Designation: E276 – 21

Standard Test Method for Particle Size or Screen Analysis at 4.75 mm (No. 4) Sieve and Finer for Metal-Bearing Ores and Related Materials[1]

This standard is issued under the fixed designation E276; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of the particle size distribution by screen analysis, dry or wet, of metal-bearing ores and related materials at 4.75 mm (No. 4) sieve and finer.

1.2 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E135 Terminology Relating to Analytical Chemistry for Metals, Ores, and Related Materials

E882 Guide for Accountability and Quality Control in the Chemical Analysis Laboratory

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this test method, refer to Terminology E135.

4. Summary of Test Method

4.1 The sample is passed through a bank of sieves by agitation. The dry screening technique described in this test method may be used on any solid particles that can be dried so that sieve blinding does not occur. The wet screening technique using liquid media may be used on any insoluble solids.

5. Significance and Use

5.1 This test method is intended to be used for compliance with compositional specifications for particle size distribution. It is assumed that all who use this procedure will be trained analysts capable of performing common laboratory practices skillfully and safely. It is expected that work will be performed in a properly equipped laboratory and that proper waste disposal procedures will be followed. Follow appropriate quality control practices such as those described in Guide E882.

6. Apparatus and Materials

6.1 *Brass and Fiber Bristle Brushes,* for cleaning sieves and pans.

6.2 *Drying Oven,* of appropriate size and capable of maintaining a uniform temperature at 110 °C ± 5 °C.

6.3 *Mechanical Sieve Shaker.*

6.4 *Pans,* for holding samples.

6.5 *Sample Splitter or Riffle* with 25.4 mm (1 in.) opening.

6.6 *Scales and Weights,* of adequate accuracy.

6.7 *Special Apparatus,* for wet screening, including deep-frame sieves.

6.8 *U.S. Standard Sieves,* conforming to the requirements of Specification E11.

6.9 *Water* or other liquid, for wet screening.

[1] This test method is under the jurisdiction of ASTM Committee E01 on Analytical Chemistry for Metals, Ores, and Related Materials and is the direct responsibility of Subcommittee E01.02 on Ores, Concentrates, and Related Metallurgical Materials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

7. Sample Preparation

7.1 If necessary, reduce the sample by riffling or other suitable means to obtain a test sample that will not overload the sieves, and dry at 110 °C ± 5 °C to constant mass. Constant mass is obtained when an additional hour drying at 110 °C ± 5 °C does not cause a change greater than 0.05 % mass.

NOTE 1—The size of the sample is very important in sieve analysis because the number of particles on a sieve surface affects the probability of any one particle passing through the sieve at a given time. The more particles there are on a sieve, the greater probability that any one particle is hindered from getting into a position to pass through the opening.

7.2 Screen the test sample from 7.1 on a 4.75 mm (No. 4) sieve. Weigh the material retained on the sieve. Record mass.

8. Preparation of Apparatus

8.1 Clean coarse sieves up to 180 µm (No. 80) with a soft brass wire brush and clean the finer sieves with a fiber brush. Clean by brushing the under side of the sieves. Gently tap the brass frame to aid in freeing trapped particles. At times, it may be necessary to wash the sieves in a warm soap and water solution. After washing, dry the sieves thoroughly. If wet screening is used, nest selected special deep-frame sieves after cleaning as described.

NOTE 2—Alternatively, ultrasonic cleaning of sieves is recommended.

9. Calibration of Sieves

9.1 Calibrate the sieves by use of calibrated glass spheres. These glass spheres are available from National Institute of Standards and Technology (NIST) and other international standardization organizations.

9.2 Use of the microscopic method in the appendix of Specification E11 is also permissible to assure that the sieves are calibrated.

10. Procedure

10.1 *Dry Screening:*

10.1.1 *For Samples Containing Less than 10 % Passing a 75 µm (No. 200) Sieve*—Nest the selected sieves and fit a pan below the bottom sieve. Place the material which passed the 4.75 mm (No. 4) sieve from 7.2, in the top sieve. Cover and clamp the nested sieves in the mechanical shaker and shake for the time interval specified in 10.1.3.

10.1.2 *For Samples Containing More than 10 % Passing a 75 µm (No. 200) Sieve*—Wash the material which passed the 4.75 mm (No. 4) sieve from 7.2 on a 75 µm (No. 200) sieve until the solution passing through the sieve is clear (see 10.2). Save the material passing the sieve. Dry the sieve fractions in accordance with 10.2.4.2 and process the retained fraction in accordance with 10.1.1.

10.1.3 *Length of Screening Time or End Point*—The screening time or end point is when additional periods of shaking fail to change the results on any sieve used in the test by more than 0.3 %. The screening time may vary from 3 min to 30 min, or more, depending on the type of material. Determine the exact time for each material experimentally.

10.1.4 *Weighing*—Remove the clamp and cover. Transfer the contents of each sieve to a tared pan, tapping and brushing the sieves to remove any lodged particles. Record the mass of each sieve fraction.

10.1.4.1 Weigh and record the mass of the material washed on a 75 µm (No. 200) sieve, as described in 10.1.2 and submitted to wet screening as described in 10.2, the same as in the other sieves.

10.1.5 *Calculation*—Sum the masses of each of the sieve fractions. The total shall be within 1 % of the mass of the original test sample or the analysis must be repeated from 7.1 with another test sample. The mass of the test sample used for calculation is the total of the sieve fractions. Calculate the percent retained on each sieve as follows:

$$\text{Material retained, \%} = (W_r/W_t) \times 100 \quad (1)$$

where:

W_r = mass retained on each sieve, and
W_t = total mass of all sieve fractions.

