



# Standard Test Method for Sampling and Fineness Test of Pulverized Coal<sup>1</sup>

This standard is issued under the fixed designation D197; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of the fineness by sieve analysis of coal sampled from a dry pulverizing operation. It is not applicable to products of wet milling or to fines that have clustered into an agglomerated mass.

1.2 The values stated in inch-pound units shall be regarded as the standard. Sample weights of 1000 g or less shall be expressed in metric units.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

**E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves**

## 3. Significance and Use

3.1 This test method provides a means for assisting in the evaluation of pulverizers and pulverizer systems in terms of fineness specifications. It may also be used to confirm the influence of coal fineness on combustion performance and to evaluate carbon loss. By consent among interested parties, it may be used for evaluation of coal fineness in preparation, pneumatic transfer systems, etc.

## 4. Apparatus

4.1 *Sample Containers*—Heavy vapor impervious bags, properly sealed, or noncorroding cans such as those with an airtight, friction top or screw top sealed with a rubber gasket and pressure sensitive tape for use in storage and transport of

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D05 on Coal and Coke and is the direct responsibility of Subcommittee D05.07 on Physical Characteristics of Coal.

Current edition approved Sept. 1, 2012. Published November 2012. Originally published in 1924. Last previous edition approved in 2007 as D197 – 87 (2007). DOI: 10.1520/D0197-87R12.

<sup>2</sup> 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.

the laboratory sample. Glass containers sealed with rubber gaskets may be used, but care must be taken to avoid breakage in transport.

4.2 *Drying Oven*—A device for passing slightly heated air over the sample. The oven should be capable of maintaining a temperature of 18 to 27°F (10 to 15°C) above room temperature with a maximum oven temperature of 104°F (40°C). Air changes should be at the rate of 1 to 4/min.

4.3 *Sieves*, square-hole, woven-wire cloth conforming to Specification **E11**:

- No. 8 USA Standard (2.36 mm)
- No. 16 USA Standard (1.18 mm)
- No. 30 USA Standard (600  $\mu\text{m}$ )
- No. 50 USA Standard (300  $\mu\text{m}$ )
- No. 100 USA Standard (150  $\mu\text{m}$ )
- No. 200 USA Standard (75  $\mu\text{m}$ )
- No. 325 USA Standard (45  $\mu\text{m}$ )

The sieve frames shall be 8 in. (203 mm) in diameter, and the height of the sieve from the top of the frame to the cloth shall be either 2 in. (50.8 mm) or 1 in. (25.4 mm). Selection of specific sizes is optional, depending on the objective of the test.

4.3.1 Since the finer mesh sieves in particular are susceptible to damage by distortion resulting from undue pressure, accidental scraping with hard brushes, etc., each sieve should be closely inspected and discarded if it shows evidence of damage.

4.4 *Mechanical Sieving Machine*—The mechanical sieving machine shall be designed to provide both a circular motion and a tapping action. It shall be designed to accept an assembly of vertically nested circular sieves as described in 4.3. The machine action shall be such that results as described in Section 7 are obtained within the allotted time frame. Action shall not be sufficiently severe to generate new fines by particle degradation. To facilitate the sieving operation, a control switch device with timer is recommended. Other equipment designs may be used provided the results are comparable.

4.5 *Balance, Laboratory*—Approximately 1000-g capacity, sensitivity 0.1 g.

4.6 *Sampling Device (Storage System)*—An instrument (scoop, dipper, or other suitable device) for collecting increments that will constitute the total sample.

4.7 *Sampling Device (Direct-Fired System)*—Apparatus as described in 6.2.1 and 6.2.2.

4.8 *Sample Riffle with Pans*—A manual sample divider that splits the coal stream into a number of alternate elements. Riffle divisions should be in the size range from ¼ to ½ in. (6.4 to 12.7 mm).

**5. Sampling, Storage System**

5.1 In the pulverized coal storage system, the coal after pulverization is conveyed into bins.

5.1.1 *Collection of Gross Sample*—Collect not less than ten increments of representative pulverized coal preferably as it is being discharged from the collector. This is best accomplished by collecting increments of not less than 50 g at regular intervals by means of a scoop, dipper, or a device capable of removing an increment from a specific location within the stream of pulverized coal. Place the increments in the sample container and seal.

