadt with that determined by the testing laboratory on its own instruments.

The difference between these two values will also be added algebraically to the 3 %, 50 % and 94/95 % values of the sample.

The following method applies:

a) determine the d_{s50} value of the Micro-F-mastergrit and calculate the difference between this value and the corresponding value shown on the MPA Darmstadt certificate;

b) measure the d_{s3}, d_{s50} and $d_{s94/95}$ values of the sample and add, algebraically, the mastergrit difference as determined above;

c) compare the corrected measured results with the values in table 1.

EXAMPLE

SiC F240, for the d_{s50} value:

— Mastergrit (MG):

MG- d_{s50} value according to MPA certificate	44,9 µm
MG- d_{s50} value measured	42,3 µm
Difference	+ 2,6 µm

— Sample:

Value measured	42,8 µm
To be added	+ 2,6 µm
Corrected value of the sample	45,4 µm

From table 1 this value is within the tolerances of the d_{s50} value for grit F240.

5.6.2 Evaluation of the corrected test results

A sample complies with this part of ISO 8486 if the corrected values for d_{s3}, d_{s50} and $d_{s94/95}$ are within the permissible limits given in tables 1 or 2.

When checking the measured results allowance must be made for the variations due to the measuring technique. These permissible deviations, given in tables 4 or 5, have been determined on the basis of the standard deviations resulting from an ISO round-robin test.

The tolerances for production microgrits, given in tables 1 and 2, are to be increased by these values.

6 Measuring instruments: Technical description and measuring methods

6.1 General

This clause describes the application of the Eppendorf photosedimentometer and the US sedimentometer for testing microgrits F230 to F1200 of fused aluminium oxide and silicon carbide to be used for bonded abrasive products and for polishing in the form of loose abrasive grains.

6.2 Eppendorf photosedimentometer

The Eppendorf photometer 1101 M is used, in combination with the sedimentation accessory equipment 1551, for testing microgrits[3)].

3) Obtainable from Eppendorf Gerätebau Netheler & Hinz GmbH, Barkhausenweg 1, D-22339 Hamburg 63.

This information is given for the convenience of users of this part of ISO 8486 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

The Eppendorf photosedimentometer consists mainly of:

a) a sedimentation tube of high light-transmitting capacity (cylindrical measuring cell) with a water jacket, the temperature of which is maintained constant at 20 °C ± 0,5 °C by means of a thermostat;

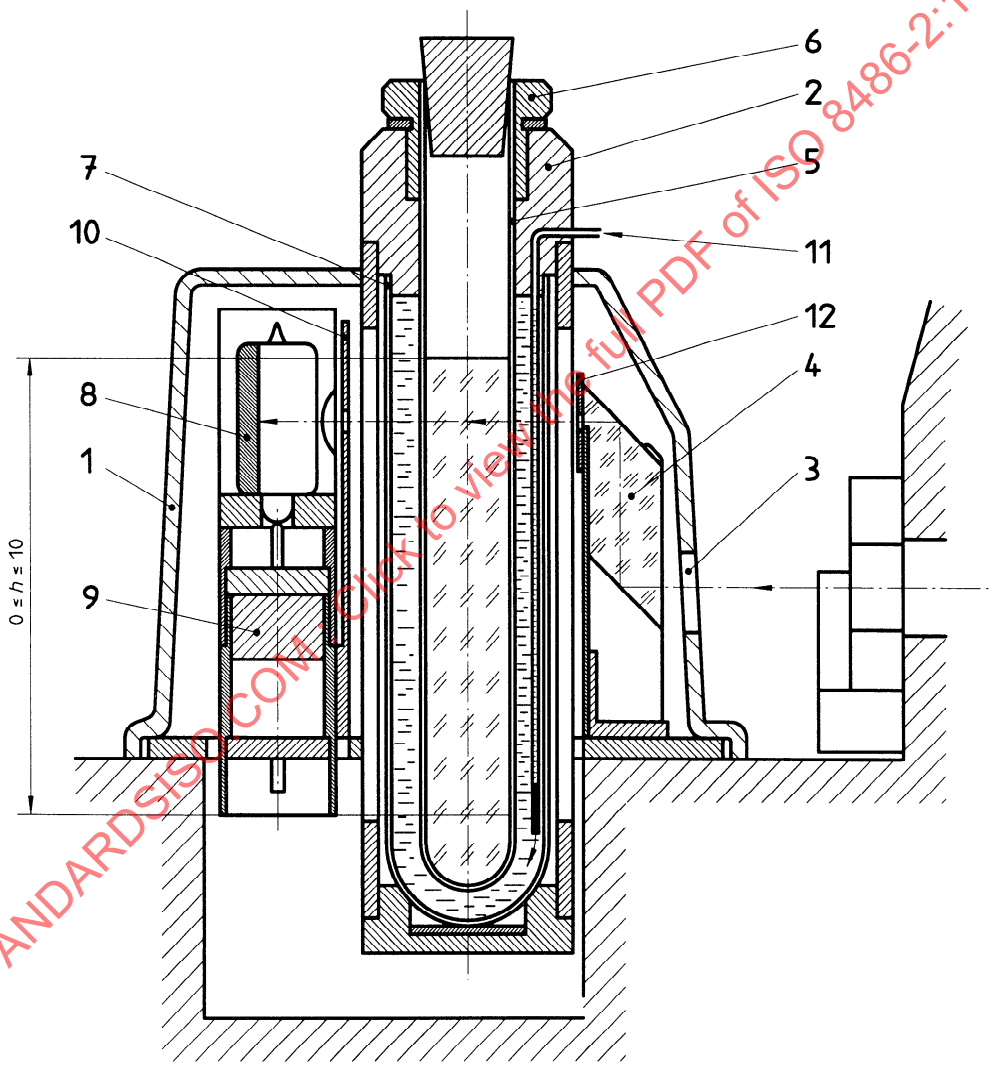
b) a light source from which a light beam falls onto a photoelectric cell passing through the sedimentation tube;

c) a galvanometer recording, at any given moment of the measurement procedure, the intensity of the light falling onto the photocell and consequently the light absorption in the sedimentation tube;

d) a device for the height adjustment of the sedimentation tube as against the light beam providing a maximum height of sedimentation, h, of 10 cm.

The fundamental assembly of the sedimentation equipment 1551 to be used in combination with the Eppendorf photometer is shown in figure 1.

Dimensions in centimetres



Key

1 Case (light-proof)
2 Heating jacket
3 Opening for light beam
4 Deviating prism
5 Sedimentation tube (cylindrical measuring cell)
6 Cell adjusting screw
7 Glass inset for heating jacket
8 Photoelectric cell
9 Photocell adapter
10 Screen
11 Inlet for heating jacket
12 Screen with slit

Figure 1 — Sedimentometer accessory equipment 1551 to be used in combination with the Eppendorf photometer

6.2.1 Test equipment

6.2.1.1 Sedimentation medium

Distilled water with a conductivity ≤ 5 µS or mixtures of distilled water and 1,2-ethandiol (ethylene glycol) shall be used as sedimentation media. These liquids may contain in some cases, an addition of tetra sodium diphosphate ($Na_4P_2O_7$) as dispersing agent.

The sedimentation medium and the concentration of the dispersing agent to be used for the different grain sizes of fused aluminium oxide and silicon carbide are given in table 6.

It is essential that the mixtures have the viscosities specified in table 6, in order to achieve required standards of measurement.

6.2.1.2 Adjustment of the sedimentation medium

The viscosity of the water-1,2-ethandiol sedimentation medium must be exactly adjusted by means of a viscosimeter. It is recommended to use the Ubbelohde viscosimeter (KPG design with suspended level, capillary No. 1, constant $k = 0{,}01$)[4].

The permissible deviation of the viscosity values according to table 6 shall not exceed ± 0,1 mPa·s.

6.2.2 Preparation of the sample

Prior to the test the sample shall be heated at a temperature of 600 °C ± 20 °C for at least 10 min. To remove agglomerates it is recommended that the dispersed sample be treated by means of ultrasonics for example.

6.2.3 Test procedure

6.2.3.1 Adjustment of the zero point

First, the light beam switch is set to the locked position. Then the light spot shall undergo fine adjustment by means of the knurled screw "light value correction" so that it is exactly on the zero point at the left end of the scale.

