



Designation: D3173/D3173M – 17

## Standard Test Method for Moisture in the Analysis Sample of Coal and Coke<sup>1</sup>

This standard is issued under the fixed designation D3173/D3173M; 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 moisture in the analysis sample of coal or coke. It is used for calculating other analytical results to a dry basis. When used in conjunction with the air drying loss as determined in accordance with Method D2013 or Practice D346, each analytical result can be calculated to an as-received basis:

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the 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 and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

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

D121 Terminology of Coal and Coke

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

D2013 Practice for Preparing Coal Samples for Analysis

D3180 Practice for Calculating Coal and Coke Analyses from As-Determined to Different Bases

D3302 Test Method for Total Moisture in Coal

### 3. Terminology

3.1 *Definitions*—For additional definitions of terms used in this test method, refer to Terminology D121.

<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 D05.21 on Methods of Analysis.

Current edition approved Feb. 1, 2017. Published February 2017. Originally approved in 1973. Last previous edition approved 2011 as D3173 – 11. DOI: 10.1520/D3173\_D3173M-17.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

### 4. Summary of Test Method

4.1 Moisture is determined by establishing the loss in weight of the sample when heated under rigidly controlled conditions of temperature, time and atmosphere, sample weight, and equipment specifications.

### 5. Significance and Use

5.1 Moisture as determined by this test method is used for calculating other analytical results to a moisture free basis using procedures in Practice D3180. Moisture percent determined by this test method may be used in conjunction with the air-dry moisture loss determined in Method D2013 and Test Method D3302 to determine total moisture in coal. Total moisture is used for calculating other analytical results to “as received” basis using Practice D3180. Moisture, ash, volatile matter, and fixed carbon percents constitute the proximate analysis of coal and coke.

### 6. Analysis Sample

6.1 The analysis sample is that sample which has been pulverized to pass 250- $\mu$ m (No. 60) sieve as prepared in accordance with Practice D346 or Method D2013.

### 7. Apparatus

7.1 *Drying Oven*, for coal samples:

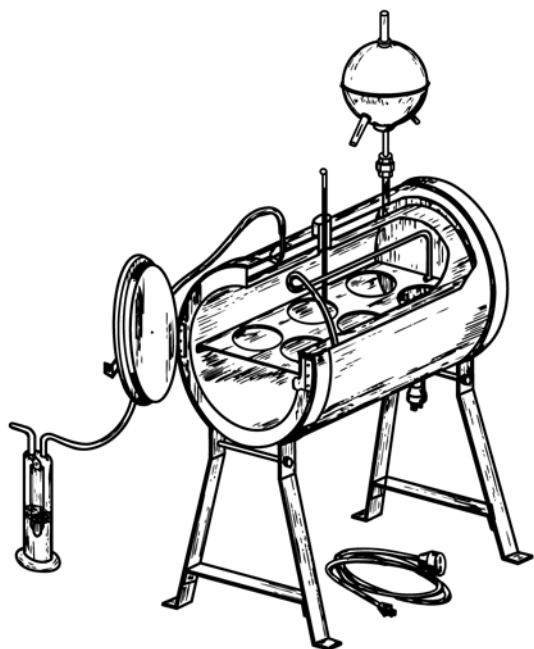
7.1.1 For determining the moisture of coal, the oven shall be so constructed as to have a uniform temperature in all parts, have a minimum of air space, and be capable of temperature regulation between the limits of 104 and 110°C. It may be of the form shown in Fig. 1. Provision shall be made for renewing the preheated air in the oven at the rate of two to four times a minute, with the air dried as defined in 8.1.

7.1.2 In the oven shown in Fig. 1, the door should contain a hole of approximately 3.2 mm [ $\frac{1}{8}$  in.] in diameter near the bottom to permit a free flow of air through the oven space.

7.2 *Drying Oven*, for coke samples. For determining the moisture of coke, an ordinary drying oven with openings for natural air circulation and capable of temperature regulation between limits of 104 and 110°C may be used.

