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Standard Test Method for Drop Shatter Test for Coke[1]

This standard is issued under the fixed designation D3038; 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 application of two procedures for the determination of the property of coke of withstanding breakage when dropped under specified test conditions.

1.2 *Procedure A,* used when the coke sample contains 50 % or less of 100 mm (4 in.) after removal of coke smaller than 50 mm (2 in.). Procedure A appears in Sections 6 – 9.

1.3 *Procedure B,* used when the coke sample contains *more* than 50 % 100 mm (4 in.) after removal of coke smaller than 50 mm (2 in.). Procedure B appears in Sections 10 – 13.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.5 *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:*[2]

D121 Terminology of Coal and Coke

D293 Test Method for the Sieve Analysis of Coke

D346 Practice for Collection and Preparation of Coke Samples for Laboratory Analysis

D4621 Guide for Quality Management in an Organization That Samples or Tests Coal and Coke (Withdrawn 2010)[3]

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E323 Specification for Perforated-Plate Sieves for Testing Purposes

3. Significance and Use

3.1 The values determined in this test, when evaluated in terms of pertinent experience with other cokes, may be used as indications of the extent to which a given coke will break in conventional transit and handling beyond the point of sampling.

4. Apparatus

4.1 *Shatter Apparatus,* including (*1*) box, (*2*) base plate, (*3*) support frame, (*4*) containers, (*5*) sieves, and (*6*) weighing scales (see Fig. 1).

4.1.1 *Box,* 455 mm (18 in.) in width, 710 mm (28 in.) in length, and 380 mm (15 in.) in depth. The bottom of the box shall consist of two doors, hinged lengthwise and provided with a trip latch for rapid opening. The doors are of 6-mm (¼-in.) plate and are mounted on freely working hinges so that they swing open rapidly and do not impede the fall of the coke. The sides of the box are made of plate at least 3 mm (⅛ in.) thick.

4.1.2 *Base Plate*—Steel plate, 1.22 m (48 in.) in length, 965 mm (38 in.) in width, and not less than 13 mm (½ in.) thick. Vertical plates at least 200 mm (8 in.) high are placed on all four sides to form a shallow box and to prevent loss of coke during the test. The back plate and side plates are rigidly fixed while the front plate is made removable to facilitate shovelling the coke from the base plate into the box after each drop. It is important that the base plate be supported rigidly.

NOTE 1—Mounting the base plate solidly on concrete is satisfactory.

4.1.3 *Support Frame*—A support frame and other appropriate mechanism are provided so the box may be readily raised and lowered to fixed or reproducible upper and lower positions. No part of the supporting frame is to impede the free fall of coke nor protrude into the 1.22- by 0.965-m (48- by 38-in.) area of the base plate. When in the upper position, the inside surface of the bottom of the box must be 1.83 m (6 ft) above the plate. The lower position shall be one convenient for loading and reloading the box without breakage of coke. The box may be constrained to only vertical movement by suitable lateral guides and may be conveniently supported by wire rope passing over pulleys. Counterweighting will reduce labor.

4.1.4 *Containers*—Conventional galvanized-iron tubs are convenient containers in which to collect and weigh coke in the various stages of the test.

[1] This test method is under the jurisdiction of ASTM Committee D05 on Coal and Coke and is the direct responsibility of Subcommittee D05.15 on Metallurgical Properties of Coal and Coke.