6.2.3.2 Adjustment and correction of the blank value

The measuring bulb shall be filled to at least half way with the pure sedimentation liquid and placed in the holding device in such a way that the upper metal edge is at 10 cm of the height scale on the bulb side. After this, the lever designated as "light beam switch" shall be set to open.

The light beam must now pass through the clear sedimentation medium and not be impeded by the surface of the liquid.

Table 6 — Sedimentation media and dispersing agent for the testing of grains of fused aluminium oxide and silicon carbide

Grit designation	Sedimentation medium at 20 °C	Dispersing agent tetrasodium diphosphate g/l	
		fused aluminium oxide	silicon carbide
F230	1,2-ethandiol 95 % Viscosity 15,2 mPa·s Density 1,107 g/cm³	0,2	0,2
F240			
F280	1,2-ethandiol 74 % Viscosity 7,7 mPa·s Density 1,091 g/cm³	0,2	0,2
F320			
F360			
F400			
F500	Distilled water Conductivity ≤ 5 µS	0,45	0,2
F600			0,1
F800			
F1000	Distilled water Conductivity ≤ 5 µS	0,45	no additive
F1200			

4) Manufacturer: Schott-Geräte GmbH, Im Langgewann 5, D-65719 Hofheim am Taunus.

This information is given for the convenience of users of this part of ISO 8486 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

With the optical light path in the open position, the median line of the light spot indicator shall be set to 0 (top) or 100 (bottom) by means of the knob "alignment right scale end".

On the left scale end the adjustment is made analogously. Here the adjustment to ∞ (top) or 0 (bottom) is made by means of the knob "alignment left scale end", with the optical light path being closed. It is necessary to re-adjust the values on the right and left scale ends. The position of the step switch of the light spot correction shall be recorded as the "clear value".

The measuring bulb shall be filled up to the top mark with the sedimentation liquid. The clear value shall be checked.

6.2.3.3 Measurement

The amount of grit to be tested (dispersed sample) which is loaded into the measuring bulb shall be such that, after it has been carefully shaken, there shall be an initial extinction of 1,3 to 1,7. Bubbles should be avoided.

The measuring bulb is closed with a rubber stopper and then heated to 20 °C ± 0,5 °C for a period of at least 10 min in a water circuit controlled by a thermostat.

Before starting the measurement, the contents of the measuring bulb shall be homogenized by turning the bulb through 180° to the left and to the right for a period of 2 min (10 times per minute – do not shake). Bubbles should be avoided in this case also.

After this, the measuring bulb shall be placed in the test apparatus. Measuring can be started.

The extinction values shall be read and recorded at the intervals given in the first column of table 7.

Table 7 — Grain sizes as a function of the sedimentation time and height

1		2	3	4	5	6	7	8
Time of sedimentation		Height of sedimentation	Grain size (theoretical grain diameter d)					
			Fused aluminium oxide			Silicon carbide		
			Water[1]	1,2-ethandiol at 74 %[1]	1,2-ethandiol at 95 %[1]	Water[1]	1,2-ethandiol at 74 %[1]	1,2-ethandiol at 95 %[1]
min	s	cm	µm	µm	µm	µm	µm	µm
0	21	10	54,5			63,2		
0	30	10	45,6	128,6		52,8		
0	42	10	38,5	108,7		44,7	126,8	
1	00	10	32,2	90,9	127,5	37,4	106,1	
1	25	10	27,1	76,4	107,5	31,4	89,1	125
2	00	10	22,8	64,3	90,1	26,4	75	105,3
2	50	10	19,1	54	75,7	22,2	63	88,4
4	00	10	16,1	45,5	63,7	18,7	53	74,4
5	40	10	13,5	38,2	53,6	15,7	44,6	62,5
8	00	10	11,4	32,1	45,1	13,2	37,5	52,6
11	20	10	9,6	27	37,9	11,1	31,5	44,2
16	00	10	8,1	22,7	31,9	9,3	26,5	37,2
18	00	7,95	6,8	19,1	26,8	7,9	22,3	31,3
20	00	6,25	5,7	16,1	22,5	6,6	18,8	26,3
22	00	4,85	4,8	13,5	18,9	5,6	15,8	22,1
24	00	3,75	4	11,4	15,9	4,7	13,3	18,6
26	00	2,9	3,4	9,6	13,5	4	11,2	15,7
28	00	2,2	2,9	8,1	11,3	3,3	9,4	13,2
30	00	1,65	2,4	6,7	9,5	2,8	7,9	11
38	20	1,5	2	5,7	8	2,3	6,6	9,3
54	20	1,5		4,8	6,7	2	5,6	7,8

1) See table 6.

Depending on the grain size distribution of the sample, extinction will remain nearly constant for a certain period of time. Negligible variations in the order of 0,01 extinction units from measuring point to measuring point may be ignored. The actual commencement of sedimentation of abrasive grits is indicated by increasing light intensity.

6.2.4 Evaluation

The following method of calculation, derived from Stokes' Law and Lambert-Beer's Law gives satisfactory results in the case of well-graded grain sizes.

It follows that the mass of a grain fraction is proportional to the product of the extinction difference between two successive measurements and the diameter of the grains.

Table 7 gives, in column 1, the reading times and in column 2 the appropriate heights of sedimentation.

Columns 3 to 8 contain the grain sizes calculated according to Stokes' Law which correspond to those times and sedimentation heights in grains of fused aluminium oxide and silicon carbide for each of the three sedimentation media.

6.2.4.1 Determination of the grain size distribution

The following factors shall be listed for the evaluation in a model form corresponding to annex A:

a) time of reading;

b) height of sedimentation;

c) position of the step switch of the light spot correction;

d) extinction as read;

e) grain size.

An example for the evaluation of grain size testing on silicon carbide having approximately 13 µm is shown in table 8. In this example distilled water with a conductivity ≤ 5 µS mixed with 0,2 g tetra sodium diphosphate per litre of water is used as sedimentation medium (see table 6, silicon carbide grain size F500).

The values for the grain size in table 8, column 7, have therefore been deduced from table 7, column 6. Thereafter

— the values read off shall be entered in columns 3 and 4 of table 8; column 5 shall contain the figures giving the extinction value with allowance being made for the clear value;

— column 6 shall contain the difference between two successive figures of column 5;

— the product of the values from columns 6 and 7 shall be calculated and shown in column 8; the results shall be added together;

— column 9 shall contain the figures of column 8 as mass percentages of their sum;

— column 10 shall contain the cumulative sums of the figures of column 9.

The grain size distribution follows from table 8, columns 7 and 10. The measuring values can be plotted on a graph.

If, on measuring microgrit fines using the Eppendorf photosedimentometer (in which the sedimentation time is that corresponding to a theoretical grain size of 2 µm), a residual extinction is found, due to the fact that certain mass percentages have not completely deposited, the evaluation must be carried out as follows:

The rectified residual extinction present (column 5) is carried over to the following line of column 6 and multiplied by half the theoretical grain size (2 µm) belonging to the residual extinction from the last lines of table 7 (38 min 20 s or 54 min 20 s).

The values in columns 9 and 10 are calculated as described before.

In the graph the cumulating sum is limited to 2 µm. If the 94 % value of a grit is less than 2 µm, the % value corresponding to a grain size of 2 µm is indicated, rather than the 94 % value.

Hence, in the present example the silicon carbide microgrit contains

a) 10,2 % mass percentage exceeding 18,7 µm,

b) 29,9 % mass percentage exceeding 15,7 µm and so on up to

c) 100 % mass percentages exceeding 4 µm.

The grain size distribution curve can be plotted with the values of columns 7 and 10 of table 8.

To determine the d_{s3} value the first measured value (in the example 10,2 % mass with 18,7 µm) shall be connected by a straight line to the next higher value of the grain diameter given in table 8, column 7. The point of intersection with the 3 % line is the required d_{s3} value.

NOTE 1 The step switch of the light spot correction makes it possible to read high extinction values off the lower and more precise part of the scale.

Each step corresponds to an extinction value of 0,25. An extinction of, for example, 1,37 can be read with a higher degree of accuracy than 0,12 by turning the switch for 5 steps ($5 \times 0,25 = 1,25$ and $1,37 - 1,25 = 0,12$).

