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Test sieving -- Part 1: Methods using test sieves of woven wire cloth and perforated metal plate

Tamisage de contrôle -- Partie 1: Modes opératoires utilisant des tamis de contrôle en tissus métalliques et en tôles métalliques perforées

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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Test sieving —

Part 1 : Methods using test sieves of woven wire cloth and perforated metal plate

Tamisage de contrôle —

Partie 1 : Modes opératoires utilisant des tamis de contrôle en tissus métalliques et en tôles métalliques perforées

Reference number
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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 approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2591-1 was prepared by Technical Committee ISO/TC 24, *Sieves, sieving and other sizing methods.*

This edition of ISO 2591-1 cancels and replaces in part ISO 2591 : 1973, of which it constitutes a technical revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Test sieving —

Part 1 :
Methods using test sieves of woven wire cloth and perforated metal plate

0 Introduction

0.1 General considerations

Test sieving is used in many industries on a wide variety of materials and for different purposes. No single method of test sieving can be specified to cover the many applications, and certain industries have already produced specifications for sieving procedures which are incorporated in the appropriate International Standard for a limited application. Standardized series of nominal openings of test sieve media are specified in ISO 565, and standardized technical requirements on test sieves are standardized in ISO 3310.

ISO 2591 is intended as a guide to all who are responsible for deciding on test sieving procedures, including those concerned with specific materials, and it formulates general principles of sieving which may be applied to many natural and artificial materials.

The procedures given depend on the predominant size range of the particles in a sample, and it is recognized in this part of ISO 2591 that some materials are difficult to sieve and require specially developed techniques (see clause 4).

Test sieving may be undertaken

a) as part of a research project involving an investigation of the particle size of a material;

b) as part of a control procedure for the production of material where the particle size distribution is important;

c) as the basis of a contract for the supply of material specified to be within stated grading limits.

The principles to be followed in the sieving procedure will be similar in each case but the actual detail may vary considerably according to the purpose for which the results are required. For example, the main criterion for a sieve analysis undertaken for research purposes may be consistency in one laboratory, whereas for a procedure which forms part of a specification in a contract it may well be maximum reproducibility between laboratories consistent with reasonable cost of testing.

The accuracy required for quality control purposes may well be relatively low and the predominant factors could be low cost, maximum mechanization and speed in obtaining the result. A simplified procedure with a given operator and particular apparatus in one set-up may be found adequate for control purposes, even though the reproducibility of the procedure as used between different laboratories may not be very good.

0.2 Principles of sieving

A single test sieve separates a particular material into two fractions, of which one is retained by the sieving medium and the other of which passes through its apertures. When applied to particles of non-spherical shape the procedure is complicated by the fact that a specific particle with a size close to that of the nominal aperture size of the test sieve may pass through the apertures only when presented in a favourable position, and will not pass through when presented in other positions. As there is inevitably a variation in the size of the sieve apertures, prolonged sieving will cause the larger apertures to exert an unduly significant effect on the sieve analysis: the proportion of oversize apertures is limited by the specifications for test sieves. The procedure is also complicated in many cases by the presence of so-called "near aperture size" particles which cause blinding of the sieve apertures and reduce the effective area of the sieving medium.

The process of sieving may be divided into two stages: firstly, the elimination of particles considerably smaller than the sieve apertures, which could occur fairly rapidly, and secondly, the separation of "near aperture size" particles, which is a gradual process rarely reaching completion. Both stages require all particles put on the sieving medium to have the opportunity of passing through an aperture. Ideally, each particle should be presented individually to an aperture, as is permitted for the largest aperture sizes, but for most sizes this is impracticable. The effectiveness of a sieving technique depends on the amount of material (charge) put on a sieve and the type of movement imparted to the charge on the sieve.

If the charge is too large, the bed of material on the sieving medium will be too many particles deep to allow each one the opportunity of being presented to an aperture in the most favourable position in order for gauging to be completed in a reasonable time. The charge, therefore, is limited by a requirement on the maximum amount of material retained at the end of sieving appropriate to the aperture size of the test sieve. However, the sample to be sieved has to contain enough particles to be representative of the consignment, so a minimum size of sample is specified. In some cases, the sample will have to be subdivided into a number of charges if the requirement for preventing overloading of the sieves is to be satisfied.

The movement imparted to a sieve by hand can be adapted, by experience, to meet the needs of the material and the sieving medium; different techniques are required for particles of quite different size. A machine, however, is usually designed to impart a particular combination of movements, irrespective of the aperture size of the test sieve or the characteristics of the material, and may not be readily adaptable to be equally effective for different materials. Nevertheless, a machine does not get tired and moderate effectiveness may often be acceptable providing that sieving continues long enough.