5.1.2 *Preparation of the Laboratory Sample*—A small riffle (Fig. 1) can be used for mixing and dividing the sample by splitting. An enclosed riffle is preferred. Mix the gross sample by splitting and recombining the halves a minimum of two times. Divide the sample amount by successive riffle splitting operations on one half of the sample until the sample is divided to approximately 500 g for the laboratory sample. To correctly use the riffle, the sample must be poured over the side of a pan (a third pan is necessary) and not from an end or corner, nor from a container such as, a pail or jar. Transfer the sample to a sample container and seal.

5.1.3 As an alternative to riffle mixing and splitting, the sample can be prepared as follows: Place the gross sample on a sheet of rubber, plastic, or paper and mix it by raising first one corner of the cloth and then the other so as to roll the coal over and over at least 20 times. After mixing, divide the sample. Continue the operations of mixing and dividing until the sample is divided sufficiently so that all of one of the divisions weighs approximately 500 g. This shall constitute the laboratory sample.

**6. Sampling, Direct-Fired System**

6.1 In the direct-fired system, the coal is pulverized and delivered directly to the furnace in an air stream. It is difficult

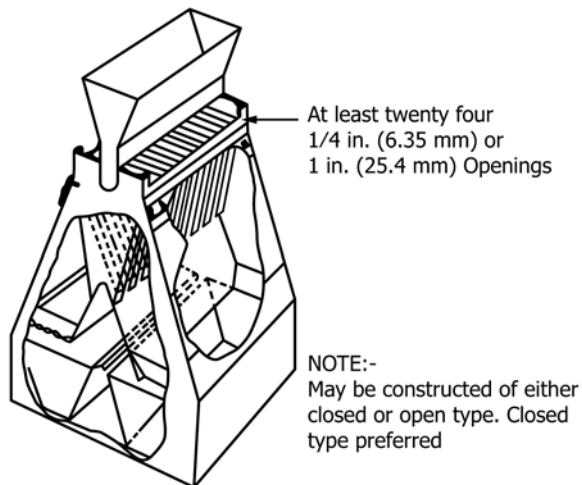


FIG. 1 Sample Divider (Riffle)

to obtain representative samples, as it is necessary to sample the coal from a moving stream of coal-air mixture inside the pipe between the pulverizer and furnace. It is preferable to collect such samples from vertical pipes, as in horizontal pipes a greater amount of segregation may take place.

6.2 *Apparatus for Sample Collection*—Because it is difficult to collect a representative sample of solids from a moving coal-air stream, it is essential that the equipment and sampling procedures are uniformly consistent to assure valid and reproducible results. Recommended equipment and sampling arrangements are shown in Fig. 2 and Fig. 3. Except in circumstances where stationary interferences in the area around the sampling location prohibits the use of the sampling equipment as shown in Fig. 3, changes to the equipment should not be allowed. Changes may produce inconsistent results.

6.2.1 Fig. 2 shows the recommended arrangement for sampling pulverized coal in a direct-fired system using a dustless sampling connection with an aspirator and a cyclone collector. In collecting the sample, turn on the compressed air to the dustless connection and adjust to give a balanced pressure at the connection. Insert the sampling tip into the dustless connection with the tip facing directly into the coal-air stream. Readjust the compressed air to give a balanced pressure with the nozzle inserted. Traverse the fuel transport line across the entire diameter of the pipe by moving at a uniform rate with the tip facing directly into the coal-air stream. The aspirating air on the cyclone collector may or may not be used, depending on the static pressure in the fuel transport line, as discussed in 6.3.7.

6.2.2 Fig. 3 shows detailed dimensions of a recommended sampling tip. The area of the tip shown is 0.5 by 0.95 in. or 0.475 in.<sup>2</sup> (12.7 by 24.1 mm or 306 mm<sup>2</sup>), which is the projected area of the tip facing the coal-air stream. Other tip configurations and dimensions can be employed provided they permit the collection of an unbiased sample from the coal stream. See Appendix X1.