Position 3 of the step switch (table 8, column 3, last line) indicates the clear value of the measuring cell

plus sedimentation medium. It is therefore necessary to add 0,25 to the 4th step, 0,5 to the 5th step, 0,75 to the 6th step and 1 to the 7th step to obtain the extinction according to column 5.

6.2.4.2 Plotting the grain size distribution curve

The mass percentages of the sample (ordinate) shall be plotted against the grain size (abscissa) in a grain size distribution curve.

A coordinate frame with logarithmic division can be used for plotting the grain size distribution curve (see example in figure 2) [5].

6.2.4.3 Evaluation of the grain size distribution curve

The d_s values at 3 %, 50 % and 94 % of the sample shall be read off the grain size distribution curve. In the present example the respective values read as follows:

d_{s3} value: 21,3 µm

d_{s50} value: 13,6 µm

d_{s94} value: 7,6 µm

The values obtained and those established by means of respective mastergrits of the microgrits F series (see clause 6) must be harmonized by adjusting the former ones. The resulting values should be within the permissible limits specified in table 1.

Table 8 — Example for the evaluation of grain size testing of silicon carbide having an approximate median diameter of 13 µm

1		2	3	4	5	6	7	8	9	10
Time of sedimentation		Height of sedimentation	Step of the switch	Extinction		Difference of corrected extinction	Grain diameter	Corrected extinction difference × grain diameter	Mass	Sum of mass
min	s	cm		as read	corrected		µm		%	%
0	42	10	7	0,62	—	—	44,7	—	—	—
1	00	10	7	0,64	—	—	37,4	—	—	—
1	25	10	7	0,64	—	—	31,4	—	—	—
2	00	10	7	0,61	—	—	26,4	—	—	—
2	50	10	7	0,62	1,62	—	22,2	—	—	—
4	00	10	7	0,52	1,52	0,1	18,7	1,87	10,2	10,2
5	40	10	7	0,29	1,29	0,23	15,7	3,61	19,7	29,9
8	00	10	6	0,2	0,95	0,34	13,2	4,49	24,6	54,5
11	20	10	5	0,1	0,6	0,35	11,1	3,89	21,3	75,6
16	00	10	4	0,13	0,38	0,22	9,3	2,05	11,2	87
18	00	7,95	3	0,24	0,24	0,14	7,9	1,11	6,1	93,1
20	00	6,25	3	0,15	0,15	0,09	6,6	0,59	3,2	96,3
22	00	4,85	3	0,11	0,11	0,04	5,6	0,22	1,2	97,5
24	00	3,75	3	0,09	0,09	0,02	4,7	0,09	0,5	98
26	00	2,9	3	0	0	0,09	4	0,36	2	100
							Total	18,26	100	100

5) The logarithmic paper used, size A4, can be obtained under reference No. 3/03048 in white paper and, under reference No. 3/03049 in transparent parchment from Max Bohlinger KG, Postfach 1340, D-87403 Kempten/Allgäu.

This information is given for the convenience of users of this part of ISO 8486 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

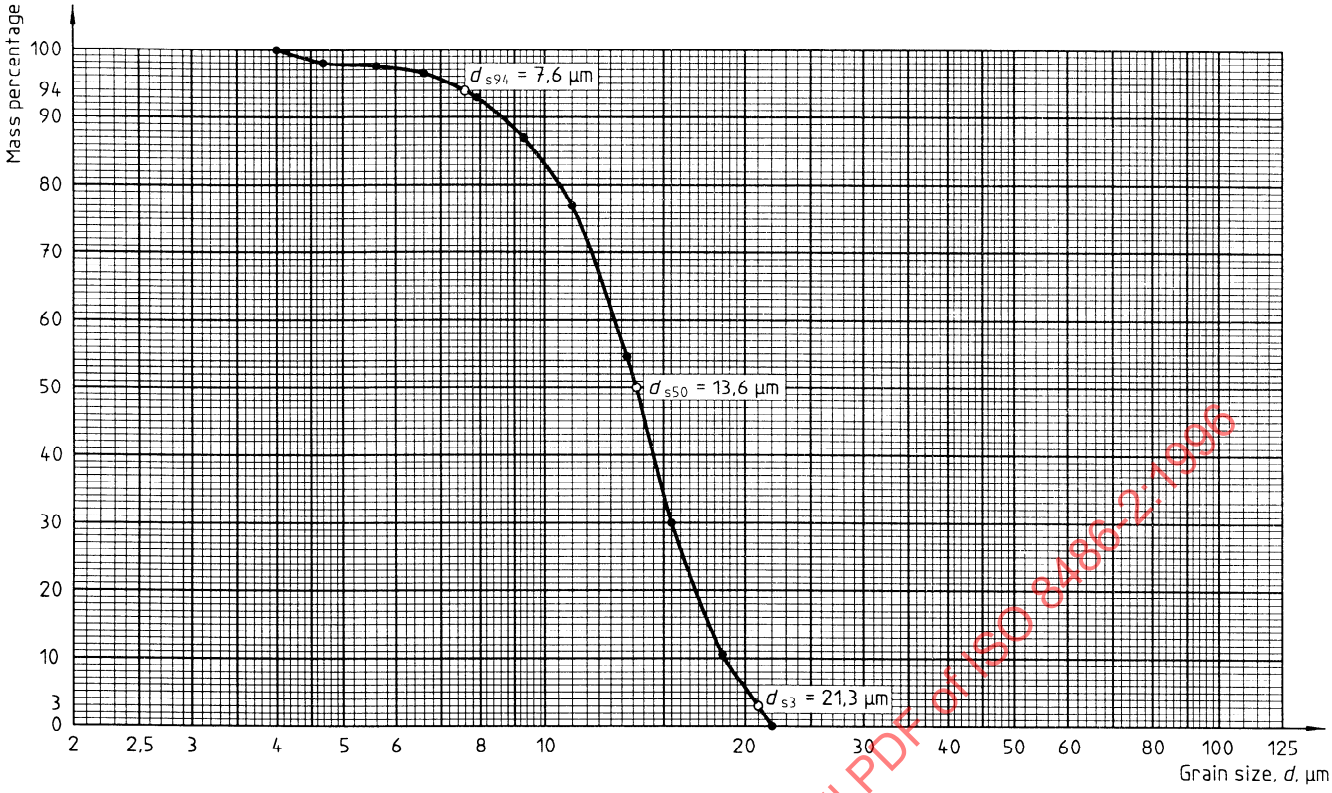


Figure 2 — Grain distribution curve of silicon carbide microgrit having approximately 13 µm median diameter

6.3 US sedimentometer

6.3.1 Testing by sedimentation

The testing of microgrits F230 to F1200 by sedimentation shall be carried out by using the US sedimentometer whereby the grain size distribution is determined.

The principle of measurement is to determine the volumes of a suspension of the grit sample settled in the collecting tube per unit of time and to calculate the equivalent grain diameter by Stokes' Law.

Criteria for the determination of the grain size distribution are:

a) the grain size at the time when 3 % of the volume of the sample has settled (d_{s3} value);

b) the median grain size at the time when 50 % of the volume of the sample has settled (d_{s50} value);

c) the grain size at the time when 95 % of the volume of the sample has settled (d_{s95} value).

The permissible values are given in table 2.

6.3.2 Test apparatus

The US sedimentometer consists of a vertical sedimentation tube of 940 mm length and of 20 mm inside diameter. It is surrounded by a water jacket in which the water temperature is maintained at ± 0,1 °C by a thermostat.

A graduated collecting tube is fixed at the bottom of the sedimentation tube. The whole assembly is mounted on a frame whose base plate is fitted with level adjusting screws for keeping the tube vertical (see figure 3).

For the design and dimensions of the collecting tube, see figure 4.

To improve the accuracy of sedimentation volume readings it is recommended that a horizontal beam light source and a magnifying glass be used. A time printer renders the recording of the sedimentation times easier.