When this part of ISO 2591 was being prepared, the alternatives of shaking the sieve by hand and by means of a machine were considered. Hand shaking by an experienced operator is generally more effective when sieving relatively coarse particles. For fine powders, however, the end point may be approached more rapidly, and certainly with less effort, by using one of the many mechanical and other sieving techniques now commercially available. Hand sieving and machine sieving are not mutually exclusive; machine sieving followed by a final brief hand sieving to ensure that the end point has been reached (see 7.2.7) may achieve the best results.

0.3 Correlation of results from different methods of size analysis

It may be necessary to combine size distributions determined by different methods, e.g. sieving, sedimentation, elutriation or microscopy. It is preferable to cover the range of a single distribution using a single method, but this is not always possible. A simple, but admittedly not a particularly accurate, procedure for establishing correlation factors for two different sizing techniques is to overlap the methods of size determination so that one or more size classes are assessed by both methods.

1 Scope and field of application

This part of ISO 2591 draws attention to and describes the main factors affecting test sieving and the results obtained; it also specifies general principles to be followed concerning apparatus, procedure and presentation of results.

It applies to methods in which test sieves of woven wire cloth or perforated metal plate are used. Test sieving methods using test sieves of electroformed sheet will form the subject of ISO 2591-2.

2 References

ISO 565, *Test sieves — Woven metal wire cloth, perforated plate and electroformed sheet — Nominal sizes of openings.*

ISO 2395, *Test sieves and test sieving — Vocabulary.*

ISO 3310, *Test sieves — Technical requirements and testing —*

Part 1: Test sieves of metal wire cloth.

Part 2: Test sieves of perforated metal plate.

Part 3: Test sieves of electroformed sheets.[1)]

3 Definitions

For the purposes of this part of ISO 2591, the definitions given in ISO 2395 apply.

4 Material to be sieved

4.1 General

Materials to be test sieved range from very coarse lumps, such as coal and stone, to very fine materials, such as pigments and clay; they differ in their physical and chemical properties. Information about the properties of a material is helpful in judging its sieving characteristics, and should be noted in the test report. The more important properties affecting sieving are dealt with in 4.2.

Because of the considerable variety of material properties encountered, it is not possible to specify a single method of test sieving which applies to all materials. The sieving method appropriate to a material should be stated in an International Standard or national standard, or in other specifications dealing with that material.

4.2 Physical and chemical properties

4.2.1 Density

The following kinds of density are important in test sieving:

a) effective particle density, which can affect the duration of sieving;

b) apparent bulk density, which can influence the quantity of material to be taken for sieving.

4.2.2 Friable nature

Some materials are liable to reduce in size during sieving because of their friable nature. This property should be taken into account in the handling of the material during sampling and test sieving.

4.2.3 Abrasive properties

Some materials, e.g. emery powders, are abrasive; these wear out the sieves and modify the apertures in the course of a prolonged sieving operation. It is desirable to ascertain whether or not the material is abrasive before commencing the test and to check the conformity of the apertures of the sieving medium against the specified tolerances.

1) At present at the stage of draft.

4.2.4 Surface moisture

Surface moisture is important because it affects the way in which a material will flow on a sieve.

4.2.5 Internal moisture

If there is a change in internal moisture during sieving, the masses of the fractions will be affected.

4.2.6 Hygroscopic properties

Some materials readily absorb moisture and cannot safely be allowed to come into equilibrium with the laboratory atmosphere. In such cases they should be handled and sieved in such a way as to reduce their contact with the atmosphere to a minimum.

4.2.7 Change of property on drying

It is important to know whether the properties of a material are changed by any proposed drying process, e.g. whether the material is liable to break or to cake.

4.2.8 Particle shape

The duration and results of sieving can be considerably affected by the shape of the particles.

4.2.9 Size distribution

The range of particle size of the material is important in deciding the sieving procedure to be used (see clause 7).

4.2.10 Cohesive property

The spreading of the particles on the sieving medium depends on the cohesive nature of the material; this, in turn, depends on the inter-particle forces and increases with the fineness of the powder.

4.2.11 Magnetic properties

Magnetic properties of materials may affect the results on account of the reaction of the particles with each other (tending to agglomerate) and with the sieve (tending to adhere).

4.2.12 Electrostatic properties

Some powders may become charged with static electricity during the sieving operation and adhere to the sieve frame, thereby affecting the results.

