



Designation: **D1510—12 D1510 – 13**

Standard Test Method for Carbon Black—Iodine Adsorption Number¹

This standard is issued under the fixed designation D1510; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the determination of the iodine adsorption number of carbon black.

1.1.1 Method A is the original test method for this determination and Method B is an alternate test method using automated sample processing and analysis.

1.2 The iodine adsorption number of carbon black has been shown to decrease with sample aging. New SRB HT Iodine Standards have been produced that exhibit stable iodine number upon aging. One or more of these SRB HT Iodine Standards are recommended for daily monitoring (x-charts) to ensure that the results are within the control limits of the individual standard. Use all SRB HT Iodine Standards for standardization of iodine testing (see Section 8) when target values cannot be obtained.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *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

[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](#)

[D4821 Guide for Carbon Black—Validation of Test Method Precision and Bias](#)

[E969 Specification for Glass Volumetric \(Transfer\) Pipets](#)

2.2 *European Standards:*³

[ISO/EN/DIN 8655-3 Piston-operated volumetric apparatus - Part 3: Piston burettes](#)

3. Summary of Test Methods

3.1 In Test Method A, a weighed sample of carbon black is treated with a portion of standard iodine solution and the mixture shaken and centrifuged. The excess iodine is then titrated with standard sodium thiosulfate solution, and the adsorbed iodine is expressed as a fraction of the total mass of black.

3.2 In Test Method B, a weighed sample of carbon black is treated with a portion of standard iodine solution using an automated sample processor where the mixture is stirred, settled and aliquoted for automatic titration. The excess iodine is titrated with standard sodium thiosulfate solution, and the adsorbed iodine is expressed as a fraction of the total mass of black.

4. Significance and Use

4.1 The iodine adsorption number is useful in characterizing carbon blacks. It is related to the surface area of carbon blacks and is generally in agreement with nitrogen surface area. The presence of volatiles, surface porosity, or extractables will influence the iodine adsorption number. Aging of carbon black can also influence the iodine number.

¹ This test method is under the jurisdiction of ASTM Committee D24 on Carbon Black and is the direct responsibility of Subcommittee D24.21 on Carbon Black Surface Area and Related Properties.

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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 Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, [http://www.iso.org](#).

5. Apparatus

- 5.1 *Vials*, glass, optically clear type, with polyethylene stoppers, 45 cm³.
- 5.2 *Gravity Convection Drying Oven*, capable of maintaining 125 ± 5°C.
- 5.3 *Buret*, either of the following may be used:
 - 5.3.1 *Digital Buret*, 25-cm³ capacity, with 0.01-cm³ increment counter and zero reset control, or
 - 5.3.2 *Buret*, glass 25-cm³, Class A, side-arm filling, graduated in 0.05 cm³ and with automatic zero.
- 5.4 *Repetitive Dispenser*, 25-cm³ capacity, ±0.1% reproducibility and calibrated to within ±0.03-cm³ accuracy.
- 5.5 *Balance*, analytical, with 0.1-mg sensitivity.
- 5.6 *Centrifuge*, with minimum speed of 105 rad/s (1000 r/min).
- 5.7 *Volumetric Flask*, 2000-cm³ with standard taper stopper.
- 5.8 *Funnel*, large diameter, with standard taper joint to fit the 2000-cm³ flask.
- 5.9 *Glass Bottle*, amber, 2000-cm³, with standard taper stopper.
- 5.10 *Glass Jug*, approximate capacity 20-dm³.
- 5.11 *Stirrer*, approximately 300 by 300 mm for mixing.
- 5.12 *Stirrer*, approximately 100 by 100 mm for titrating.
- 5.13 *Desiccator*.
- 5.14 *Miscellaneous Class A Glassware*, and equipment necessary to carry out the test as written.
- 5.15 *Mechanical Shaker*, with at least 1 in. stroke length and a minimum of 240 strokes/min.
- 5.16 *Automatic Titrator*.
- 5.17 *Redox Electrode*, combined platinum ring electrode with an Ag/AgCl/KCl reference electrode and a ceramic frit.
- 5.18 *Volumetric Flask*, 500 cm³ with standard taper stopper.
- 5.19 *Flask*, 250 cm³ with ground glass stopper.
- 5.20 *Automatic Sample Processor and Titration Apparatus*, equipped with disposable filter.⁴