Dimensions in millimetres

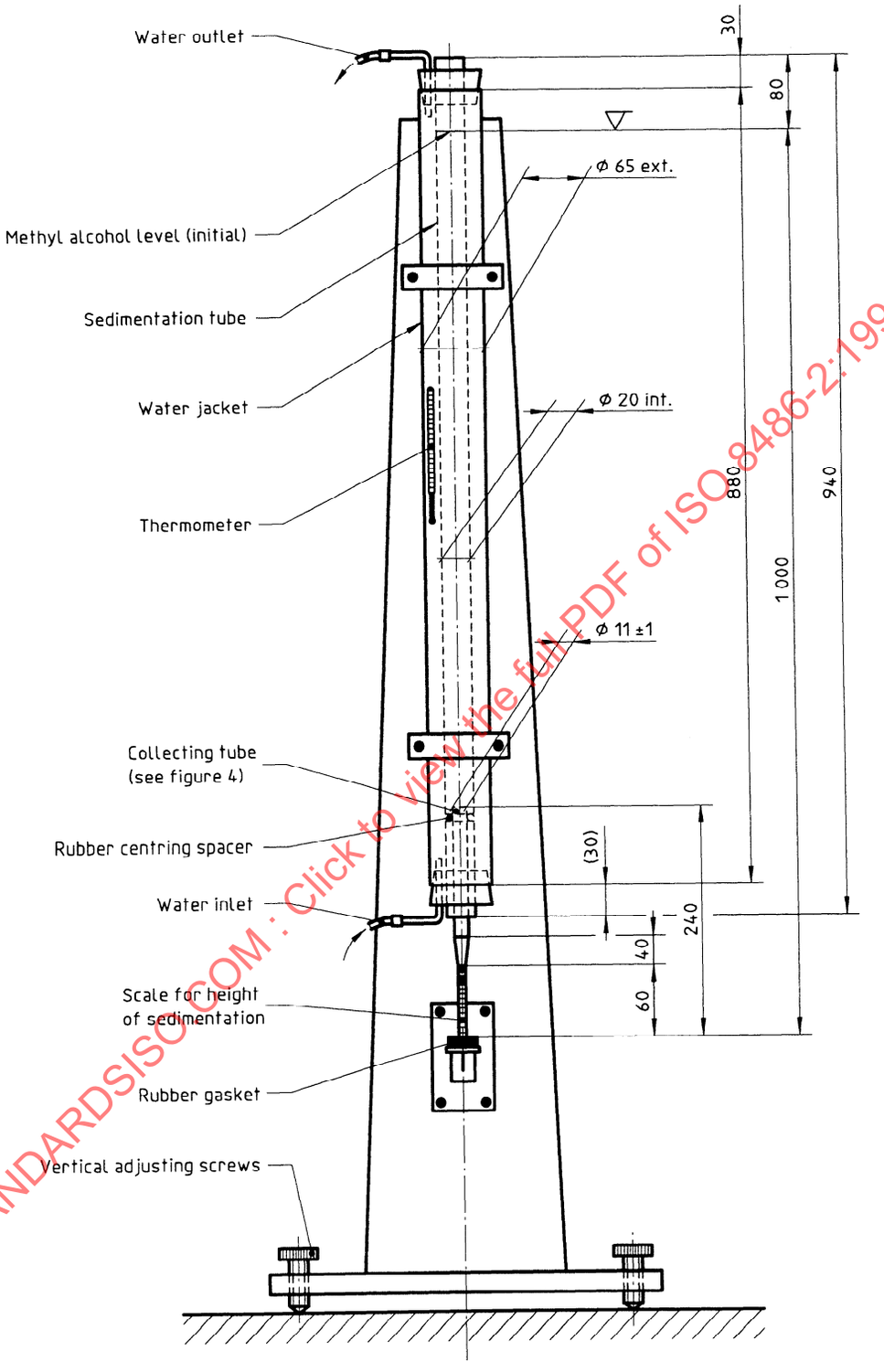
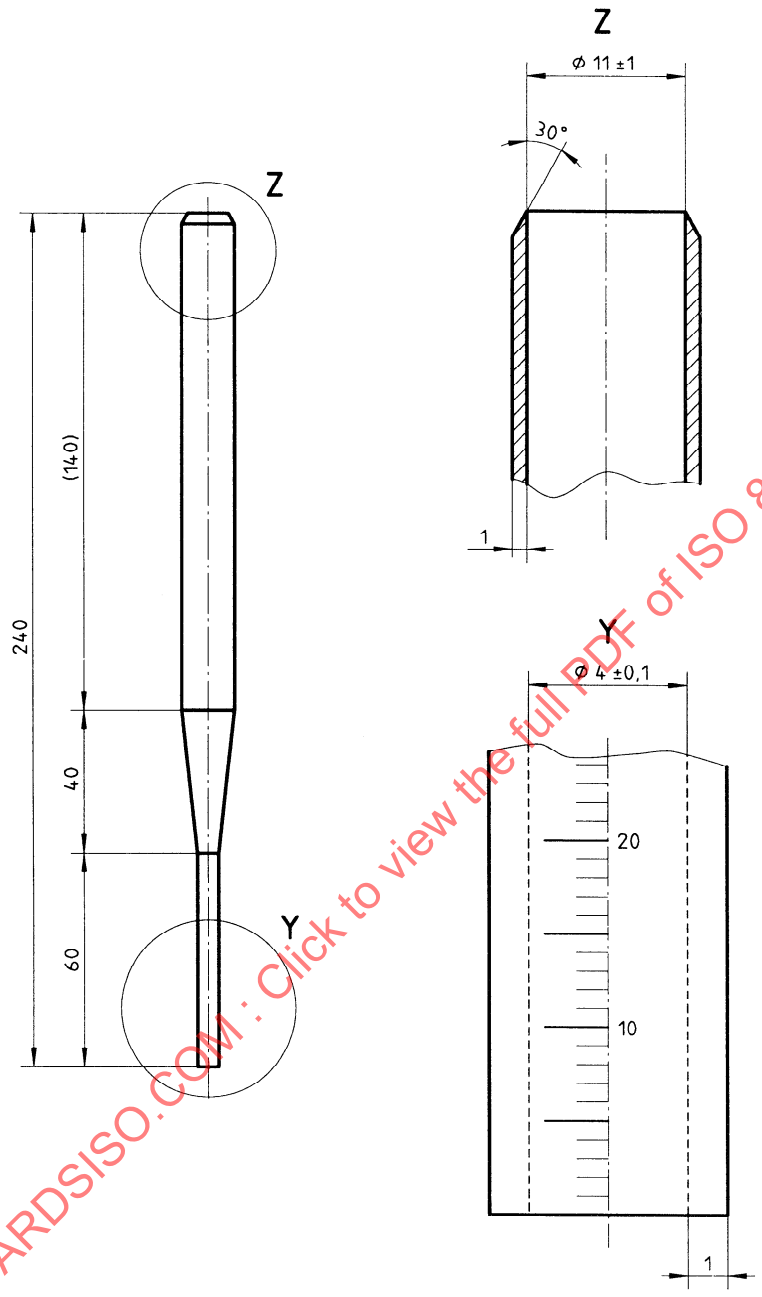


Figure 3 — US sedimentometer

Dimensions in millimetres



Dial graduation and figures to be in white
50 division marks at equal intervals (graduation about 1 mm)

Length of division mark:	3 mm
Every fifth division mark:	4 mm
Thickness of division mark:	0,25 mm

Figure 4 — Collecting tube

6.3.3 Test equipment

6.3.3.1 Sedimentation medium

Methyl alcohol of 95 % up to 99 % is used.

The adjustment of the sedimentation medium with checking minerals is described in 6.3.4.1.3.

6.3.3.2 Dispersing agent

In order to avoid grain agglomeration, a dispersing agent must be added to the methyl alcohol such as EDTA (tetrasodium salt of ethylendiamine tetra-acetic acid) i.e. 4 ml of a 1 % aqueous EDTA-solution per litre methyl alcohol.

6.3.3.3 Checking minerals

The adjustment of the whole measuring procedure is controlled by means of checking minerals 280 and 320[6]. Each supply of checking minerals is accompanied by a cumulative volume grain size distribution curve (see figure 5). The 10 %, 20 %, 30 %, 40 % and 50 % points must not deviate by more than ± 2 % from sizes indicated in table 9.

NOTE 2 The grain size distributions of the checking minerals do not correspond to identical grain sizes of this International Standard.