7.3 *Capsules*, with covers. A convenient form, which allows the ash determination to be made on the same sample, is a porcelain capsule, 22 mm [ $\frac{7}{8}$  in.] in depth and 44 mm [ $1\frac{3}{4}$  in.] in diameter, or a fused silica capsule of similar shape. These

\*A Summary of Changes section appears at the end of this standard



NOTE 1—Details in U.S. Bureau of Mines Bulletin No. 492, 1951, p 6.  
**FIG. 1 Moisture Oven**

capsules shall be used with a well-fitting flat aluminum cover, illustrated in Fig. 2. Platinum crucibles or glass capsules with ground-glass caps may also be used. They should be as shallow as possible, consistent with convenient handling.

## 8. Reagents

8.1 *Dry Air*—Air used to purge the drying oven should be dried to a moisture content of 1.9 mg/L or less. (Dew point – 10°C or less.) Any desiccant or drying method capable of achieving this degree of dryness is suitable.

8.2 *Desiccants*—Materials suitable for use in the desiccator may be chosen from the following:

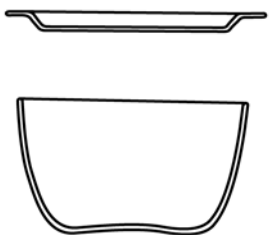
8.2.1 *Anhydrous Calcium Sulfate* (0.004 mg/L).

8.2.2 *Silica Gel*.

8.2.3 *Magnesium Perchlorate* (0.0005 mg/L).

8.2.4 *Sulfuric Acid, Concentrated* (0.003 mg/L).

8.2.5 The desiccant must be kept fresh enough to assure that the air in the desiccator is dry as defined in 8.1. Values in parentheses ( ) are literature values for the residual amount of moisture in air at equilibrium with these desiccants. (**Warning:** Sulfuric acid is corrosive and can cause severe damage to eyes, skin, and clothing. Magnesium perchlorate is a strong oxidant and can react violently with organic materials.)



**FIG. 2 Capsule for Use in Determining Moisture**

## 9. Procedure for Sample Passing a 250-µm (No. 60) Sieve

9.1 Heat the empty capsules under the conditions at which the sample is to be dried, place the stopper or cover on the capsule, cool over a desiccant for 15 to 30 min, and weigh. Dip out with a spoon or spatula from the sample bottle approximately 1 g of the sample. Put this quickly into the capsule, close, and weigh at once to the nearest ±0.1 mg.

9.2 An alternative procedure for weighing the sample (more subject to error) is as follows: After transferring an amount of the sample slightly in excess of 1 g, bring to exactly 1 g in weight (±0.5 mg) by quickly removing the excess weight of the sample with a spatula. The utmost dispatch must be used to minimize the exposure of the sample until the weight is determined.

9.3 After removing the covers, quickly place the capsules in a preheated oven (at 104 to 110°C) through which passes a current of dry air. (The current of dry air is not necessary for coke.) Close the oven at once and heat for 1 h. Open the oven, cover the capsules quickly, cool in a desiccator over desiccant, and weigh as soon as the capsules have reached room temperature.

9.4 Use the percentage of moisture in the sample passing a 250-µm (No. 60) sieve to calculate the results of the other analyses to a dry basis.

## 10. Calculations

10.1 Calculate the percent moisture in the analysis sample as follows:

$$\text{Moisture in analysis sample, \%} = [(A - B)/A] \times 100 \quad (1)$$

where:

A = grams of sample used and

B = grams of sample after heating.