Calculate the percent passing the finest sieve as follows:

$$\text{Material passing, \%} = (W_p/W_t) \times 100 \quad (2)$$

where:

W_p = mass passing the finest sieve, retained on a pan or filter, and
W_t = total mass of all sieve fractions.

10.1.5.1 Rounding of test results obtained using this test method shall be performed as directed in Practice E29, Rounding Method, unless an alternative rounding method is specified by the customer or applicable material specification.

Obtain the percent cumulative by adding each percent retained on each sieve as the series progresses.

10.1.6 *Report:*

10.1.6.1 Report the following data: sieve size, mass retained on or passing through sieve, percent retained on sieve, and percent cumulative.

10.1.6.2 Present the data of a screen analysis graphically as a cumulative direct plot or a cumulative logarithmic plot. From the plots, the percentages remaining on any set of openings other than those of the testing sieves used, can be found by interpolation and in this way, the redistribution of the same material by any assumed set of openings can be determined.

10.2 *Wet Screening:*

10.2.1 Wet screening can be performed on a single sieve by hand washing or by the use of a mechanical shaker. Similarly, a nest of screens can be used preferably through use of a specially adapted mechanical shaker.

10.2.2 Washing of a sample on a single sieve causes the finest particles to be removed quickly from the larger or coarser particles. This also has the advantage of breaking up aggregates of fine particles and removing the slime coatings from coarse particles, making a product more amenable to dry sieve analysis. The liquid used for washing is generally water, but for specific cases, some other nonreacting liquid can be used. Dry the retained fraction and return to the sieve or nest of sieves for dry screening as described in 10.1.

10.2.3 For more accuracy or reproducibility of tests, use a controlled volume of liquid. To accomplish the results

required, a set volume of liquid cannot be determined to meet all conditions, but through experimentation for specific cases, such requirements can be accomplished.

10.2.4 *Single Screen Testing:*

10.2.4.1 Place the material which passed the 4.75 mm (No. 4) sieve from 7.2 in a deep-frame sieve. Wash the material on the screen in accordance with 10.2. Continue washing until the liquid passing the sieve is clear.

10.2.4.2 *Drying*—Wash the material on the sieve into a drying pan. Dry in an oven at 110 °C ± 5 °C. Recover the material from the retained washings by using a filter press or by evaporation, then dry in an oven at 110 °C ± 5 °C.

10.2.4.3 *Weighing, Calculation, and Report*—Transfer the contents of the sieve to a tared pan as described in 10.1.4 and weigh. Calculate and report the data as described in 10.1.5 and 10.1.6.

10.2.5 *Multiple Screen Testing:*

10.2.5.1 Nest the selected deep-frame sieves and fit a pan containing a drain pipe to the bottom sieve. Place the material passing the 4.75 mm (No. 4) sieve from 7.2 into the top sieve. Place a sieve cover equipped with two inlet pipes on the top sieve and clamp the nested sieves in the mechanical shaker. Connect the inlet pipe to the liquid supply and the drain pipe to a collection container. Start the mechanical shaker and turn on the liquid supply. Continue the washing until the discharge liquid is clear. Turn off the liquid supply and allow the shaker to continue operation for a few minutes.

10.2.5.2 Remove the sieves from the shaker, and dry the sieve fractions in accordance with 10.2.4.2.

10.2.5.3 *Weighing, Calculation, and Report*—Transfer the contents of the sieves to tared pans as described in 10.1.4 and weigh. Calculate and report the data as described in 10.1.5 and 10.1.6.

11. Precision and Bias

11.1 *Precision*—It is generally agreed that errors in screening arise from the way in which screening is performed. Selection of the sample loading of the sieves, sieves themselves, and the final weighing, all influence the reproducibility or accuracy of screening. Some particle wear occurs, but for the 4.75 mm (No. 4) and finer sieves, this wear is usually insignificant. Brittleness, hardness, mass of charge, and the mode of operation of the mechanical shaker influence slightly the results of the test. It is agreed, however, that normally any variations due to these factors would not effectively alter the results of the test. The size and shape of the particles significantly influence the probability of passing when sizes of aperture and particle are close. Screening time is important, but it cannot be said that a specific time of screening should be used for all types of materials. End point of time of screening for different materials is to be established by experimentation.

11.2 If the sample is known to contain naturally occurring ferromagnetic material, it shall be demagnetized in a 60 Hz field of not less than 300 Oe.

11.3 It is not practical to specify the precision of the procedure in this test method because the precision is related to the quantity of sample tested, the distribution of particles and the shape of the particles, which vary for each type of material tested.

11.4 *Bias*—No information on the accuracy of this test method is known. The accuracy of this test method as measured by calibration of sieves using calibrated reference materials, is not directly transferable to metal-bearing ores and related materials.

12. Keywords

12.1 ores; particle size; related materials; screen analysis; sieve

APPENDIX

(Nonmandatory Information)

X1. SUMMARY OF U.S. SIEVE, TYLER SCREEN, AND ISO EQUIVALENTS

U.S. Standard Sieve No.	Tyler Screen Number, mesh	ISO Designation
4	4	4.75 mm
5	5	4.00 mm
6	6	3.35 mm
7	7	2.80 mm
8	8	2.36 mm
10	9	2.00 mm
12	10	1.70 mm
14	12	1.40 mm
16	14	1.18 mm
18	16	1.00 mm
20	20	850 µm
25	24	710 µm
30	28	600 µm
35	32	500 µm
40	35	425 µm
45	42	355 µm
50	48	300 µm