6.3 *Collection of Gross Sample:*

6.3.1 In sampling, it is essential that the velocity into the sampling tip be nearly the same as the velocity in the pipe. If the velocity in the sampling tube is insufficient, the full quota of the coarse particles will be entrained, but some of the fine particles that should be caught will follow the air in passing around the tip. If the velocity in the sampling tube is greater, more than the proper number of fine particles will be drawn into the sampling tip.

6.3.2 A procedure for confirming sample validity is included in Appendix X4.

6.3.3 A sample obtained in a given time should be weighed and compared with the weight of coal passing through the fuel transport line. The weight of the coal passing through the pipe may be determined from the total coal to the pulverizer divided by number of pipes. The weight of coal passing through the fuel transport line, multiplied by the ratio of the cross-sectional area of the sampling tip to that of the pipe, should be approximately equal to the sample weight (see 6.3.9). For example, if a pulverizer has an output of 63 000 lb of coal per hour passing through six lines, and if each line is 15.25 in. (387 mm) in inside diameter, with a cross-sectional area of 182.65

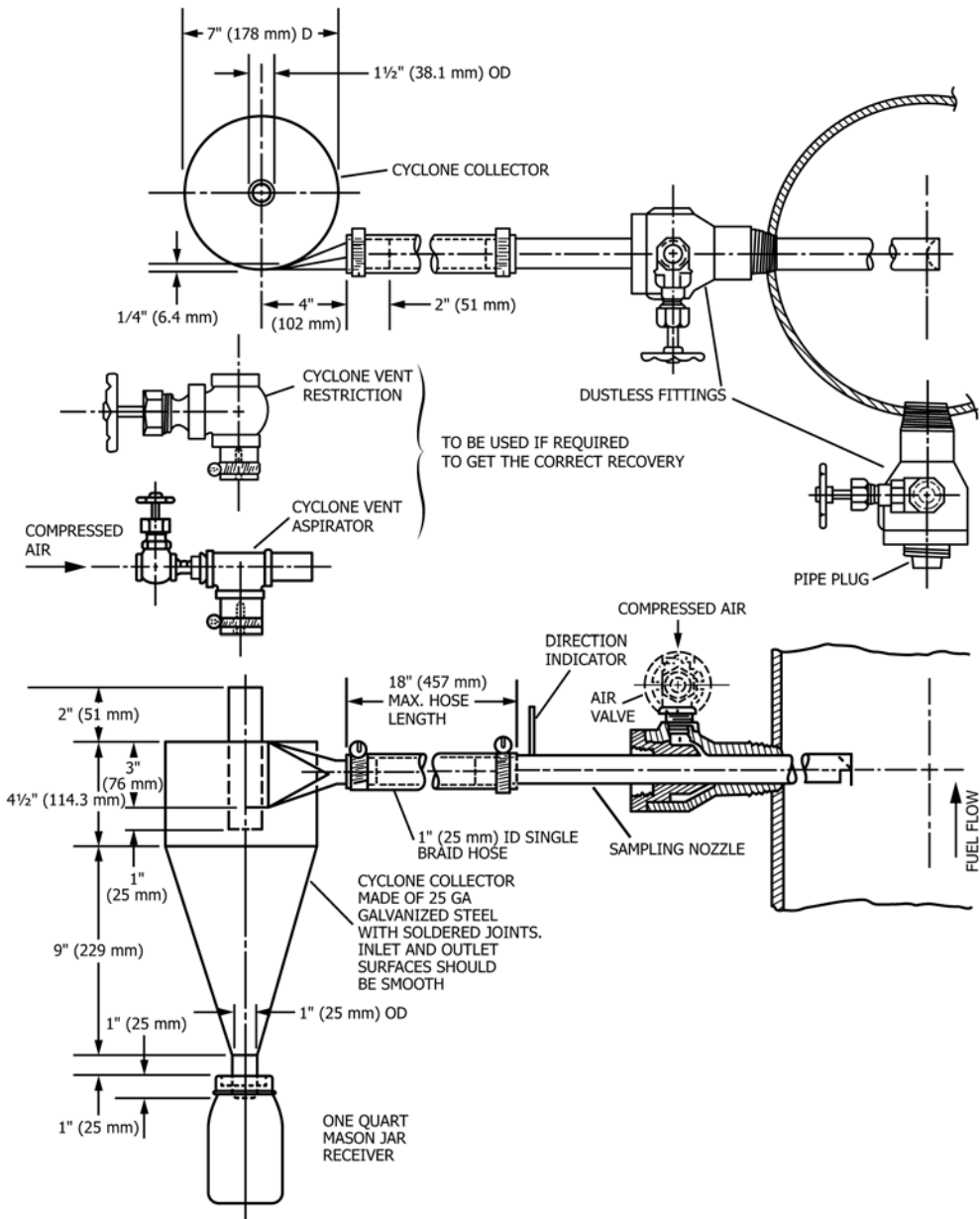


FIG. 2 Recommended Arrangement for Sampling Pulverized Coal in a Direct-Fired System