## 11. Report

11.1 Report the following information:

11.1.1 Moisture in the analysis sample, %, to the nearest 0.01 percentage point.

## 12. Precision and Bias<sup>3</sup>

12.1 *Precision*—The precision of this method for the determination of moisture in the analysis sample of coal and coke is

<sup>3</sup> An interlaboratory study, designed consistent with Practice E691, was conducted in 1995. Twelve labs participated. Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D05-1020. In addition, information for coke was calculated per Practice E 691 using 48 sets of data for 24 coke samples from a commercially available inter-laboratory proficiency test program. The cokes used in this study included furnace coke, foundry coke and coke breeze. Details and supporting information are given in Research Report RR:D05-1039.

**TABLE 1 Precision**

	Range	Repeatability Limit (r)	Reproducibility Limit (R)
Coal	1.0 – 21.9 %	$0.09 + 0.01\bar{x}^A$	$0.23 + 0.02\bar{x}^A$
Coke	0.18–1.87%	0.08	0.24

<sup>A</sup>Where  $\bar{x}$  is the average of two single test results.



shown in **Table 1** and **Table A1.2**. The precision characterized by repeatability ( $S_r$ ,  $r$ ) and reproducibility ( $S_R$ ,  $R$ ) is described in **Table A1.1** in **Annex A1**.

12.1.1 *Repeatability Limit ( $r$ )*—The value below which the absolute difference between two test results calculated to separate consecutive test determinations, carried out on the same sample in the same laboratory, by the same operator, using the same apparatus on samples taken at random from a single quantity of homogenous material, may be expected to occur with a probability of approximately 95%.

12.1.2 *Reproducibility Limit ( $R$ )*—The value below which the absolute difference between two test results, carried out in different laboratories, using samples taken at random from a single quantity of material that is as nearly homogenous as possible, may be expected to occur with a probability of approximately 95%.

12.2 *Bias*—Certified Reference Materials are not available for the determination of bias by this test method.

## ANNEX

### (Mandatory Information)

#### A1. PRECISION STATISTICS

A1.1 The precision of this test method, characterized by repeatability ( $S_r$ ,  $r$ ) and reproducibility ( $S_R$ ,  $R$ ) has been determined for the following materials as listed in **Table A1.1** and **Table A1.2**.

A1.2 *Repeatability Standard Deviation ( $S_r$ )*—The standard

deviation of test results obtained under repeatability conditions.

A1.3 *Reproducibility Standard Deviation ( $S_R$ )*—The standard deviation of test results obtained under reproducibility conditions.

**TABLE A1.1 Repeatability ( $S_r$ ,  $r$ ) and Reproducibility ( $S_R$ ,  $R$ )  
Parameters Used for Calculation of Precision Statement for Coal  
Samples**

NOTE 1—The R-Squared statistic for both the repeatability ( $r$ ) and reproducibility ( $R$ ) indicates that the model as fitted explains 62% of the variability in the two variables.

Material	Average	$S_r$	$S_R$	$r$	$R$
91-2lvb	0.9683	0.0479	0.0853	0.1341	0.2388
91-1 hvAb	1.5689	0.0569	0.1387	0.1593	0.3884
91-5 hvAb	3.1178	0.0559	0.0977	0.1564	0.2736
89-4 hvCb	5.4428	0.0601	0.1408	0.1682	0.3943
91-4 hvCb	9.6392	0.0636	0.1004	0.1781	0.2811
90-1 subB	11.9	0.1252	0.2193	0.3505	0.614
89-7 subA	12.4556	0.0798	0.1188	0.2234	0.3326
91-6 subA	15.1753	0.0577	0.1737	0.1615	0.4865
89-6 subC	21.9461	0.1949	0.2843	0.5456	0.796



**TABLE A1.2 Repeatability ( $S_r$ ,  $r$ ) and Reproducibility ( $S_R$ ,  $R$ )  
Parameters Used for Calculation of Precision Statement for Coke  
Samples**

