



Standard Test Method for Carbon Black—Automated Individual Pellet Hardness¹

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1. Scope

1.1 This test method covers a procedure for measuring individual pellet hardness of carbon black by the automated pellet hardness tester.²

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

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:³

D1511 Test Method for Carbon Black—Pellet Size Distribution

D1799 Practice for Carbon Black—Sampling Packaged Shipments

D1900 Practice for Carbon Black—Sampling Bulk Shipments

D4483 Practice for Evaluating Precision for Test Method Standards in the Rubber and Carbon Black Manufacturing Industries

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

¹ This test method is under the jurisdiction of ASTM Committee D24 on Carbon Black and is the direct responsibility of Subcommittee D24.51 on Carbon Black Pellet Properties.

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² The sole source of supply of the Concarb Titan Automated Pellet Hardness Tester known to the committee at this time is Jaron Technologies LLC, 2338 Duncan, Pampa, TX 79065, E-mail: <http://www.jarontech.com>. The HITEC IPHT is available from HITEC Luxembourg, 5 rue de L' Eglise, L-1458, Luxembourg, E-mail: info@hitec.lu, <http://www.hitec.lu/>. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

³ 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. Summary of Test Method

3.1 A sample of carbon black is passed through two sieves to isolate a fraction of uniform size. An appropriate amount of pellets from this portion is selected and placed into the tester. The individual pellets are pressed against a platen with a load cell for measuring force. As pressure is applied the pellet will either break with a rapid force reduction or the pellet will simply compress. The individual pellet hardness is the maximum force prior to a force reduction of at least 3 cN or the maximum force required to compress the pellet to 90 %, whichever comes first.

4. Significance and Use

4.1 Individual pellet hardness is related to several carbon black characteristics. Among these are mass strength and attrition. The subsequent level of dispersion obtained in some mixed compounds containing the carbon black may be affected by pellet hardness. Acceptable pellet hardness must be agreed to by the user and the producer.

5. Apparatus

5.1 *Automated Pellet Hardness Tester*,² capable of achieving an absolute measuring accuracy of ± 2 cN (2 gf) for the force measurement and ± 0.1 mm for the diameter measurement and a relative accuracy of ± 0.5 cN (0.5 gf) for the force measurement and 0.02 mm for the diameter measurement and consisting of the following major components and characteristics.

5.1.1 A means for automatic loading of a pellet on the transport platen for transporting the pellet so as to contact the second platen with a minimum force. Typically one platen contains a force measuring device. The required force to detect the contact shall not exceed 2 cN (2 gf),

5.1.2 A means for applying the force at a constant rate,

5.1.3 A means for transporting the pellet so to minimize its movement during the application of force.

5.1.4 A means for measuring the diameter of the individual pellet under test as measured along the axis of the application of force.

5.1.5 A control device for directing the instrument through the test cycle that includes crushing the pellet under controlled conditions, measuring and storing the results of the initial diameter and crush force determinations, cleaning the fragments from the platen surfaces, and starting the next cycle.

5.1.6 An algorithm for determining the individual test end point (determination) as the maximum observed force prior to the first occurrence of either a specified reduction in diameter or a specified reduction in force from the maximum force observed,

5.1.7 A program for calculating for a specified number of pellets the data as requested in Section 9, and

5.1.8 A means for identifying, viewing, printing, and storing the data in an ASCII file.

5.2 *Mechanical Sieve Shaker*, conforming to Test Method **D1511**.

5.3 *Sieves*, U.S. Standard No. 12 (1700 μm) and No. 14 (1400 μm) conforming to Specification **E11** shall be used to test grades of black that can be segregated in a $-12/+14$ fraction. For grades of black that are too small to be retained on a No. 14 sieve, i.e., acetylene and thermal blacks, it is acceptable to test with U.S. Standard No. 16 (1180 μm) and No. 18 (1000 μm) sieves.

5.4 *Bottom-Receiver Pan and Top-Sieve Cover*.

6. Sampling

6.1 Take samples in accordance with Practice **D1799** or Practice **D1900**.

7. Calibration

7.1 Calibrate force and diameter measurement following the manufacturer's instructions.

7.2 Instrument Parameters:

7.2.1 Crush diameter, 0.90. A reduction of the pellet diameter to 90 % of the original value is one of two end point criteria.

7.2.2 Force drop. A decrease of 3 cN (3gf) from the maximum force observed is one of two end point criteria.

7.2.3 Rate of piston movement during crush, 0.125 mm/s.

7.2.4 Number of pellets tested; normal applications, 20 pellets, critical applications, 50 pellets. Critical applications are determined by agreement between customer and supplier.

7.2.5 The following ranges of acceptable pellet diameters were established to minimize the number of pellets rejected due to instrument variation and non-spherical pellets.