Table 9 — Grain size of the checking minerals

Volume percentage of the settled checking minerals	Grain size, d µm	
	Checking minerals	
	280	320
0	74,7	75,1
3	62,1	58,7
10	52,9 ± 1,06	49,8 ± 1
20	47,9 ± 0,96	44,2 ± 0,88
30	44,7 ± 0,89	40,5 ± 0,81
40	42 ± 0,84	37,5 ± 0,75
50	39,7 ± 0,79	34,9 ± 0,7
60	37,4	32,5
70	35	30,1
80	32,3	27,5
90	28,8	24,4
100	20	16,5

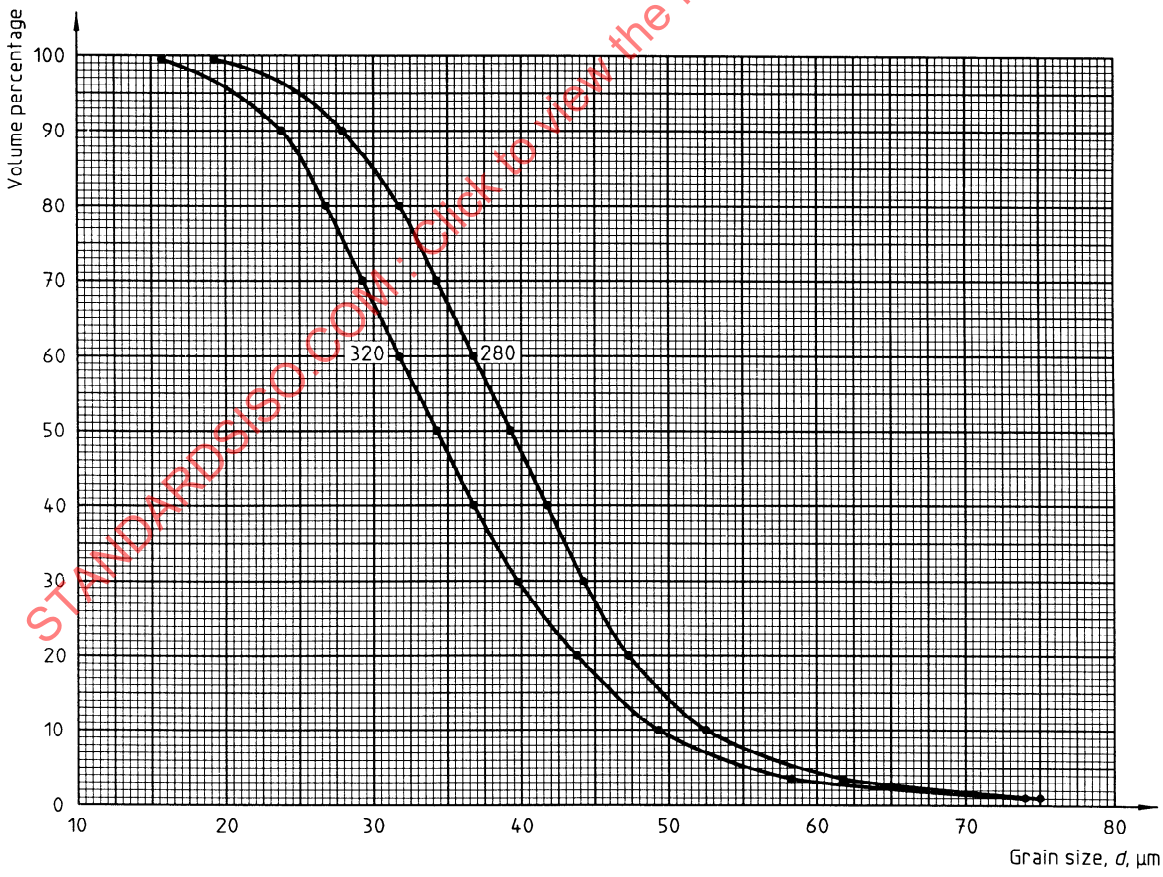


Figure 5 — Cumulative volume grain size distribution curve of the checking minerals 280 and 320

6) Checking minerals can be obtained from Staatliche Materialprüfungsanstalt, see footnote 2), page 3.

6.3.4 Testing

6.3.4.1 Preparation of test

6.3.4.1.1 Setting up of test device

When setting up the US sedimentometer for use as the test device it shall be checked that the collecting tube is positioned centrally in the sedimentation tube. It is held in the vertical position by a rubber spacer located about 30 mm from the top of the collecting tube. This is checked with a plumb line suspended from the top of the sedimentation tube and the collecting tube. The plumb line must pass centrally through both the sedimentation tube and the collecting tube. The device is adjusted by means of the adjusting screws on the base plate.

After adjustment, the water jacket is filled and connected to a thermostat.

6.3.4.1.2 Test temperature

The testing of the grain size shall be carried out under constant temperature with a permissible deviation of ± 0,1 °C.

It is convenient to use a test temperature of 25 °C. The grain diameters indicated in tables 10 and 11 for the respective times of sedimentation apply to this temperature only.

For the determination of the grain diameters for other test temperatures see 6.3.5.1.

6.3.4.1.3 Adjustment of the sedimentation medium

The methyl alcohol used for the test shall be adjusted by means of one of the two checking minerals, 280 or 320.

The grain sizes corresponding to 10 %, 20 %, 30 %, 40 % and 50 % points must not deviate by more than ± 0,5 µm from the values specified on the curves supplied with the checking minerals. The average of the algebraic sum of the deviations shall not exceed ± 0,3 µm.

If agreement with the accompanying curves is not reached within the permissible tolerances, then the density and viscosity of the sedimentation medium must be changed in such a way so that agreement is obtained.

6.3.4.2 Test procedure

6.3.4.2.1 Filling of the sedimentation tube

The sedimentation tube is filled with the previously adjusted sedimentation liquid to a height of 1 000 mm (measured from the bottom of the collecting tube). It is then allowed to stand until equilibrium is reached between the water jacket connected to the thermostat and the sedimentation tube temperatures.

6.3.4.2.2 Preparation of the sample

Prior to the test, the sample shall be heated to a temperature of 600 °C ± 20 °C for at least 10 minutes.

6.3.4.2.3 Dispersion of the sample

A sufficient amount of the sample is placed in a test tube in order to obtain a height of 20 to 25 divisions in the collecting tube after sedimentation. For silicon carbide this will be about 1,6 g, while for fused aluminium oxide it will be about 2,2 g.

It is recommended that the dispersed sample be submitted to ultrasonic treatment to remove agglomerates.

15 ml of sedimentation medium containing the specified quantity of dispersing agent and the sample to be settled shall be transferred to a test tube and the test tube shall be shaken to achieve complete dispersion. The grit shall be allowed to stand in the sedimentation medium for at least 30 min and the test tube shall be shaken vigorously several times during this period. The temperature of the medium shall be the same as the temperature of the medium in the sedimentation tube.

6.3.4.2.4 Transfer to the sedimentation tube

A suitable funnel is placed in the sedimentation tube. The test tube containing the sample and the sedimentation liquid shall be shaken vigorously for at least 30 s. Then its contents are poured on to the sedimentation liquid down the slope of the funnel.

Subsequently, the funnel shall be quickly removed from the sedimentation tube in order to prevent any residue from dropping into the tube as this would distort the results.

6.3.4.2.5 Start of measurement

Measurement begins at the time of transfer.

