Designation: E389 – 21

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

This standard is issued under the fixed designation E389; 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 of metal-bearing ores and related materials at 4.75 mm (No. 4) sieve and coarser.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses 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

E276 Test Method for Particle Size or Screen Analysis at 4.75 mm (No. 4) Sieve and Finer for Metal-Bearing 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 in this test method, refer to Terminology E135.

3.1.2 *nominal topsize, n*—the sieve designating the upper limit or topsize shall be that sieve of the series with the smallest openings upon which is cumulatively retained a total of less than 5 % of the sample. This defined topsize is not to be confused with the size of the largest particle in the lot.

4. Summary of Test Method

4.1 The sample is passed through a bank of standard sieves by agitation. The screening technique described in this procedure may be used on any solid particles that can be dried so that sieve blinding does not occur.

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 *Brushes,* for cleaning sieves and pans.

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

6.3 *Pans,* for holding samples.

6.4 *Sample Splitter or Riffle,* with openings not less than three times the size of the nominal topsize.

6.5 *Scales and Weights,* of adequate accuracy.

6.6 *Sieve Shaker,* mechanical or manual.

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

[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 means of a sample splitter or riffle, or by the alternate-shovel method. 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. Record 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. Avoid overloading the sieves.

7.2 Screen the test sample from 7.1 on a 4.75 mm (No. 4) sieve. Weigh the material passing the sieve and, if desired, screen in accordance with Test Method E276.

8. Procedure

8.1 Clean the sieves and apparatus by brushing.

8.2 Nest the selected sieves and fit a pan to the bottom sieve. Place the material which was retained on the 4.75 mm (No.4) sieve from 7.2 in the top sieve. Cover and clamp in the mechanical shaker and shake for the length of time as specified in 8.3.

8.3 *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 %. For highly friable material the 0.3 % specification may be meaningless and an acceptable end point shall be determined experimentally.

8.4 *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 (Note 2). Record the mass of each sieve fraction.

NOTE 2—For sieves 50 mm (2 in.) and larger, the probability of a piece of material passing through the sieve is related to its shape. Retained particles approximating the size of the sieve openings should be adjusted by hand to see if they will pass through. For sieves smaller than 50 mm (2 in.), gently shake by hand to determine if screening is complete.

9. Calculation

9.1 Sum the masses of each sieve fraction including the mass of the material passing the 4.75 mm (No. 4) sieve in 7.2. 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.

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

9.2 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.

10. Report

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

10.2 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 thus distribution of the same material by any assumed set of openings can be determined.

11. Calibration of Sieves

11.1 Calibrate the sieves by use of calibrated glass beads. These glass beads are available through the National Institute of Standards and Technology (NIST)[3] and other international standardization organizations.

12. Precision and Bias

12.1 *Precision*—It is generally agreed that the selection of the sample, loading of the sieves, sieves themselves, or the final mass, all influence the reproducibility and accuracy of screening. Some particle wear occurs but is usually insignificant. Brittleness or hardness of the ore and the mode of operation of the mechanical shaker influence slightly the results of the test. The size and shape of the particles significantly influence the probability of passing when screen or sieve aperture and particle size 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 or time of screening for different materials is to be established by experimentation.

12.2 When fines form clusters of agglomerates or adhere to coarse particles, wet screening may be required or be desirable, depending upon each user's needs.

13. Keywords

13.1 analysis; ores; particle; screen; size

[3] Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, http://www.nist.gov/srm.