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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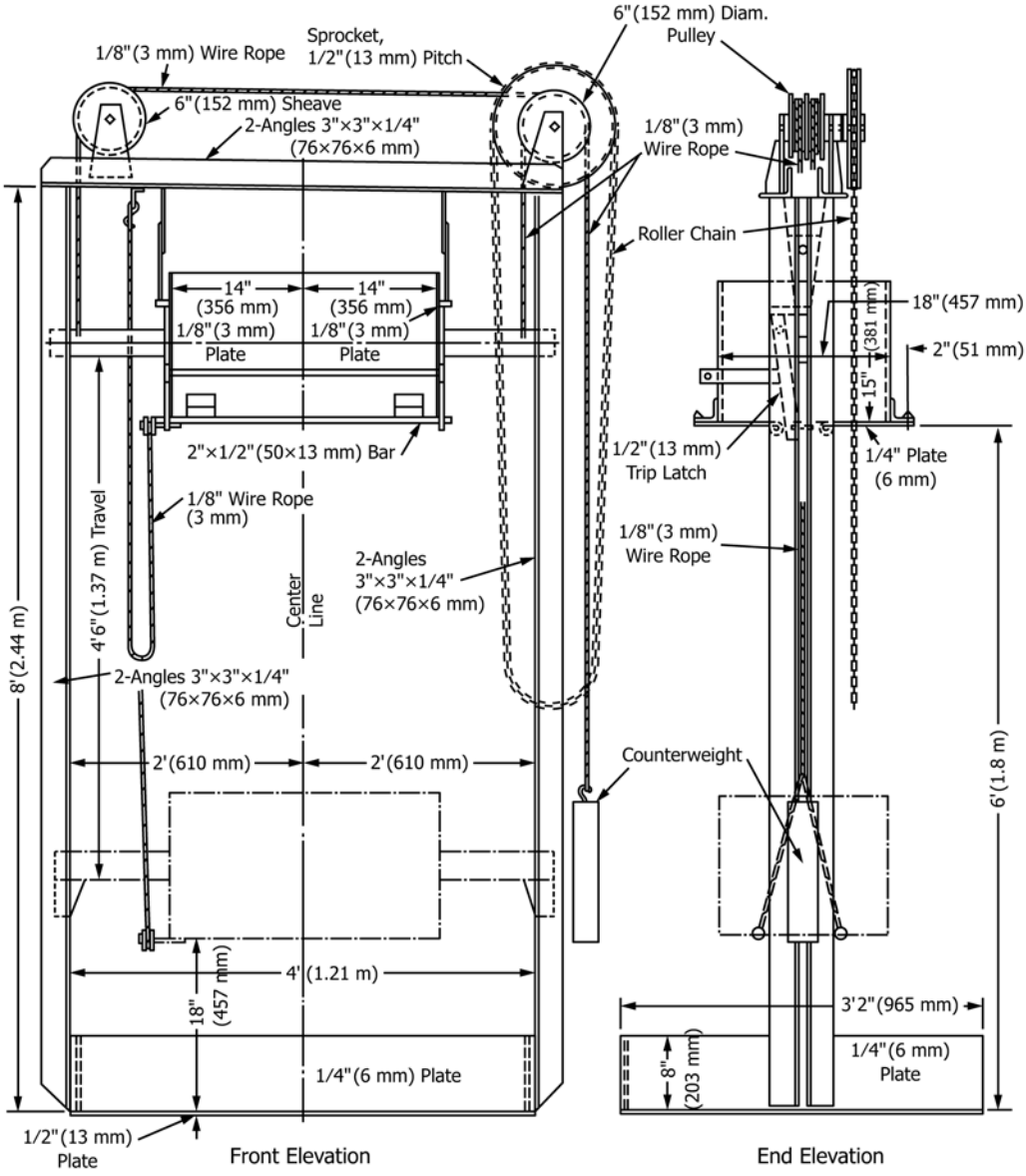

FIG. 1 Shatter Test Machine

4.1.5 *Sieves*—Woven-wire square-mesh sieves of the following sizes: 150 mm (6 in.), 125 mm (5 in.), 100 mm (4 in.), 75 mm (3 in.), 50 mm (2 in.), 37.5 mm (1½ in.), 25 mm (1 in.), and 12.5 mm (½ in.). The sieves must conform to Specification E11.

