



Designation: **D3180—12 D3180 – 15**

Standard Practice for Calculating Coal and Coke Analyses from As-Determined to Different Bases¹

This standard is issued under the fixed designation D3180; 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 practice lists formulas that allow analytical data to be expressed in various bases in common use. Such bases are: as received, dry, equilibrium moisture, dry ash free, and others.

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

~~1.3 The values stated in SI units are to be regarded as the standard.~~

2. Referenced Documents

2.1 *ASTM Standards:*²

[D388 Classification of Coals by Rank](#)

[D1412 Test Method for Equilibrium Moisture of Coal at 96 to 97 Percent Relative Humidity and 30°C](#)

[D2013 Practice for Preparing Coal Samples for Analysis](#)

[D3173 Test Method for Moisture in the Analysis Sample of Coal and Coke](#)

[D3174 Test Method for Ash in the Analysis Sample of Coal and Coke from Coal](#)

[D3302 Test Method for Total Moisture in Coal](#)

[D7582 Test Methods for Proximate Analysis of Coal and Coke by Macro Thermogravimetric Analysis](#)

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

3. Terminology

3.1 *Definitions:*

3.1.1 *as-determined basis*—analytical data obtained from the analysis sample of coal or coke after conditioning and preparation to No. 60 (250- μ m) sieve in accordance with Practice [D2013](#) and Test Method [D3302](#). As-determined data represents the numerical values obtained at the particular moisture level in the sample at the time of analysis. These values are normally converted, according to formulae contained herein, to conventional reporting bases.

3.1.2 *as-received basis*—analytical data calculated to the moisture condition of the sample as it arrived at the laboratory and before any processing or conditioning. If the sample has been maintained in a sealed state so that there has been no gain or loss, the as-received basis is equivalent to the moisture basis as sampled.

3.1.3 *dry basis*—data calculated to a theoretical base of no moisture associated with the sample. The numerical value as established by Test Methods [D3173](#) or [D7582](#) is used for converting the as-determined data to a dry basis.

3.1.4 *dry, ash-free basis*—data calculated to a theoretical base of no moisture or ash associated with the sample. Numerical values as established by Test Methods [D3173](#), [D3174](#), or [D7582](#) are used for converting the as-determined data to a moisture- and ash-free basis.

3.1.5 *equilibrium moisture base*—data calculated to the moisture level established as the equilibrium moisture. Numerical values as established by Test Method [D1412](#) are used for the calculation.

¹ This practice is under the jurisdiction of ASTM Committee [D05](#) on Coal and Coke and is the direct responsibility of [D05.21](#) on Methods of Analysis. Current edition approved April 1, 2012; Jan. 1, 2015. Published June 2012; January 2015. Originally approved in 1974. Last previous edition approved in 2007; 2012 as [D3180—07](#); [D3180 – 12](#). DOI: [10.1520/D3180-12](#); [10.1520/D3180-15](#).

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.

4. Significance and Use

4.1 The calculations of analytical data for the coal and coke test parameters listed in Section 6, assume the analysis sample has been prepared according to Practice D2013 and Test Method D3302.

4.2 This practice provides formulas, to enable calculations of data from the as-determined analysis sample to various moisture bases, in common use by the coal and coke industry.

4.3 This practice provides guidance to enable calculations of weight-average data from various lots or sublots, which, initially, are provided at different moisture bases.

4.4 The principles given in this practice are applicable to the calculation of cumulative data (e.g., for trade purposes or for sieve analyses or washability analyses).

5. Applicable Parameters and Symbols Used

5.1 The calculation procedures defined in 6.1.36.3.3 and 6.2.26.4.2 are applicable to the following analysis parameters when expressed as weight percent, µg/g (trace elements) or Btu/lb (gross calorific value):

Ash
 Ash
 Carbon
 Carbon
 Carbon dioxide
 Carbon dioxide
 Chlorine
 Chlorine
 Calorific value (gross)
 Calorific value (gross)
 Fixed carbon
 Fixed carbon
 Major, minor and trace elements
 Nitrogen
 Nitrogen
 Sulfur
 Sulfur
 Sulfur forms (namely, pyritic, sulfate, organic)
 Sulfur forms (namely, pyritic, sulfate, organic)
 Volatile matter
 Volatile matter

5.2 The symbols used in this practice:

A = ash; weight %

M = moisture, weight %

P = any analysis parameter listed in 5.1, weight % (except gross calorific value is Btu/lb)

ADL = air-dry loss, weight % of as-received sample. See Test Method D3302

H = hydrogen, weight %

Ox = oxygen, weight %

5.3 Subscripts used in this practice:

ad = as-determined

ar = as-received

d = dry

daf = dry, ash-free (equivalent to moisture and ash free, maf)

6. Methods for Calculating Data

6.1 Whenever calculating a test result from observed values, avoid rounding of intermediate quantities. As far as is practicable with the calculating device, carry out calculations with the observed values exactly, and round only the final result (see E29).