4.2.13 Chemical reactivity

Certain materials to be sieved may react with the atmosphere or with the materials of the sieve. Consequently, it is necessary that all component parts of the sieve be inert. Furthermore, the test may have to be conducted in an inert atmosphere.

4.2.14 Production of material

The source of the material and method of preparation may provide information on the properties dealt with in 4.2.1 to 4.2.13; such information should be included in the test report.

5 Sampling

5.1 Sampling method

Precise sampling is a necessary condition for obtaining accurate results for sieve tests. Just as much care should, therefore, be taken with the sampling as with the actual sieving.

The sampling method used should be such that the sample taken for sieving is truly representative of the material from which it has been drawn. The most suitable method will depend both on the material and on the form in which it is presented, e.g. whether it is in bags, in a heap or flowing as a continuous stream. It is not possible to specify one method that is applicable to all materials; precise sampling methods should be specified for particular materials and circumstances.

The sampling method shall comply with the requirements specified for individual products in the relevant International Standards concerned with those products; otherwise, the methods specified in national standards shall be complied with.

5.2 Division of the sample

The original sample is often too large for direct use in a sieve test: it shall therefore be reduced. In reducing the sample, it is just as important to ensure that the final quantity (test sample) taken for sieving is truly representative of the original sample as it is to ensure that the original sample was representative of the material (see 5.1).

As in the case of the original sampling, the division of samples of particular material shall comply with the relevant International Standards concerned with that material, or, in the absence of any International Standards, the appropriate national standards.

5.3 Storage of samples and test samples

Samples and test samples shall be stored in such a way that they are not liable to be contaminated or changed in any other way.

6 Apparatus

6.1 Test sieves

Test sieves shall comply with the relevant part of ISO 3310 or with International Standards based on ISO 3310.

Test sieving shall be carried out with a single test sieve or with a series of test sieves with different nominal aperture sizes. A lid and receiver pan should be included in both cases, where appropriate. The number of sieves used in the test should be sufficient to give the requisite information about the material and to avoid excessive wear or blinding.

The same type of sieving medium (i.e. wire cloth or perforated plate) and the same geometrical form of the apertures shall be used for all the test sieves used in any one nest.

If more than one nest of sieves has to be used in series, the results shall be combined.

6.2 Preparation and maintenance of test sieves

Before each use, the sieving medium and frame should be scrutinized against an illuminated background for defects, blinding or contamination. If it is necessary to clean the sieve, cleaning should be carried out with great care to avoid damage to the sieving medium.

Sieves may be washed in warm water containing a liquid synthetic detergent. The sieve should afterwards be rinsed thoroughly in clean water and dried in a warm atmosphere. The test sieves should not be heated to high temperature; heating above 80 °C is liable to cause permanent damage.

Other useful methods for removing entrapped material from the sieving medium, particularly from the finer apertures, include shaking the sieve upside down on a sieving machine or immersing the sieve in a bath of water agitated by an ultrasonic transducer, provided that the sieving medium will withstand such a process.

The accuracy of the sieving medium in the test sieve shall be verified at the outset and shall subsequently be re-verified in the course of use. Factors such as the frequency of use and type of material sieved will influence how often such verifications are carried out. It is desirable, therefore, to have a record card for each test sieve. Verification and re-verification shall be carried out according to the procedure described in ISO 3310. If a sieving medium no longer complies with the tolerances specified, the marking of the label shall be obliterated and the sieve discarded.

Test sieves of the same nominal aperture size may not give identical results with the same product. A method for checking the effective sieving size (cut size) of a test sieve is to calibrate it with a certified reference material, glass spheres, quartz particles, etc., and to retest it from time to time to verify that the effective sieving size has not changed.

6.3 Accessories

Depending on the material characteristics and the particle size distribution of the sample to be tested, the following auxiliary apparatus may be useful:

a) for dry sieving: a soft brush, e.g. a paint brush, to clean the underside of the sieving medium from time to time;

b) for wet sieving: an installation with a reservoir of liquid, regulating valve and collecting tank.

For test sieving purposes, the use of mechanical accessories, such as rubber cubes or balls, is not permitted since these may damage both the material to be sieved and the sieving medium.

7 Test sieving methods

7.1 General

7.1.1 Principle

Test sieving consists in gently placing the material to be sieved on the test sieve having the specified nominal aperture size and separating the material, by shaking, tapping or washing, into oversize and undersize. In sieving successively with test sieves of different aperture size, the test sample is separated into size fractions designated by the aperture sizes of the test sieves used.