NOTE 2—The 150-mm (6-in.) and the 125-mm (5-in.) sieves are not defined in Specifications E11 but shall have nominal wire diameters of 7.11 mm (0.2800 in.) and 6.73 mm (0.2650 in.), respectively, and have permissible variations in average opening, permissible variations for not more than 5 % of openings, and maximum variation in individual openings equivalent to that specified for the 100-mm (4-in.) sieve.

NOTE 3—For Procedure A, in which the coke samples do not contain more than 50 % plus 100-mm (4-in.) sizes, the 150-mm (6-in.), 125-mm (5-in.), and 100-mm (4-in.) sieves may be excluded. For Procedure B, in which the coke samples contain more than 50 % plus 100-mm (4-in.) sizes, it is permissible to exclude the 37.5-mm (1½-in.), 25-mm (1-in.), and the 12.5-mm (½-in.) sieves.

4.1.6 *Weighing Scale*—For Procedure A, a scale having a capacity of 35 kg (75 lb) is to be provided and be graduated so that it may be read directly, without interpolation, to 0.05 kg (0.1 lb). The sensitivity is to be not less than 0.025 kg (0.05 lb).

4.1.6.1 For Procedure B, this scale is to have a capacity of 60 kg (125 lb) graduated to 0.1 kg (0.2 lb) and have a sensitivity not less than 0.05 kg (0.10 lb).

5. Sampling

5.1 The gross sample of coke must be taken as close as possible to the point of interest, include all sizes, and be collected in such a way as to be representative of the total lot or quantity in question, in accordance with Practice D346.

5.2 For Procedure A, the minimum size of the gross sample must be such as to yield 68 to 75 kg (150 to 165 lb) of coke

retained on 50-mm (2-in.) sieve when processed according to the procedure set forth in Section 7.

5.2.1 For Procedure B, this sample must be such as to yield at least 140 kg (300 lb) of coke retained on 75-mm (3-in.) sieve when processed in accordance with the procedure set forth in Section 11.

5.2.2 If experience shows that more than three tests are usually necessary, the quantity of gross sample will need to be increased appropriately.

5.3 The gross sample is to be assembled from increments regularly and systematically collected, so that the entire quantity of coke sampled will be represented proportionately in the gross sample, and with such frequency that a gross sample of at least the minimum required amount is collected.

5.4 Increments may be collected from a stopped conveyor belt or by interposing a collecting container into a moving stream while the coke is being loaded or unloaded or otherwise transported. The increment collected from a stopped belt must be all the coke on the belt between parallel planes separated by a distance 2.5 times the nominal top size of the coke. In the same way, when collecting from a moving stream, the collecting container must be as wide as the stream, or be moved uniformly through its whole width and have a mouth opening 2.5 times the nominal top size of the coke. The nominal top size, for this method, is that nearest standard sieve for which about 5 % of the coke is oversize.

5.5 Samples collected from the surface of coke in piles, bins, cars, ships, or barges, are in general unreliable because of size segregation and should not be used for determining conformance to specifications unless the purchaser and the seller so agree. As it may be very difficult to collect a representative sample from coke exposed in bins and cars, care must be taken to collect increments representing the entire exposed area, if sampling must be done in this manner. This is best accomplished by dividing the exposed surface to be sampled into approximately equal areas and collecting an increment from each area.

PROCEDURE A—COKE SAMPLE CONTAINING 50 % 100 mm (4 in.) OR LESS

6. Summary of Method

6.1 A test sample is prepared by removing and discarding the coke smaller than 50 mm (2 in.) from a representative gross sample. The test sample, approximately 23 to 25 kg (50 to 55 lb) is dropped four times from a height of 1.83 m (6 ft) onto a rigid steel plate. The shattered coke is sieved. The resistance to breakage is judged from the cumulative percentages of coke that remain, after the test, on sieves of various sizes.

7. Preparation of Test Samples

7.1 The coke used for the shatter test is only that portion which is over 50 mm (2 in.) in size, but the distribution of sizes in the portion tested is to be in the same proportions as in the plus 50-mm (2-in.) part of the gross sample as found in a preliminary size analysis to which the whole of the gross sample is subjected.