6. Reagents and Solutions

- 6.1 *Purity of Reagents*—Unless otherwise stated, all chemicals shall be of reagent grade.
- 6.2 The preparation of the solutions listed below is described in **Annex A1**. Pre-mixed 0.04728 *N* iodine solution and 0.0394 *N* sodium thiosulfate may be purchased from commercial sources. It is recommended that the normality of pre-mixed solutions be verified before use.
- 6.3 *Iodine Solution*, $c(\text{I}_2) = 0.02364 \text{ mol/dm}^3$ (0.04728 *N*), containing 57.0 g potassium iodide KI per dm³.
- 6.4 *Potassium Iodate Solution*, $c(\text{KIO}_3) = 0.00657 \text{ mol/dm}^3$ (0.0394 *N*) containing 45.0 g potassium iodide per dm³.
- 6.5 *Potassium Dichromate Solution*, $c(\text{K}_2\text{Cr}_2\text{O}_7) = 0.006567$ (0.0394 *N*), containing 1.932 g potassium dichromate (certified/traceable primary standard) per dm³. (**Warning**—Potassium dichromate is carcinogenic.)
- 6.6 *Sodium Thiosulfate Solution*, $c(\text{Na}_2\text{S}_2\text{O}_3) = 0.0394 \text{ mol/dm}^3$ (0.0394 *N*), containing 5 cm³ n-amyl alcohol per dm³.
- 6.7 *Sulfuric Acid*, 10 %.
- 6.8 *Soluble Starch Solution*, 1 %, containing 0.02 g salicylic acid per dm³.
- 6.9 *Deionized Water*.

7. Standardization of Solutions

- 7.1 *Sodium Thiosulfate*, 0.0394 *N* (±0.00008):
 - 7.1.1 Use potassium dichromate solution as follows:
 - 7.1.1.1 Measure approximately 20 cm³ of 10 % potassium iodide (see **A1.4**) solution into a small graduated cylinder and transfer to a 250 cm³ iodine flask with a ground glass stopper.

⁴The sole source of supply of the apparatus known to the committee at this time is Brinkmann Instruments, Inc., One Cantiague Rd., PO Box 1019, Westbury, NY 11590-0207. The sole source of supply of the filter (disposable filter part #17594 K 5 µm Minisart with luer lock outlet) known to the committee at this time is Sartorius Stedim North America Inc., 131 Heartland Blvd., Edgewood, NY 11717. 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.

7.1.1.2 Measure approximately 20 cm³ of 10 % sulfuric acid solution (see A1.5) into a small graduated cylinder and add to the KI solution in the iodine flask. The mixture should remain colorless.

NOTE 1—If a yellow color should develop, discard this KI solution.

7.1.1.3 Using a 20 cm³ pipet, transfer 20 cm³ of standard 0.0394 N potassium dichromate solution (see A1.8) into the 250 cm³ iodine flask, replace stopper, swirl, and place in the dark for 15 min.

7.1.1.4 Titrate the contents of the iodine flask against the new sodium thiosulfate solution following 7.1.3 or 7.1.4.

7.1.2 Use potassium iodate/iodide solution as follows:

7.1.2.1 Pipet exactly 20 cm³ of 0.0394 N potassium iodate/iodide solution into a 250-cm³ iodine flask.

7.1.2.2 Measure approximately 5 cm³ of 10 % sulfuric acid into a small graduated cylinder and add to the iodate/iodide solution.

7.1.2.3 Cap immediately and mix thoroughly.

7.1.2.4 Titrate the contents of the iodine flask against the new sodium thiosulfate solution following 7.1.3 or 7.1.4.

7.1.3 *Digital Buret:*

7.1.3.1 Switch the digital buret to fill mode, fill the reservoir with unstandardized sodium thiosulfate solution, and flush the inlet and delivery tubes.

7.1.3.2 Change to the titrate mode and zero the counter.

7.1.3.3 Add sodium thiosulfate until the contents of the iodine flask are a pale yellowish (potassium iodate) or pale yellowish-green (potassium dichromate). Wash the buret tip and the walls of the flask with water.