in.<sup>2</sup> (1170 cm<sup>2</sup>) and if the standard sampler has a tip opening of 0.5 by 0.95 in. (12.7 mm by 24.1 mm) and a cross-sectional area of 0.475 in.<sup>2</sup> (306 mm<sup>2</sup>), the sample rate per minute with 100 % recovery should then be as follows:

$$\text{Sample rate, lb/min} = 63\,000 \text{ lb/h-pulverizer} \times 1 \text{ h}/60 \text{ min} \times 1 \text{ pulverizer}/6 \text{ lines} \times 0.475 \text{ in.}^2/\text{sampler}/182.65 \text{ in.}^2/\text{line} \times 1 \text{ sampler}/1 \text{ line} = 0.455 \text{ lb/min-line} (206 \text{ g/min-line})$$

Sampling for a 3-min period should then be 1.37 lb (618 g) for 100 % recovery.

6.3.4 If the recovery is between 90 and 110 %, the sample shall be considered satisfactory as to collection rate for the pipe and flow velocities. See [Appendix X2](#).

6.3.5 After taking one or two samples and weighing them for confirmation, the collector vent control can be adjusted to

give a recovery within the 90 and 110 % limits. Discard those samples that do not meet the recovery limits.

6.3.6 If the static pressure in the fuel transport line is so high that the recovery is above 110 % with all aspirator air shut off, throttle the flow from the cyclone to reduce the recovery to the desired range between 90 and 110 %. This can be done by installing a valve or orifice at the cyclone collector vent discharge (see [Fig. 2](#)).

6.3.7 Samples shall be taken by carefully traversing at least two complete diameters 90° apart. Two common sampling methods are the continuous transversing technique or the equal area method. If preliminary samples taken at each individual line show wide variations in fineness and recovery, better