Table 10 — Theoretical grain diameter, d, for grits of fused aluminium oxide as a function of the time of sedimentation, t, when using methyl alcohol as sedimentation medium for a test temperature of 25 °C

t min	d µm	t min	d µm	t min	d µm	t min	d µm	t min	d µm
0,50	112,7	2,50	50,4	4,50	37,6	8,00	28,2	23,00	16,6
0,55	107,5	2,55	49,9	4,55	37,4	8,20	27,8	24,00	16,3
0,60	102,9	2,60	49,4	4,60	37,2	8,40	27,5	25,00	15,9
0,65	98,9	2,65	49	4,65	37	8,60	27,2	26,00	15,6
0,70	95,3	2,70	48,5	4,70	36,8	8,80	26,9	27,00	15,3
0,75	92	2,75	48,1	4,75	36,6	9,00	26,6	28,00	15,1
0,80	89,1	2,80	47,6	4,80	36,4	9,20	26,3	29,00	14,8
0,85	86,4	2,85	47,2	4,85	36,2	9,40	26	30,00	14,6
0,90	84	2,90	46,8	4,90	36	9,60	25,7	32,00	14,1
0,95	81,8	2,95	46,4	4,95	35,8	9,80	25,5	34,00	13,7
1,00	79,7	3,00	46	5,00	35,6	10,00	25,2	36,00	13,3
1,05	77,8	3,05	45,6	5,10	35,3	10,20	25	38,00	12,9
1,10	76	3,10	45,3	5,20	35	10,40	24,7	40,00	12,6
1,15	74,3	3,15	44,9	5,30	34,6	10,60	24,5	42,00	12,3
1,20	72,8	3,20	44,6	5,40	34,3	10,80	24,2	44,00	12
1,25	71,3	3,25	44,2	5,50	34	11,00	24	46,00	11,8
1,30	69,9	3,30	43,9	5,60	33,7	11,20	23,8	48,00	11,5
1,35	68,6	3,35	43,5	5,70	33,4	11,40	23,6	50,00	11,3
1,40	67,4	3,40	43,2	5,80	33,1	11,60	23,4	55,00	10,8
1,45	66,2	3,45	42,9	5,90	32,8	11,80	23,2	60,00	10,3
1,50	65,1	3,50	42,6	6,00	32,5	12,00	23	65,00	9,9
1,55	64	3,55	42,3	6,10	32,3	12,50	22,5	70,00	9,5
1,60	63	3,60	42	6,20	32	13,00	22,1	75,00	9,2
1,65	62,9	3,65	41,7	6,30	31,8	13,50	21,7	80,00	8,9
1,70	61,1	3,70	41,4	6,40	31,5	14,00	21,3	85,00	8,6
1,75	60,2	3,75	41,2	6,50	31,3	14,50	20,9	90,00	8,4
1,80	59,4	3,80	40,9	6,60	31	15,00	20,6	95,00	8,2
1,85	58,6	3,85	40,6	6,70	30,8	15,50	20,2	100,00	8
1,90	57,8	3,90	40,4	6,80	30,6	16,00	19,9	105,00	7,8
1,95	57,1	3,95	40,1	6,90	30,3	16,50	19,6	110,00	7,6
2,00	56,4	4,00	39,9	7,00	30,1	17,00	19,3	115,00	7,4
2,05	55,7	4,05	39,6	7,10	29,9	17,50	19,1	120,00	7,3
2,10	55	4,10	39,4	7,20	29,7	18,00	18,8	130,00	7
2,15	54,4	4,15	39,1	7,30	29,5	18,50	18,5	140,00	6,7
2,20	53,7	4,20	38,9	7,40	29,3	19,00	18,3	150,00	6,5
2,25	60,1	4,25	38,7	7,50	29,1	19,50	18	160,00	6,3
2,30	52,6	4,30	38,4	7,60	28,9	20,00	17,8	170,00	6,1
2,35	52	4,35	38,2	7,70	28,7	20,50	17,6	180,00	5,9
2,40	51,4	4,40	38	7,80	28,5	21,00	17,4	190,00	5,8
2,45	50,9	4,45	37,8	7,90	28,4	22,00	17	200,00	5,6

Table 11 — Theoretical grain diameter, d, for grits of silicium carbide as a function of the time of sedimentation, t, when using methyl alcohol as sedimentation medium for a test temperature of 25 °C

t min	d µm	t min	d µm	t min	d µm	t min	d µm	t min	d µm
0,50	128,8	2,50	57,6	4,50	42,9	8,00	32,2	23,00	19
0,55	122,8	2,55	57	4,55	42,7	8,20	31,8	24,00	18,6
0,60	117,6	2,60	56,5	4,60	42,5	8,40	31,4	25,00	18,2
0,65	112,9	2,65	56	4,65	42,2	8,60	31,1	26,00	17,9
0,70	108,8	2,70	55,4	4,70	42	8,80	30,7	27,00	17,5
0,75	105,1	2,75	54,9	4,75	41,8	9,00	30,4	28,00	17,2
0,80	101,8	2,80	54,4	4,80	41,6	9,20	30	29,00	16,9
0,85	98,8	2,85	54	4,85	41,4	9,40	29,7	30,00	16,6
0,90	96	2,90	53,5	4,90	41,2	9,60	29,4	32,00	16,1
0,95	93,4	2,95	53	4,95	40,9	9,80	29,1	34,00	15,6
1,00	91,1	3,00	52,6	5,00	40,7	10,00	28,8	36,00	15,2
1,05	88,9	3,05	52,2	5,10	40,3	10,20	28,5	38,00	14,8
1,10	86,9	3,10	51,7	5,20	40	10,40	28,2	40,00	14,4
1,15	85	3,15	51,3	5,30	39,6	10,60	28	42,00	14
1,20	83,2	3,20	50,9	5,40	39,2	10,80	27,7	44,00	13,7
1,25	81,5	3,25	50,5	5,50	38,8	11,00	27,5	46,00	13,4
1,30	79,9	3,30	50,2	5,60	38,5	11,20	27,2	48,00	13,1
1,35	78,4	3,35	49,8	5,70	38,2	11,40	27	50,00	12,9
1,40	77	3,40	49,4	5,80	37,8	11,60	26,7	55,00	12,3
1,45	75,7	3,45	49	5,90	37,5	11,80	26,5	60,00	11,8
1,50	74,4	3,50	48,7	6,00	37,2	12,00	26,3	65,00	11,3
1,55	73,2	3,55	48,4	6,10	36,9	12,50	25,8	70,00	10,9
1,60	72	3,60	48	6,20	36,6	13,00	25,3	75,00	10,5
1,65	70,9	3,65	47,7	6,30	36,3	13,50	24,8	80,00	10,2
1,70	69,9	3,70	47,4	6,40	36	14,00	24,3	85,00	9,9
1,75	68,9	3,75	47	6,50	35,7	14,50	23,9	90,00	9,6
1,80	67,9	3,80	46,7	6,60	35,5	15,00	23,5	95,00	9,4
1,85	67	3,85	46,4	6,70	35,2	15,50	23,1	100,00	9,1
1,90	66,1	3,90	46,1	6,80	34,9	16,00	22,8	105,00	8,9
1,95	65,2	3,95	45,8	6,90	34,7	16,50	22,4	110,00	8,7
2,00	64,4	4,00	45,6	7,00	34,4	17,00	22,1	115,00	8,5
2,05	63,6	4,05	45,3	7,10	34,2	17,50	21,8	120,00	8,3
2,10	62,9	4,10	45	7,20	34	18,00	21,5	130,00	8
2,15	62,1	4,15	44,7	7,30	33,7	18,50	21,2	140,00	7,7
2,20	61,4	4,20	44,5	7,40	33,5	19,00	20,9	150,00	7,4
2,25	60,7	4,25	44,2	7,50	33,3	19,50	20,6	160,00	7,2
2,30	60,1	4,30	43,9	7,60	33	20,00	20,4	170,00	7
2,35	59,4	4,35	43,7	7,70	32,8	20,50	20,1	180,00	6,8
2,40	58,8	4,40	43,4	7,80	32,6	21,00	19,9	190,00	6,6
2,45	58,2	4,45	43,2	7,90	32,4	22,00	19,4	200,00	6,4

6.3.4.2.6 Recording of the measured values

The initial point of the grain size distribution curve is the time when the first continuous flow of particles reaches the bottom of the collecting tube. Check for agglomeration.

The falling particles are observed and the times recorded successively when the surface of the settled grains reaches a division line of the collecting tube (reading without parallax).

The end point of measurement is that time when all the particles have settled, i.e. when the height of sedimentation is no longer changing.

During sedimentation, the rubber gasket at the bottom of the collecting tube shall be tapped gently but continuously. This can be carried out by means of a tapper. It shall, however, not be tapped on the pressing lever supporting the tube or on the tube itself.

If agglomerations of abrasive grits can be observed during the sedimentation this is a sign of insufficient pretreatment of the sample. In such cases the analysis is to be repeated.