7.1.3.4 Add 5 drops of starch solution to the flask.

7.1.3.5 Continue adding sodium thiosulfate dropwise until the blue or blue-violet color almost disappears.

7.1.3.6 Wash the tip and walls of the flask with water, then advance the counter in 0.01-cm³ increments. Continue this sequence until the endpoint is reached, indicated by a colorless (potassium iodate) or sea-green (potassium dichromate) solution.

7.1.3.7 Record the titration value and repeat from 7.1.1 or 7.1.2 for a duplicate determination.

7.1.3.8 Calculate the normality of the sodium thiosulfate solution as in 7.1.5 and proceed as in 7.1.6. If the titration is made to standardize the iodine solution as described in 7.2 calculate the normality of the iodine solution as in 7.2.1.2 and proceed as in 7.2.1.3.

7.1.4 *Glass Buret:*

7.1.4.1 Using a conventional glass buret, fill the buret with unstandardized sodium-thiosulfate solution and flush 2 to 3 cm³ through the tip.

7.1.4.2 Adjust to the mark and titrate to a pale yellowish (potassium iodate) or pale yellowish-green (potassium dichromate).

7.1.4.3 Wash the buret tip and the walls of the flask with water.

7.1.4.4 Add 5 drops of starch solution to the iodine flask.

7.1.4.5 Continue adding sodium thiosulfate dropwise until the endpoint is reached, indicated by a colorless (potassium iodate) or sea-green (potassium dichromate) solution.

7.1.4.6 Record the titration value to the nearest 0.025 cm³ and repeat from 7.1.1 or 7.1.2 for a duplicate determination.

NOTE 2—To achieve maximum performance from a glass buret, it is necessary to use a small magnifier and to read to the nearest 0.025 cm³.

7.1.4.7 Calculate the normality of the sodium thiosulfate solution as in 7.1.5 and proceed as in 7.1.6. If the titration is made to standardize the iodine solution as described in 7.2 calculate the normality of the iodine solution as in 7.2.1.2 and proceed as in 7.2.1.3.

7.1.5 Calculate the normality of the sodium thiosulfate solutions as follows:

$$N = 20 (0.0394)/T \quad (1)$$

where:

N = normality, and

T = titration volume, cm³.

7.1.6 If N is not equal to 0.0394, adjust the solution in the following manner: if the solution is too strong, add water (2.5 cm³/dm³ solution for each 0.0001 N over 0.0394); if the solution is too weak, add solid sodium thiosulfate (0.025 g/dm³ for each 0.0001 N under 0.0394).

7.2 *Iodine Solution 0.04728 N (± 0.00003)*—This solution may be standardized against the secondary standard sodium-thiosulfate solution (see A1.3) standardized as in 7.1.

7.2.1 Use sodium thiosulfate solution as follows:

7.2.1.1 Pipet exactly 20 cm³ of iodine solution into a 250-cm³ iodine flask and cap. Continue as in 7.1.3 or 7.1.4.

7.2.1.2 Calculate the normality of the iodine solution as follows:

$$N = (0.0394) T/20 \quad (2)$$

where:

N = normality, and

$T = \text{cm}^3$ of 0.0394 *N* sodium thiosulfate solution.

7.2.1.3 If *N* is not equal to 0.04728 *N*, adjust solution in the following manner: if the solution is too concentrated, add water ($2.1 \text{ cm}^3/\text{dm}^3$ for each 0.0001 *N* over 0.04728); if the solution is too diluted, add iodine ($12.7 \text{ mg}/\text{dm}^3$ for each 0.0001 *N* under 0.04728). (This iodine may be more conveniently dispensed from a concentrated solution.)

8. Normalization Using SRB HT Iodine Standards

8.1 When a laboratory cannot obtain target values for all three SRB HT Iodine Standards within established x-chart tolerances, the user should review recommendations found in Guide **D4821**. If any one of the three SRB HT Iodine Standards is still outside acceptable tolerances, the method described in **8.2-8.5** should be used to normalize all test results.

8.2 Test the three SRB HT Iodine Standards four times each.

8.3 Perform a regression analysis using the target value of the SRB HT Iodine Standards (*y* value) and the individual measured value (*x* value).