Material	Average	$S_r$	$S_R$	$r$	$R$
CK980108 - Furnace	0.19	0.04	0.08	0.12	0.22
CK980312 - Furnace	0.30	0.05	0.15	0.13	0.41
CK980716 - Foundry	0.27	0.03	0.10	0.08	0.29
CKReference2 - Furnace	0.18	0.03	0.11	0.09	0.30
CKNIST01 - Foundry	0.57	0.04	0.09	0.13	0.24
CKNIST02 - Furnace	0.30	0.03	0.06	0.09	0.18
CK0303 - Foundry	0.75	0.03	0.06	0.09	0.16
CK9903 - Foundry	0.50	0.04	0.10	0.10	0.29
CK9904 - Furnace	0.65	0.03	0.10	0.08	0.27
CK0001 - Furnace	0.44	0.03	0.07	0.09	0.21
CK0401 - Furnace	0.58	0.03	0.10	0.07	0.30
CK0002 - Breeze	0.46	0.02	0.15	0.04	0.42
CK0302 - Breeze	0.55	0.04	0.05	0.10	0.13
CK0003 - Foundry	0.31	0.02	0.08	0.07	0.24
CK0101 - Furnace	0.19	0.02	0.08	0.04	0.23
CK0504 - Furnace	0.28	0.04	0.08	0.10	0.23
CK0701 - Furnace	0.29	0.02	0.08	0.06	0.24
CK0102 - Furnace	0.33	0.04	0.10	0.10	0.29
CK0301 - Furnace	0.34	0.01	0.08	0.04	0.23
CK0404 - Furnace	0.50	0.02	0.07	0.06	0.21
CK0103 - Furnace	1.04	0.03	0.30	0.07	0.84
CK0304 - Furnace	1.49	0.02	0.10	0.06	0.27
CK0601 - Furnace	1.54	0.03	0.05	0.08	0.14
CK0903 - Furnace	1.87	0.07	0.08	0.18	0.23
CK0104 - Furnace	0.20	0.01	0.08	0.04	0.23
CK0503 - Furnace	0.35	0.02	0.06	0.06	0.17
CK0201 - Furnace	0.51	0.03	0.08	0.08	0.22
CK0501 - Furnace	0.59	0.03	0.13	0.08	0.36
CK0802 - Furnace	0.72	0.02	0.08	0.05	0.23
CK0904 - Furnace	0.77	0.03	0.08	0.08	0.24
CK0202 - Furnace	0.35	0.02	0.13	0.06	0.36
CK0502 - Furnace	0.46	0.02	0.11	0.06	0.32
CK0603 - Furnace	0.53	0.04	0.08	0.10	0.23
CK0203 - Furnace	0.21	0.02	0.08	0.05	0.24
CK0403 - Furnace	0.24	0.02	0.07	0.06	0.20
CK0604 - Furnace	0.23	0.03	0.09	0.07	0.26
CK0801 - Furnace	0.18	0.02	0.05	0.06	0.14
CK0204 - Breeze	0.60	0.04	0.19	0.10	0.54
CK0402 - Breeze	0.72	0.04	0.10	0.12	0.27
CK0602 - Breeze	0.72	0.03	0.14	0.07	0.40
CK0704 - Breeze	0.81	0.02	0.08	0.05	0.22
CK0702 - Furnace	0.64	0.06	0.24	0.18	0.67
CK0902 - Furnace	0.91	0.04	0.18	0.11	0.50
CK0703 - Coke	1.68	0.04	0.11	0.11	0.30
CK0803 - Furnace	0.43	0.02	0.10	0.06	0.28
CK0804 - Furnace	0.44	0.02	0.06	0.06	0.17
CK0901 - Coke	0.27	0.03	0.06	0.09	0.18
CK1001 - Furnace	0.29	0.03	0.11	0.09	0.30

## SUMMARY OF CHANGES

Committee D05 has identified the location of selected changes to this standard since the last issue (D3173-11) that may impact the use of this standard.

(1) Added sections 3 and 11.

(2) Note 3 of subsection 12.2 was deleted.

(3) Section A1.1 was revised.

(4) Designation was corrected to D3173/D3173M.



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