7.2.5.1 For a $-12/+14$ fraction, 1.31–1.93 mm.

7.2.5.2 For a $-16/+18$ fraction, 0.80–1.44 mm.

8. Procedure

8.1 Prepare a sample of carbon black as follows:

8.1.1 Stack the sieves in the following order from bottom to top: bottom receiver pan, No. 14, and No. 12.

NOTE 1—It is permissible to use multiples of sieve stacks to screen several samples simultaneously.

8.1.2 Stack the No. 12 above the No. 14 sieve, or to test smaller pellet blacks, stack the No. 16 above the No. 18 sieve with the receiver pan on the bottom.

8.1.3 Transfer the sample to the No. 12 screen, install the cover and transfer the assembly to the mechanical shaker.

8.1.4 Allow the sieve assembly to shake for 60 s with the hammer operating.

8.2 Remove the assembly from the shaking device. Select a sufficiently large sample from the pellets retained on the bottom sieve. The sample size required for testing depends on the apparatus that is used.

8.3 Conduct the test following the instructions in the equipment operation manual.

9. Report

9.1 Report the following information:

9.1.1 Proper identification of the sample,

9.1.2 Average value in centinewtons (gram force) rounded to the nearest millinewton (nearest 0.1 g force),

9.1.3 Maximum value in centinewtons (gram force) rounded to a whole number

9.1.4 Number of pellets tested, and

9.1.5 Size of sieves used to prepare the sample.

10. Precision and Bias

10.1 These precision statements have been prepared in accordance with Practice **D4483**. Refer to this practice for terminology and other statistical details.

10.2 The precision results in this precision and bias section give an estimate of the precision of this test method with the materials used in the particular interlaboratory program described below. The precision parameters should not be used for acceptance or rejection testing of any group of materials without documentation that they are applicable to those particular materials and the specific testing protocols of the test method. Any appropriate value may be used from **Table 1**.

10.3 A type 1 inter-laboratory precision program was conducted as detailed in **Table 2**. Both repeatability and reproducibility represent short term (daily) testing conditions. The testing was performed using two operators in each laboratory performing the test once on each of two days (total of four tests). A test result is the average of all the individual pellet hardness values obtained in a single determination. Acceptable difference values were not measured. The between operator component of variation is included in the calculated values for r and R .

10.4 The results of the precision calculations for this test are given in **Table 1**. The materials are arranged in ascending "mean level" order.

10.5 *Repeatability*—The pooled relative repeatability, (r), of this test has been established as 5 %. Any other value in **Table 1** may be used as an estimate of repeatability, as appropriate.

TABLE 1 Precision Parameters for D5230 Automated Individual Pellet Hardness, (Type 1 Precision)

Units	cN (gf)	Within Laboratory		Between Laboratory	
		Sr	(r)	SR	(R)
Material	Mean Level				
N650	23	2	5	4	13
SRB D4 (N762)	24	2	5	6	16
IRB#6 (N330)	30	2	6	4	13
SRB A5 (N135)	31	2	5	5	13
N550	32	2	6	5	15
Average	28				
Pooled Values		2	5	5	14

TABLE 2 Interlaboratory Precision Program

Nominal Test Period	Material	Number of Laboratories
March 1996	N650	50
October 1996	IRB#6 (N330)	39
March 1997	SRB D4 (N762)	46
September 1997	SRB A5 (N135)	41
March 1998	N550	46

The difference between two single test results (or determinations) found on identical test material under the repeatability conditions prescribed for this test will exceed the repeatability on an average of not more than once in 20 cases in the normal and correct operation of the method. Two single test results that differ by more than the appropriate value from **Table 1** must be suspected of being from different populations and some appropriate action taken.

NOTE 2—Appropriate action may be an investigation of the test method procedure or apparatus for faulty operation or the declaration of a significant difference in the two materials, samples, etc., which generated the two test results.

10.6 Reproducibility—The pooled relative reproducibility, (R), of this test has been established as 14 %. Any other value

in **Table 1** may be used as an estimate of reproducibility, as appropriate. The difference between two single and independent test results found by two operators working under the prescribed reproducibility conditions in different laboratories on identical test material will exceed the reproducibility on an average of not more than once in 20 cases in the normal and correct operation of the method. Two single test results produced in different laboratories that differ by more than the appropriate value from **Table 1** must be suspected of being from different populations and some appropriate investigative or technical/commercial action taken.

10.7 Bias—In test method terminology, bias is the difference between an average test value and the reference (true) test property value. Reference values do not exist for this test method since the value or level of the test property is exclusively defined by the test method. Bias, therefore, cannot be determined.

11. Keywords

11.1 carbon black; pellet crush strength; pellet hardness

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