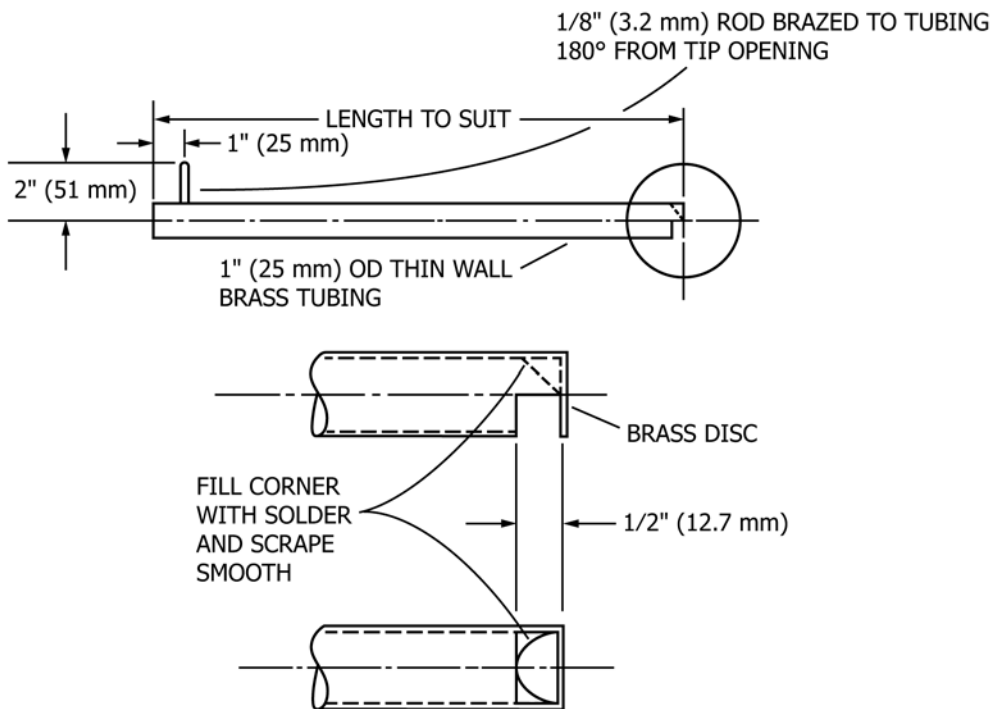


FIG. 3 Detail of Sampling Nozzle

locations should be used. The location shall preferably be in a vertical pipe as far as possible from preceding bends, changes of cross section, or valves. A distance of seven to ten times the pipe diameter is desirable. Sampling connections shall be cleared of accumulated coal before taking samples.

6.3.8 Precautions should be taken to keep the samples above the water dew point during collection.

6.3.9 When the sampling points are in the pipes and a pulverizer has two or more pipes, the total weight of the samples from all the pipes should be compared with total coal weight to check the recovery, as explained in 6.3.2 - 6.3.4.

6.3.10 When the air velocity and static pressure in each fuel transport line are nearly equal, the same cyclone throttle setting and the same air pressure at the aspirator should give about the same sample tip velocity. Then, even if the coal is not equally distributed in the several pipes, duplicate cyclone throttle settings should result in samples from each pipe that will be approximately proportional in weight to the coal distribution, but the total should be between 90 and 110 % of the proportional total coal flow. Samples at each point should be taken for equal time periods and not by equal amounts collected. Each sample may be sieved separately and the weighted average used to obtain the average fineness of the pulverizer output or the samples may be thoroughly mixed and one sieve determination made of the mixture, since the sample from each line represents the proper proportion of the pulverizer output.

6.3.11 In storage systems, take samples at the outlet of the cyclone collector. If the sampling location is under suction, provide the container with a cover that can be closed before it is withdrawn from the sampling connection.

6.3.12 The fineness of pulverized coal samples taken in a storage system shall be either the weighted average of the

fineness of all samples taken during the test or the fineness of the composite sample.

NOTE 1—The collection of a valid representative sample requires both properly maintained equipment and close attention to details by the samplers. The collection is best accomplished by one person actually sampling, assisted by a person to facilitate equipment and sample handling.

## 7. Fineness Test

7.1 *Drying Sample*—Air-dry the entire laboratory sample in a drying oven at 18 to 27°F (10 to 15°C) above room temperature. Continue the drying until the loss in weight is not more than 0.1 %/h.

7.2 *Dividing the Sample*—After air-drying, divide the sample amount to 50 to 100 g as described in 5.1.2 and 5.1.3.

### 7.3 Sieve Test:

7.3.1 Select the proper sieve sizes for the test and thoroughly clean each by carefully brushing and tapping to assure that no solid particles from previous tests are trapped in the meshes. Nest the sieves together with the coarsest mesh at the top and in descending order with the finest mesh at the bottom. Set a pan receiver at the bottom of the nest to receive the undersize. Place 45 to 55 g of coal weighed to ±0.05 g on the top sieve and cover with a fitted cover to prevent loss.

7.3.2 Place the assembled set into the sieving machine and make the necessary adjustments for the sieving operation. Adjust the timer for a 10-min period and start the machine. For hand sieving alternative, see Appendix X3.

7.3.3 At the end of the sieving period, remove the stack, slip off the receiver pan, and carefully brush into the pan receiver any particles that have adhered to the bottom surface of the



bottom sieve. Carefully transfer all of the pan contents into another receptacle and return the clean pan receiver to the bottom of stacker sieves. Retain the transferred fines for weighing.

7.3.4 Return the stacked sieves to the sieving machine, set the timer for a 5-min period, and start the machine. At the end of this interval, remove the stack and repeat the procedure described in 7.3.3. However, this time collect the fines from the pan receiver and those brushed from the under-surface of the sieve and weigh. When the collected fines from the 5-min sieving weigh less than 0.5 g, consider the sieving operation complete. If the fines weigh in excess of 0.5 g, reassemble the stack and repeat the sieving operation at 2-min intervals until less than 0.2 g of fines are collected for a 2-min interval.