6.3.5 Evaluation

6.3.5.1 Determination of grain diameter, d

The determination of the grain size distribution according to this test method is based on Stokes' Law. Since all conditions, except the time of sedimentation, and the grain size are constant for a given microgrit, the Stokes' formula can be simplified as follows:

$$d = \frac{K}{\sqrt{t}}$$

where

d is the equivalent grain diameter, in micrometres;

K is the constant whose value is dependent upon temperature, material to be tested and sedimentation medium;

t is the time of sedimentation, in minutes.

When the test temperature is 25 °C the K values for methyl alcohol are 79,7 for fused aluminium oxide and 91,1 for silicon carbide.

These values represent a basis for the determination of the equivalent grain diameters in tables 10 and 11. For other test temperatures, the grain diameters are also to be calculated according to Stokes' Law.

The K values for the temperatures between 20 °C and 25 °C are given in table 12.

Table 12 — K values

Test temperature θ °C	K values	
	Fused aluminium oxide	Silicon carbide
20	83	94,8
21	82,3	94,1
22	81,7	93,3
23	81	92,6
24	80,4	91,8
25	79,7	91,1

The formulae for the determination of the K values are

— for fused aluminium oxide: $K = 96{,}16 - 0{,}657 \cdot \theta$

— for silicon carbide: $K = 109{,}6 - 0{,}741 \cdot \theta$

Where θ is the temperature of medium in the sedimentation tube in degrees Celsius.

NOTE 3 Concerning the case of application described herein, Stokes' Law states that grit which reaches the bottom of the collecting tube and the surface of the grits already settled at the bottom of the collecting tube respectively after a time, t, in minutes, has an equivalent diameter, d, in micrometres.

6.3.5.2 Determination of the grain size

It is helpful if a form of the type shown in annex B is used for the recording and interpretation of the data. This shows

— column 1: height of sedimentation h, in division lines as marked on the collecting tube;

— column 2: time of sedimentation t;

— column 3: volume percentage of the settled sample determined according to table 13;

— column 4: grain size d, for fused aluminium oxide determined according to table 10 and for silicon carbide according to table 11.

6.3.5.3 Plotting the grain size distribution curve

In the grain size distribution curve the volume percentages of the sedimented sample (ordinate) are plotted against the grain equivalent sizes d (abscissa) determined according to 6.3.5.2 (see figures 6, 7 and 8).

Millimetre graph paper can be used for the grain size distribution curve (see figure 6).

It is, however, more helpful to use logarithmic probability graph paper (see figures 7 and 8). With this type of graph paper it is possible to interpret results from only a few measuring points (see figure 8).

The volume percentages of the settled sample can be read off table 13 for the respective heights of sedi-

mentation, h. If the height of sedimentation of the total sample, h_{tot}, is, for example, 24 division marks, then table 13 results in a volume percentage of the total sample of 45,8 % for a height of sedimentation of 11 division lines.

6.3.5.4 Evaluation of the grain distribution curve

In the grain size distribution curve the d_s values for 3 %, 50 % and 95 % volume percentages of the sample are read and compared with the permissible values according to table 2.

The sample is in accordance with this International Standard when the values for d_{s3}, d_{s50} and d_{s95} are within the permissible limits.

When checking the measured results, allowance must be made for variations due to the measuring technique. These permissible deviations, given in table 5, have been determined on the basis of the standard deviations resulting from an ISO round-robin test. The tolerances for production microgrits given in table 2 shall be increased by these values.

6.3.5.5 Example of testing a sample of fused aluminium oxide

A grit made of fused aluminium oxide is tested in the sedimentation medium at a temperature of 25 °C.

The time is measured and recorded when the first continuous flow of particles reaches the bottom of the collecting tube.

After this, the times are recorded when the sedimentation heights h have reached one division mark each. At the end of the measurement, the total sedimentation height, h_{tot}, reaches 24 division marks. The established times are entered in column 2 of the form.

The volume percentages of the sample can only be determined after the termination of the measurement, when the total height of sedimentation, h_{tot}, is established. They are determined on the basis of table 11 and entered in the form shown in annex C.

For the times of sedimentation t given in column 2, the grain sizes d are to be determined from table 10 and entered in column 4 of the form.

For drawing up the grain size distribution curve, the volume percentages of the sample (column 3 of the form) are plotted against the corresponding grain size (column 4 of the form) (see figures 6, 7 and 8).

Figure 8 shows that when using the probability grid a much lower number of points of measurement (6 points of measurement instead of 24 in figure 6) can lead to a usable result. Only the points of measurement at the division lines 1, 2, 5, 10, 15 and 20 are entered. The established values are to be compared with the permissible values according to table 2.

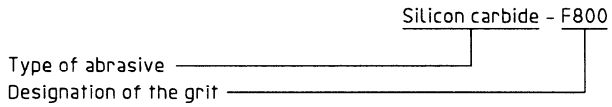
7 Designation

The designation of microgrits for fused aluminium oxide or silicon carbide complying with the requirements of this part of ISO 8486 shall comprise

a) the type of abrasive;

b) the designation of the grit including the letter "F" for a bonded abrasive followed by a characteristic number representing the grit size.

EXAMPLE



8 Marking

When packing grits of fused aluminium oxide and silicon carbide for bonded abrasive products and polishing with loose abrasive grains, the grit designation i.e. F240 shall be marked on each of the smallest packing units.

Table 13 — Volume percentages of the settled sample as a function of the height of sedimentation h, related to the total height of sedimentation h_{tot} of the sample

Height of sedimentation h in division marks	**Total height of sedimentation, h_{tot}, of the sample** in division marks										
	20,0	20,5	21,0	21,5	22,0	22,5	23,0	23,5	24,0	24,5	25,0
	Volume percentage of settled sample										
1	5,0	4,9	4,8	4,7	4,5	4,4	4,3	4,3	4,2	4,1	4,0
2	10,0	9,8	9,5	9,3	9,1	8,9	8,7	8,3	8,3	8,2	8,0
3	15,0	14,6	14,3	14,0	13,6	13,3	13,0	12,8	12,5	12,3	12,0
4	20,0	19,5	19,0	18,6	18,2	17,8	17,4	17,0	16,7	16,7	16,0
5	25,0	24,4	23,8	23,3	22,7	22,2	21,7	21,3	20,8	20,4	20,0
6	30,0	29,3	28,6	27,9	27,3	26,7	26,1	25,5	25,0	24,5	24,0
7	35,0	34,1	33,3	32,6	31,8	31,1	30,4	29,8	29,2	28,6	8,0
8	40,0	39,0	38,1	37,2	36,4	35,6	34,8	34,0	33,3	32,7	32,0
9	45,0	43,9	42,9	41,9	40,9	40,0	39,1	38,3	37,5	36,7	36,0
10	50,0	48,8	47,6	46,5	45,5	44,4	43,5	42,6	41,7	40,8	40,0
11	55,0	53,7	52,4	51,2	50,0	48,9	47,8	46,8	45,8	44,9	44,0
12	60,0	58,5	57,1	55,8	54,5	53,3	52,2	51,1	50,0	49,0	48,0
13	65,0	63,4	61,9	60,5	59,1	57,8	56,5	55,3	54,2	53,1	52,0
14	70,0	68,3	66,7	65,1	63,3	62,2	60,9	59,6	58,3	57,1	56,0
15	75,0	73,2	71,4	69,8	68,2	66,7	65,2	63,8	62,5	61,2	60,0
16	80,0	78,0	76,2	74,4	72,7	71,1	69,6	68,1	66,7	65,3	64,0
17	85,0	83,0	81,0	79,1	77,3	75,6	73,9	72,3	70,8	69,4	68,0
18	90,0	87,8	85,7	83,7	81,8	80,0	78,3	76,6	75,0	73,5	72,0
19	95,0	92,7	90,5	88,4	86,4	84,4	82,6	80,8	79,2	77,6	76,0
20	100,0	97,6	95,2	93,0	90,6	88,9	87,0	85,1	83,3	81,6	80,0
21	—	100,0	100,0	97,7	95,5	93,3	91,3	89,4	87,5	85,7	84,0
22	—	—	—	100,0	100,0	97,8	95,7	93,6	91,7	89,8	88,0
23	—	—	—	—	—	100,0	100,0	97,9	95,8	93,9	92,0
24	—	—	—	—	—	—	—	100,0	100,0	98,0	96,0
25	—	—	—	—	—	—	—	—	—	100,0	100,0