7.2 This preliminary size analysis is carried out, mainly, by hand placing, a process in which each piece of coke is handled and counted as undersize if it will, in some position and without forcing, pass through the sieve. Proceeding in this way, and taking care in all operations to avoid breakage, separate the gross sample into the following fractions which are segregated appropriately in tubs:

Passing	Retained on	Percent
	100-mm (4-in.) sieve	
100-mm (4-in.) sieve	75-mm (3-in) sieve	
75-mm (3-in.) sieve	50-mm (2-in.) sieve	
50-mm (2-in.) sieve		

7.3 Make appropriate weighings so that the percentage of each size in the portion of the original gross sample retained on a 50.8-mm (2-in.) sieve can be calculated.

7.4 Reconstitute each sample for testing, 23 to 25 kg (50 to 55 lb), from the segregated sizes above 50 mm (2 in.). Select pieces at random from the total amount of each size, the quantity of each size fraction taken being based on the data of the preliminary size analysis.

7.5 If the coke contains 5 % of moisture or less, test the sample as is. Wetter coke is to be dried to 5 % or less before testing.

8. Procedure

8.1 Weigh 23 to 25 kg (50 to 55 lb) of the prepared reconstituted sample to the nearest 0.05 kg (0.1 lb). Transfer the coke carefully into the box of the shatter test apparatus by either inserting the container into the box and allowing the coke to slide out or by removing the coke and placing it into the box by hand. Do not empty the container by tipping out the contents.

8.2 Raise the box to the standard height and allow the coke to fall onto the base plate. Lower the box to the lower position, drop the front plate, and shovel the coke from the base plate into the box, taking care to place the coke into the box without much dropping. Return the whole of the coke over about 12.5 mm (½ in.) in size from the base plate to the box; this can be done using the shovel, without sweeping at this stage. Repeat the process until four drops in all have been carried out. Some form of indicator is helpful for counting the number of drops to avoid error. Collect all the shattered coke into a container, sweeping up all the fine material and determine the weight. If the weight loss is more than 0.10 kg (0.2 lb), reject the test at this stage.

8.3 Carry out a sieve analysis on the shattered coke in accordance with Test Method D293. The sieves to be used are

75 mm (3 in.), 50 mm (2 in.), 37.5 mm (1½ in.), 25 mm (1 in.), and 12.5 mm (½ in.).

9. Report

9.1 Report the results of each individual shatter test as follows:

Retained on	Percent Cumulative
75-mm (3-in.) sieve	_____
50-mm (2-in.) sieve	_____
37.5-mm (1½-in.) sieve	_____
25-mm (1-in.) sieve	_____
12.5-mm (½-in.) sieve	_____

9.1.1 In case the sum of the percentages does not total 100.0, correct the quantity passing through the smallest sieve so that the total will be 100.0.

9.2 Conduct three tests on each sample. If the range of values of the 50-mm (2-in.) shatter index does not exceed 5.0 units, average the three results and report the arithmetic mean. If the range does exceed 5.0 units, make one or more further tests until three values are obtained that do so agree. After carrying out one extra test, thus making a total of four tests, it may sometimes be found that either of two results can be rejected by the above rule, one at a time, to leave two alternative sets of three results that agree to within the stated limits. In this case, none of the results are rejected and all four should be averaged in the calculation of the means.

PROCEDURE B—COKE SAMPLE CONTAINING MORE THAN 50 % 100 mm (4 in.)

10. Summary of Method

10.1 A test sample is prepared by removing and discarding the coke smaller than 75 mm (3 in.) from a representative gross sample. The test sample, approximately 40 to 45 kg (90 to 100 lb) is dropped four times from a height of 1.83 m (6 ft) onto a rigid steel plate. The shattered coke is sieved. The resistance to breakage is judged from the cumulative percentages of coke that remain, after the test, on sieves of various sizes.