6.2 Avoid calculating with reported test results (rounded and reported) and comparing these calculated values to other reported values, with the exception of obtaining the exact same calculated value.

NOTE 1—Calculations based on values that have been rounded and contain a limited number of decimal places may provide a different result than calculations based upon values that are not rounded and contain a much larger number of decimal places (e.g., up to 14 or more). Therefore, comparable, exact values will not always be calculated by the two methods. The reported value developed using un-rounded results is more precise than the value calculated off-line, e.g., in a spreadsheet program, using rounded data with a limited number of decimal places.

6.2.1 Where a composite analysis of sublots is required, whenever possible, rather than use the individual, rounded values on the individual reports to calculate a composite value, the composite analysis should be based upon the un-rounded data.

6.3 Converting from the analysis sample basis to the as-received basis (Note 12):

6.3.1 *Moisture:*

TABLE 1 Conversion Formula Chart

Given	Wanted			
	As-Determined (ad)	As-Received (ar)	Dry (d)	Dry Ash-free (daf)
As-Determined (ad)		$\frac{100 - M_{ar}}{100 - M_{ad}}$	$\frac{100}{100 - M_{ad}}$	$\frac{100}{100 - M_{ad} - A_{ad}}$
As-Received (ar)	$\frac{100 - M_{ad}}{100 - M_{ar}}$		$\frac{100}{100 - M_{ar}}$	$\frac{100}{100 - M_{ar} - A_{ar}}$
Dry (d)	$\frac{100 - M_{ad}}{100}$	$\frac{100 - M_{ar}}{100}$		$\frac{100}{100 - A_d}$
Dry Ash-free (daf)	$\frac{100 - M_{ad} - A_{ad}}{100}$	$\frac{100 - M_{ar} - A_{ar}}{100}$	$\frac{100 - A_d}{100}$	

TABLE 1 Conversion Formula Chart

Given	Wanted			
	As-Determined (ad)	As-Received (ar)	Dry (d)	Dry Ash-free (daf)
As-Determined (ad)		$\frac{100 - M_{ar}}{100 - M_{ad}}$	$\frac{100}{100 - M_{ad}}$	$\frac{100}{100 - M_{ad} - A_{ad}}$
As-Received (ar)	$\frac{100 - M_{ad}}{100 - M_{ar}}$		$\frac{100}{100 - M_{ar}}$	$\frac{100}{100 - M_{ar} - A_{ar}}$
Dry (d)	$\frac{100 - M_{ad}}{100}$	$\frac{100 - M_{ar}}{100}$		$\frac{100}{100 - A_d}$
Dry Ash-free (daf)	$\frac{100 - M_{ad} - A_{ad}}{100}$	$\frac{100 - M_{ar} - A_{ar}}{100}$	$\frac{100 - A_d}{100}$	

TABLE 2 Proximate Analysis

Sample Coal Analysis	As Determined Basis	Dry Basis	As Received Basis
Moisture, %	8.23	...	23.24
Ash, %	4.46	4.86	3.73
Volatile, %	40.05	43.64	33.50
Fixed carbon, %	47.26	51.50	39.53
Total	100.00	100.00	100.00

(Air-Dry Loss in accordance with Test Method D3302 = 16.36%)

$$M_{ar} = \left[M_{ad} \times \frac{100 - ADL}{100} \right] + ADL \quad (1)$$

$$ADL = 100 \times [1 - (100 - M_{ar}) / (100 - M_{ad})] \quad (2)$$

6.3.2 *Hydrogen and Oxygen*—Inasmuch as hydrogen and oxygen values may be reported on the basis of containing or not containing the hydrogen and oxygen in water (moisture) associated with the sample, alternative conversion procedures are defined as follows:

6.3.2.1 *H* and *Ox* reported include *H* and *Ox* in water:

$$H_{ar} = \left[(H_{ad} - 0.1119M_{ad}) \times \frac{100 - M_{ar}}{100 - M_{ad}} \right] + 0.1119M_{ar} \quad (3)$$

$$Ox_{ar} = \left[(Ox_{ad} - 0.8881M_{ad}) \times \frac{100 - M_{ar}}{100 - M_{ad}} \right] + 0.8881M_{ar} \quad (4)$$

6.3.2.2 *H* and *Ox* reported do not include *H* and *Ox* in water:

$$H_{ar} = (H_{ad} - 0.1119M_{ad}) \times \frac{100 - M_{ar}}{100 - M_{ad}} \quad (5)$$