8.4 Normalize the values of all subsequent test results using this regression equation:

$$\text{Normalized value} = (\text{measured value} \times \text{slope}) + y - \text{intercept} \quad (3)$$

8.5 Alternatively, a table of numbers may be generated based on the regression equation to find the correspondence between a measured value and a normalized value.

8.6 Reevaluate the need for normalization whenever replacement apparatus or new lots of iodine or sodium thiosulfate solutions, or both, are put into use.

9. Sampling

9.1 Samples shall be taken in accordance with Practices **D1799** and **D1900**.

10. Blank Iodine Determination

10.1 Method A—Blank Iodine Determination:

10.1.1 Make a blank iodine determination by pipeting 20 cm^3 or dispensing 25 cm^3 of 0.04728 *N* iodine solution into a 125-cm^3 Erlenmeyer flask and titrating with 0.0394 *N* sodium thiosulfate as in **11.10.1**, **11.10.2**, or **11.10.3**.

10.1.2 A 25-cm^3 blank must be multiplied by 0.8 for use in the formula of **13.1**.

10.1.3 Make a duplicate blank determination and use the average of the two in the calculations.

NOTE 3—A duplicate blank determination need be run only once each day, unless new solutions are introduced during the day.

10.1.4 If both solutions are within acceptable limits, the blank will measure $24.00 \pm 0.09 \text{ cm}^3$. If not, the normalities of one or both solutions should be rechecked. If, after the recheck of solutions, normalities are still outside the acceptable limits refer to **7.2.1.3** to adjust iodine solution. See **Table 1** for blank tolerance components.

10.1.5 The blank tolerance for a 20 cm^3 volume of iodine solution is defined as the sum of (1) titration volume deviation for acceptable variation in both iodine and sodium thiosulfate solution concentrations, and (2) dispenser tolerance for Class A 20 mL pipet.

10.1.6 The solution deviation is based on the maximum variation in solution concentrations defined in **7.1** and **7.2**. Tolerances for Class A volumetric pipets are from Specification **E969**.

10.2 Method B—Blank Iodine Determination:

10.2.1 Make a blank iodine determination by placing a magnetic stir bar into an empty beaker and place the beaker into the automated sample processor.

10.2.2 Initiate the automatic sample processor and titration apparatus.

10.2.3 Dispense an appropriate volume of 0.04728 *N* iodine solution into the beaker. Treat the blank in the same manner as the sample, refer to Section **12**.

NOTE 4—For different size beakers, ensure stir bar covers the bottom surface of beaker for good mixing.

10.2.4 Measures should be taken to ensure adequate purging of the entire system prior to delivering the final aliquot for titration (see **Note 5**).

NOTE 5—An example of adequate purging of the system is achieved by double rinsing with the current blank solution followed with a distilled water rinse. This can be done in the following manner: (1) fill the dosing device, which is equipped with a disposable filter, with an aliquot of the blank solution

TABLE 1 Blank Tolerance Components

Blank Volume cm^3	A. Solution Deviations cm^3	B. Dispenser Tolerance cm^3	Blank Tolerance cm^3
20.00	± 0.06	± 0.03	± 0.09

from the beaker, dispense the entire volume into titration vessel, and pump out into the waste container; (2) repeat previous step one more time and fill the dosing device with the final aliquot of blank solution (this aliquot should have an excess amount that will be used to flush the air bubbles, possibly formed during the two previous steps—the volume of aliquot used for titration can vary depending on user’s preference (7 to 20 cm³ has been found satisfactory)); (3) dispense a small portion of the blank solution into the reaction vessel, ensure that appropriate amount of the solution is left for titration in the dosing device; and (4) clean the reaction (titration) vessel by rinsing with distilled water and pumping out waste repetitively.

10.2.5 Dispense a final aliquot of the blank solution into the reaction vessel for titration and wash the walls of the vessel, stirrer, and redox-electrode with distilled water to ensure that any splashed iodine is washed into the mixture.

10.2.6 Automatically titrate the iodine solution with 0.0394 N sodium thiosulfate.

10.2.7 Make duplicate blank determinations. The average of two determinations is to be used in calculations.

10.2.8 Blank measurements may be made daily, especially where small solution lots are prepared within a lab. Alternatively, blanks may be measured once per solution lot or other prescribed frequency, for large solution lots which are purchased, and where adequate measures are used to monitor testing such as the daily use of x-charting HT or INR standards.