Before test sieving is begun, the following conditions should be stipulated:

a) the sieving method, i.e. dry, wet, or a combination of both;

b) the number of sieves to be used and their nominal aperture sizes;

c) the size and shape of the frame;

d) the type of sieving medium (i.e. woven wire cloth, perforated plate or electroformed sheet), square or round holes, material of frame and sieving medium.

7.1.2 Hand sieving and machine sieving

Test sieving can be carried out by hand and/or on test-sieving machines. If test-sieving machines are used, the sieving results shall conform, within agreed tolerances, to those obtained by hand sieving. The reference method shall always include final hand sieving, performed under specified conditions (see 7.2.7). If machine test sieving alone is carried out, the machine and the method of operation shall be stated in the test report.

7.1.3 Dry sieving and wet sieving

For test sieving by hand, the following procedures are commonly used:

a) for dry sieving: shaking and tapping (the procedure suitable for most materials);

b) for wet sieving: washing (for materials which tend to agglomerate).

The hand-sieving process may be adapted to the sieving characteristics of the sample concerned by choosing from the alternatives given above.

7.1.4 Weighing accuracy

It is recommended that the masses of the charge and the fractions should be determined by weighing to an accuracy of better than 0,1 % of the mass of the charge.

7.1.5 Influence of the humidity of the air

Samples which are not hygroscopic or chemically reactive and which are to be dry sieved shall be in equilibrium with the laboratory atmosphere; this is achieved by adopting the method best suited to the product. If there is a change in humidity during the test, the masses of the charges and fractions shall be corrected to their dry masses or to an agreed basis.

7.1.6 Test sample

The quantity of material (charge) to be placed on a sieve depends on

a) the sieve nominal aperture size;

b) the apparent bulk density of the material;

c) the cross-sectional area of the sieve;

d) the proportion of oversize material (determined if necessary by preliminary sieving).

The recommended quantity of material to be sieved on a 200 mm diameter round sieve is given, for guidance, in the table (column 2 gives the quantity for sizes in the R 20/3 series between 22,4 mm and 25 µm). The quantity should be that specified for the sieve corresponding to the dominant size fraction of the sample, providing that the size distribution does not cause excess volume on any of the sieves in the set as indicated in column 2 of the table.

The values given in the table apply both to single sieves and to sieves in nests, and both to hand sieving and to machine sieving.

However, the incidence of blinding if there is a large proportion of near aperture size particles on any sieve may necessitate a reduction of the charge.

The proportion of oversize material should be such that the volume retained on the sieve after sieving has been completed is not greater than the volume specified in column 3 of the table. It may be necessary, therefore, to sieve a test sample in two or more charges to avoid exceeding the maximum permissible volume of residue. The results shall be combined.

To obtain the best results, it is always preferable to place a reduced charge on the coarsest aperture sieve to avoid overloading any of the finer aperture sieves in the set.

If any of the fractions of particular interest do not contain a sufficient number of particles to be representative of the bulk material, the sieving shall be repeated with further charges until this fraction is sufficient.

7.1.7 Largest particle to be permitted on a test sieve

To avoid damage to the sieve, the size of the largest particle in the charge should not exceed $10w^{0,7}$ mm, where w is the nominal aperture size in millimetres.

Examples:

Nominal aperture size, w	Approximate size of largest particle
4 mm	25 mm
1 mm	10 mm
0,25 mm	4 mm
0,045 mm	1 mm

Table — Guide to quantity of material for test sieving on a 200 mm diameter round sieve[1)]

1	2	3
Nominal aperture size, w	Bulk volume of material[2)]	
	Approximate volume of charge	Maximum volume of residue[3)]
mm	cm³	cm³
22,4	1 600	800
16	1 000	500
11,2	800	400
8	500	250
5,6	400	200
4	350	175
2,8	240	120
2	200	100
1,4	160	80
1	140	70

1	2	3
Nominal aperture size, w	Bulk volume of material[2)]	
	Approximate volume of charge	Maximum volume of residue[3)]
µm	cm³	cm³
710	120	60
500	100	50
355	80	40
250	70	35
180	60	30
125	50	25
90	42	21
63	35	17
45	30	15
32	26	13
25	22	11

1) When using test sieves of different shapes and sizes, the values should be modified in proportion to the sieving area.

2) Masses of materials can be determined by multiplying the values specified in columns 2 and 3 by the apparent bulk density, in grams per cubic centimetre, of the material to be sieved.

3) Maximum volume permitted on the sieve after sieving has been completed.