7.3.5 Combine the fines collected in all of the operations from 7.3.3 and 7.3.4 and weigh on a balance sensitive to 0.01 g. Disassemble the sieves beginning with the largest. Material that can be brushed from the bottom of a sieve shall be considered to be part of the sample that has passed through that sieve. This material can be brushed directly onto the next finer sieve. Material that is lodged in the sieve shall be considered a portion of the sample that was retained on that sieve. The sieve can be placed over glazed paper, foil, or a pie pan and lodged material brought onto that surface and then recombined with the material retained on that sieve.

NOTE 2—The procedure described in 7.3.4 and 7.3.5 is applicable to samples from a normal dry-pulverizing process. If, for whatever reason, the sample consists of a major percentage concentrated on an intermediate size interval, sieving operations should be continued until it is confirmed that less than 0.2 g of fines pass that sieve in a 2-min interval.

7.3.6 Weigh and record the amount of material collected from each sieve surface, including the undersize material.

## 8. Calculations

8.1 Calculate the fineness from the weights of the residues on the sieves, including the undersize from the finest sieve, and express as percentages of the weight of the original sample. A difference between the original sample portion and cumulative sieve weights is considered to be due to loss (or gain) of the

undersize material and is so calculated. If the loss is greater than 1 % for coals having 75 % or less undersize or is greater than 2 % for coals having more than 75 % undersize, discard the results and repeat the determination.

NOTE 3—An operator working at a site with a particular coal may ascertain that in routine operations, differences in sample weights before and after sieving are within such close tolerances that he may choose not to weigh the undersize material. It should be recognized that results so obtained are subject to question.

## 9. Report

9.1 The fineness test shall be reported as follows:

Retained on USA Standard	Passing USA Standard	%
No. 8 (2.36 mm)	...	...
No. 16 (1.18 mm)	No. 8 (2.36 mm)	...
No. 30 (600 μm)	No. 16 (1.18 mm)	...
No. 50 (300 μm)	No. 30 (600 μm)	...
No. 100 (150 μm)	No. 50 (300 μm)	...
No. 200 (75 μm)	No. 100 (150 μm)	...
No. 325 (45 μm)	No. 200 (75 μm)	...
...	No. 325 (45 μm)	...

For procedure to confirm sample validity, see [Appendix X4](#) (See [Fig. 4](#)).

## 10. Precision and Bias

10.1 *Repeatability*—Duplicate determinations on splits of the gross sample, by the same operator, using the same sieves, shall check within 2 % of the material weight passing the finest sieve.

10.2 *Reproducibility*—Duplicate determinations on splits of the gross sample, by different operators, using different sieves, shall check within 4 % of the material weight passing the finest sieve.

10.3 *Bias*—The lack of a reference material precludes a bias statement.