NOTE 6—For daily blanks, a duplicate blank determination need be run only once each day, unless new solutions are introduced during the day.

NOTE 7—When the particulate filter is changed adequate measures should be taken to saturate the filter with iodine solution. An example of an adequate measure found to be satisfactory includes running a minimum of five blanks. The fourth and fifth blank are then averaged for the final blank value and use the average of the two in the calculations. If the filter has not been changed use the average of the first and second blanks for calculations.

10.2.9 Blank tolerances are found in Table 2 for different volumes of iodine solution. A blank tolerance is defined as the sum of (1) titration volume deviation for acceptable variation in both iodine and sodium thiosulfate solution concentrations, and (2) dispenser tolerance for a piston-operated volumetric apparatus.

10.2.10 A blank tolerance can be calculated from the linear equation as follows:

$$Y = 0.0056x + 0.0059 \tag{4}$$

where:

Y = tolerance \pm , and
 x = aliquot volume, mL.

10.2.11 Blank tolerances for Method B are also found in Fig. 1. The function for solution deviation only and solution deviation plus dispenser tolerance are included for reference.

10.2.12 The solution deviation is based on the maximum variation in solution concentrations defined in 7.1 and 7.2. Tolerances for piston-operated volumetric apparatus are from ISO/EN/DIN 8655-3.

11. Method A Sample Preparation and Iodine Number Determination—Method A

11.1 *Blank Iodine Determination:* Dry an adequate sample of carbon black for 1 h, in a gravity-convection oven set at 125°C, in an open container of suitable dimensions, so that the depth of the black is no more than 10 mm. Cool to room temperature in a desiccator before use.

10.1.1 Make a blank iodine determination by pipeting 20 cm³ or dispensing 25 cm³ of 0.04728 N iodine solution into a 125-cm³ Erlenmeyer flask and titrating with 0.0394 N sodium thiosulfate as in 10.3.1, 10.3.2, or 10.3.3.

10.1.2 A 25-cm³ blank must be multiplied by 0.8 for use in the formula of 12.1.

10.1.3 Make a duplicate blank determination and use the average of the two in the calculations.

NOTE 3—A duplicate blank determination need be run only once each day, unless new solutions are introduced during the day.

10.1.4 If both solutions are within acceptable limits, the blank will measure 24.00 \pm 0.06 cm³. If not, the normalities of one or both solutions should be rechecked. If, after the recheck of solutions, normalities are still outside the acceptable limits refer to 7.2.1.3 to adjust iodine solution.

11.2 *Sample Preparation and Iodine Determination:* Weigh a mass of the dried sample into a glass vial as shown by the following table. All masses must be to the nearest 0.001 g in case of iodine numbers from 0 to 520.9 and to the nearest 0.0001 g in case of iodine numbers from 521.0 and above.

10.2.1 Dry an adequate sample of carbon black for 1 h, in a gravity-convection oven set at 125°C, in an open container of suitable dimensions, so that the depth of the black is no more than 10 mm. Cool to room temperature in a desiccator before use.

TABLE 2 Blank Tolerances

Blank Volume cm ³	A. Solution Deviations cm ³	B. Dispenser Tolerance cm ³	Blank Tolerance cm ³
20.00	± 0.064	± 0.054	± 0.118
10.00	± 0.032	± 0.027	± 0.059
6.00	± 0.019	± 0.024	± 0.043
1.00	± 0.003	± 0.007	± 0.010