11. Preparation of Test Samples

11.1 The coke used for the shatter test is only that portion which is over 75 mm (3 in.) in size, but the distribution of sizes in the portion tested is to be in the same proportions as in the plus 75-mm (3-in.) part of the gross sample as found in a preliminary size analysis to which the whole of the gross sample is subjected.

11.2 This preliminary size analysis is carried out, mainly, by hand placing, a process in which each piece of coke is handled and counted as undersize if it will, in some position and without forcing, pass through the sieve. Proceeding in this way, and taking care in all operations to avoid breakage, separate the gross sample into the following fractions which are segregated appropriately in tubes:

Passing	Retained on	Percent
_____	150-mm (6-in.) sieve	_____
150-mm (6-in.) sieve	125-mm (5-in.) sieve	_____
125-mm (5-in.) sieve	100-mm (4-in.) sieve	_____
100-mm (4-in.) sieve	75-mm (3-in.) sieve	_____
75-mm (3-in.) sieve		

11.3 Make appropriate weighings so that the percentage of each size in the portion of the original gross sample retained on a 75-mm (3-in.) sieve can be calculated.

11.4 Reconstitute each sample for testing, 40 to 45 kg (90 to 100 lb), from the segregated sizes above 75 mm (3 in.). Select pieces at random from the total amount of each size, the quantity of each size fraction taken being based on the data of the preliminary size analysis.

11.5 If the coke contains 5 % of moisture or less, test the sample as is. Wetter coke is to be dried to 5 % or less before testing.

12. Procedure

12.1 Weigh 40 to 45 kg (90 to 100 lb) of the prepared reconstituted sample to the nearest 0.1 kg (0.2 lb). Transfer the coke carefully into the box of the shatter test apparatus by either inserting the container into the box and allowing the coke to slide out or by removing the coke and placing it into the box by hand. Do not empty the container by tipping out the contents.

12.2 Raise the box to the standard height and allow the coke to fall onto the base plate. Lower the box to the lower position, drop the front plate, and shovel the coke from the base plate into the box, taking care to place the coke into the box without much dropping. Return the whole of the coke over about 12.5 mm (½ in.) in size from the base plate to the box; this can be done using the shovel, without sweeping at this stage. Repeat the process until four drops in all have been carried out. Some form of indicator is helpful for counting the number of drops to avoid error. Collect all the shattered coke into a container, sweeping up all the fine material and determine the weight. If the weight loss is more than 0.10 kg (0.2 lb), reject the test at this stage.

12.3 Carry out a sieve analysis on the shattered coke in accordance with Test Method D293. The sieves to be used are 100 mm (4 in.), 75 mm (3 in.), and 50 mm (2 in.).

13. Report

13.1 Report the results of each individual shatter test as follows:

Retained on	Percent Cumulative
100-mm (4-in.) sieve	_____
75-mm (3-in.) sieve	_____
50-mm (2-in.) sieve	_____

13.1.1 Distribute any losses incurred during sieving more or less uniformly over the various fractions.

13.2 Conduct three tests on each sample. If the range of values of the 76.1-mm (3-in.) shatter index does not exceed 5.0 units, average the three results and report the arithmetic mean. If the range does exceed 5.0 units, make one or more further tests until three values are obtained that do so agree. After carrying out one extra test, thus making a total of four tests, it may sometimes be found that either of two results can be rejected by the above rule, one at a time, to leave two alternative sets of three results that agree to within the stated limits. In this case, none of the results are rejected, and all four should be averaged in the calculation of the means.

13.3 In case a certain special size, such as full-length pieces or a double-screened fraction, is tested, the results shall be so identified by a suitable note.

14. Precision and Bias

14.1 *Reproducibility*—No precision statement has been developed for this test method because of the impracticality of obtaining, transporting, and handling representative splits of the materials in the quantities that would be needed to establish the precision statement.

14.2 *Repeatability*—The precision of this test method is being investigated by a task group. At this time the values have not been determined.

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

15. Keywords

15.1 breakage; coke; drop shatter

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