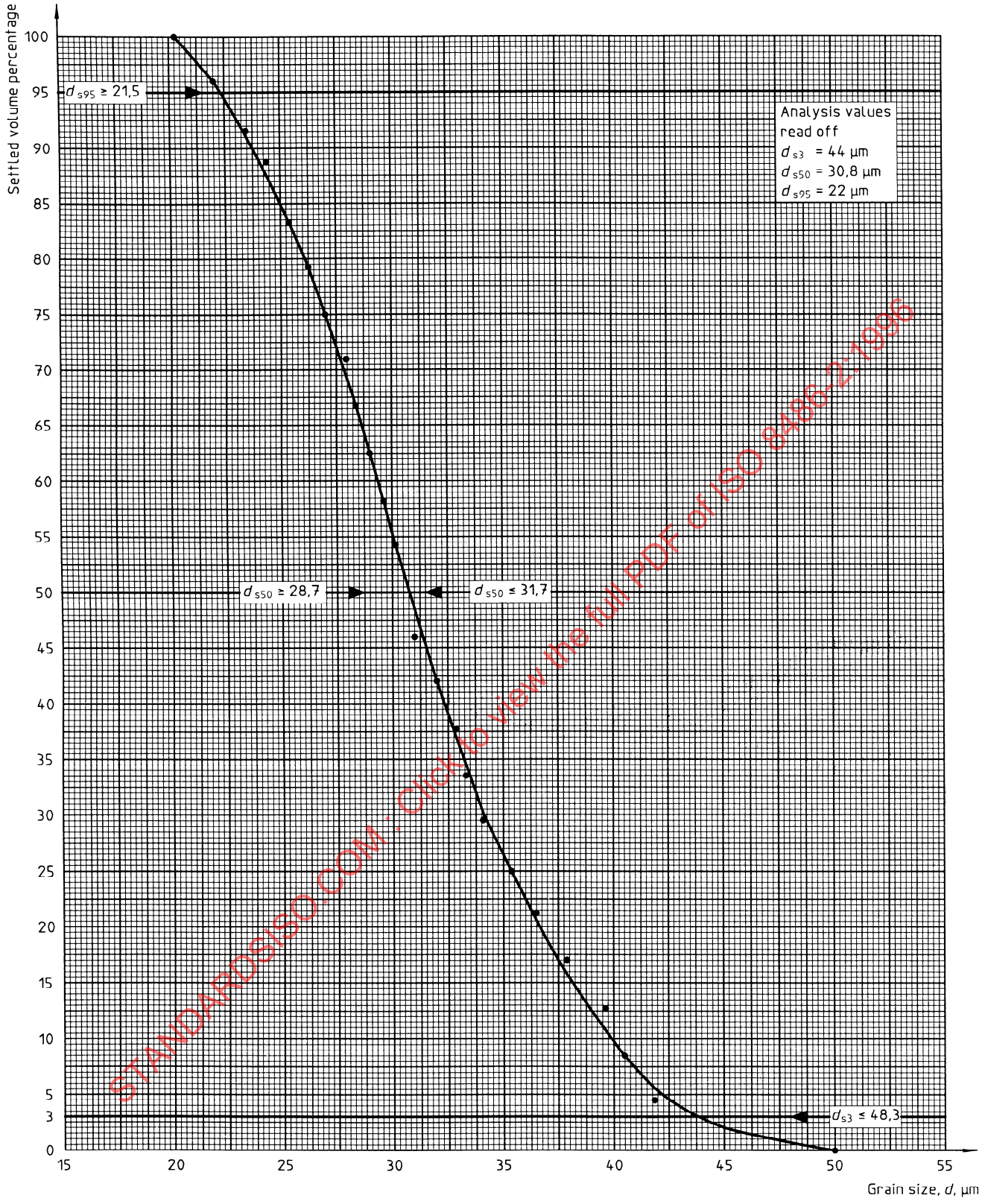


Figure 6 — Grain size distribution curve, represented on linear graph paper — Measuring values and permissible limiting values

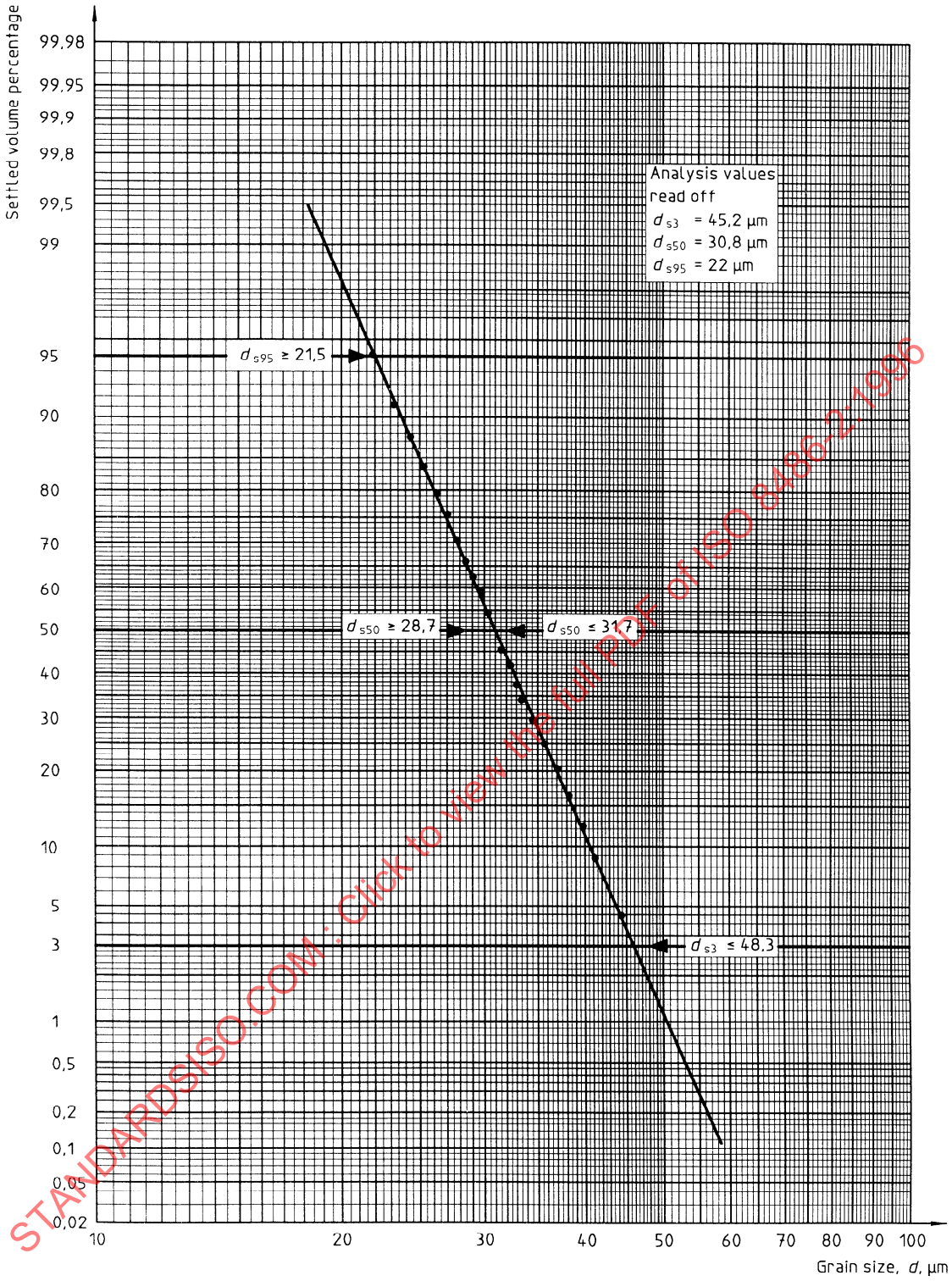


Figure 7 — Grain size distribution curve, represented on logarithmic probability graph paper (example as in figure 6) **— Measuring values and permissible limiting values** (see also figure 8)