## 11. Keywords

11.1 fineness; pulverized coal; sampling; sieve analysis

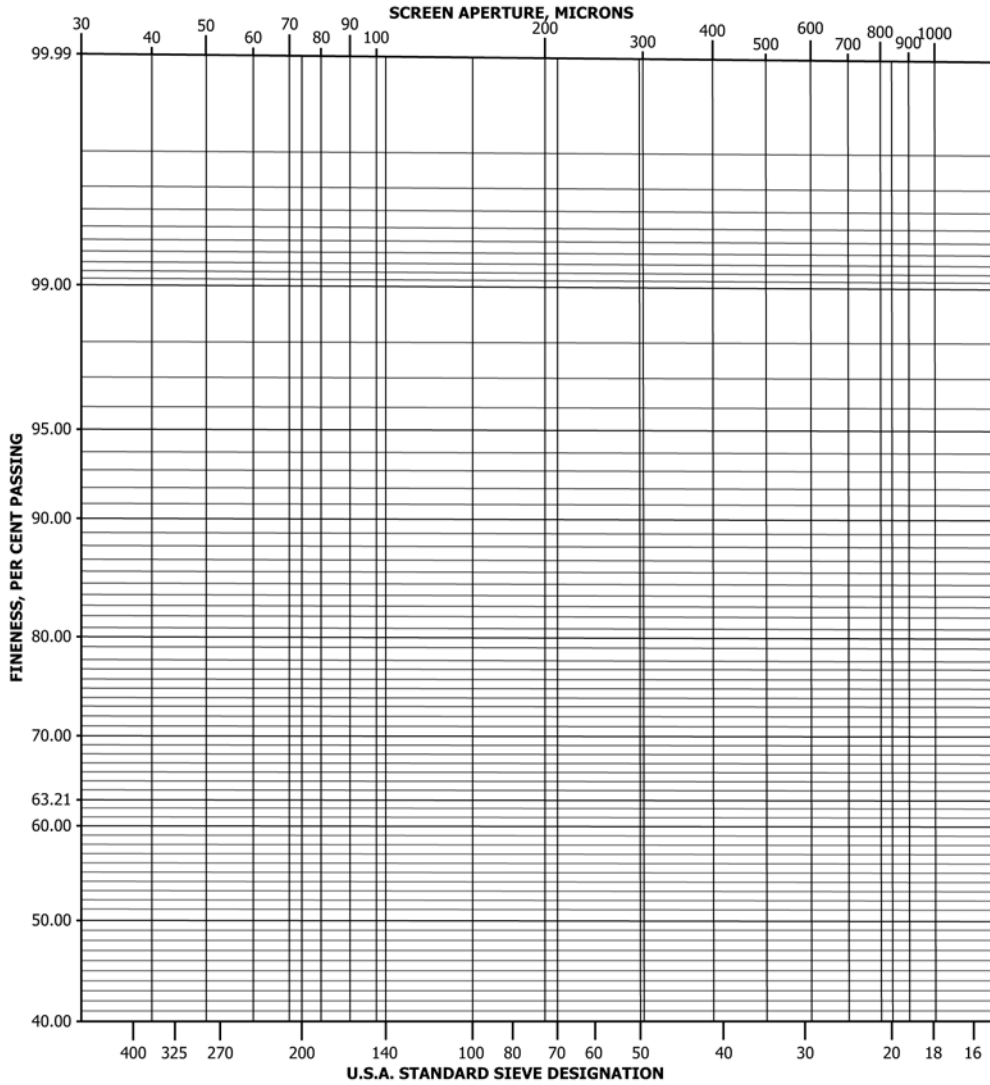


FIG. 4 Plot of Rosin and Rammler Equation for Use with Pulverized Coal

APPENDIXES

(Nonmandatory Information)

X1. ALTERNATE TIP CONFIGURATIONS

X1.1 If tip configurations other than illustrated in Figs. 2 and 3 are used, their ability to permit the collection of an unbiased sample shall be evaluated on the basis of sample

fineness matching that obtained with the recommended tip design within the limits of reproducibility identified in 10.2.

## **X2. EXTREME MALDISTRIBUTION**

X2.1 If extreme maldistribution of coal exists among fuel pipes, it may not be possible to obtain a recovery rate of 90 to

110 % in each line. In this case, use the procedure in 6.3.9 to verify the recovery rate.

## **X3. FINENESS TEST BY HAND SIEVING**

X3.1 For field testing or similar operations where a sieving machine is not available, the test can be performed by a hand-sieving operation. The object of the hand-sieving operation is to duplicate as nearly as possible the details of test as performed by mechanical sieving. This can be accomplished as described below.

X3.2 Prepare the sieves and the sample amount as described in 7.1, 7.2, and 7.3.1, with the exception of placing the nest of

sieves into a sieving machine.

X3.3 Instead, hold the nest of sieves with both hands and move back and forth in a slightly circular orbit while resting on a ¼-in. (6.4-mm) plate (suggested dimensions 4 by 12 in. (100 × 300 mm)). With each movement, the stack is permitted to move over the plate edge and tap the table surface. The above-described manual movement is designed to simulate the rotation and tapping of machine sieving (see 4.4).

## **X4. PROCEDURE FOR CONFIRMING SAMPLE VALIDITY**

X4.1 Rosin and Rammler chart paper (Fig. 4) may be used to confirm the validity of sampling. Fineness results plotted on the chart paper should approach a straight line with possibly a slight deviation at the extremes. Consistency in sampling

techniques is verified when duplicate results are confirmed by duplication of the curve. Wide deviations from a straight-line plot should be investigated to confirm reasons for the deviation.

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; http://www.copyright.com/*