Blank Tolerance Based on Solution and Piston-Operated Dispenser Tolerances

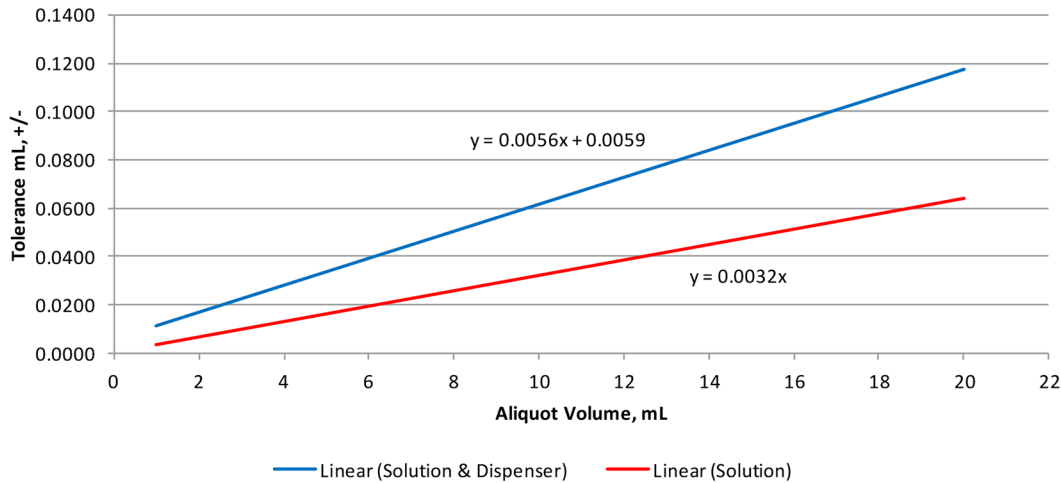


FIG. 1 Blank Tolerances for Method B as a Function of Aliquot Volume

Iodine Number	Sample Mass (g)	Ratio I ₂ : Sample Mass
0-130.9	0.500	50:1
131.0-280.9	0.250	100:1
281.0-520.9	0.125	200:1
521.0 and above	0.0625	400:1

10.2.2 Weigh a mass of the dried sample into a glass vial as shown by the following table. All masses must be to the nearest 0.001 g in case of iodine numbers from 0 to 520.9 and to the nearest 0.0001 g in case of iodine numbers from 521.0 and above:

Iodine Number	Sample Mass (g)	Ratio I ₂ : Sample Mass
0-130.9	0.500	50:±
131.0-280.9	0.250	100:±
281.0-520.9	0.125	200:±
521.0 and above	0.0625	400:±

10.2.2.1 Use the sample mass determined by the expected iodine number. If the result falls either above or below the range shown for that sample size, retest using the sample mass specified in 10.2.2 for the range into which it has fallen.

NOTE 4—Unagitated, unpelleted carbon black may be densified, if desired, before drying, prior to weighing.

10.2.2.2 The sample mass table given in 10.2.2 pertains to the 25 cm³ iodine solution as given in 10.2.3. Different volumes of iodine solution and of sample masses are permissible only if the iodine solution to sample mass ratio is kept the same as that given by the table in 10.2.2. The sample mass must be kept to 1.000 g maximum. Should the sample mass and corresponding volume of iodine solution be increased, then a glass vial with a volume that is at least two times the amount of iodine solution used for the test should be used in order to preserve the efficiency of the shaking.

10.2.3 Pipet (or dispense from a calibrated repetitive dispenser) 25 cm³ of 0.04728 N I₂ solution into the glass vial containing the sample and cap immediately.

10.2.4 Secure the vial in the mechanical shaker and shake for 1 min at a minimum of 240 strokes/min.

10.2.5 Centrifuge immediately for 1 min for pelleted black and 3 min for loose black.

10.2.6 Decant immediately. If more than one sample is being analyzed, the solution should be decanted into small flasks or clean, dry vials and capped immediately.

10.2.7 Pipet 20 cm³ of solution into a 250-cm³ Erlenmeyer flask and titrate with standardized 0.0394 N sodium thiosulfate solution using either the digital or glass buret as described in 10.3.

11.3 Use the sample mass determined by the expected iodine number. If the result falls either above or below the range shown for that sample size, retest using the sample mass specified in 11.2 for the range into which it has fallen.

NOTE 8—Unagitated, unpelleted carbon black may be densified, if desired, before drying, prior to weighing.

11.4 The sample mass table given in 11.2 pertains to the 25 cm³ iodine solution as given in 11.5. Different volumes of iodine solution and of sample masses are permissible only if the iodine solution to sample mass ratio is kept the same as that given by the table in 11.2. The sample mass must be kept to 1.000 g maximum. Should the sample mass and corresponding volume of iodine solution be increased, then a glass vial with a volume that is at least two times the amount of iodine solution used for the test should be used in order to preserve the efficiency of the shaking.