



Standard Test Methods for Determination of Trace Elements in Coal, Coke, and Combustion Residues from Coal Utilization Processes by Inductively Coupled Plasma Atomic Emission Spectrometry, Inductively Coupled Plasma Mass Spectrometry, and Graphite Furnace Atomic Absorption Spectrometry¹

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1. Scope

1.1 These test methods pertain to the determination of antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, vanadium, and zinc in coal and coke. These test methods can also be used for the analysis of residues from coal combustion processes.

NOTE 1—These test methods may be applicable to the determination of other trace elements.

1.2 The values stated in SI units shall be regarded as 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:*²

[D121 Terminology of Coal and Coke](#)

[D346 Practice for Collection and Preparation of Coke Samples for Laboratory Analysis](#)

[D1193 Specification for Reagent Water](#)

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

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

[D3180 Practice for Calculating Coal and Coke Analyses from As-Determined to Different Bases](#)

¹ These test methods are under the jurisdiction of ASTM Committee [D05](#) on Coal and Coke and are the direct responsibility of Subcommittee [D05.29](#) on Major Elements in Ash and Trace Elements of Coal.

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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.

[D7448 Practice for Establishing the Competence of Laboratories Using ASTM Procedures in the Sampling and Analysis of Coal and Coke](#)

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

[E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

2.2 *Other Documents:*

[EPA/600/4-91/010 Methods for the Determination of Metals in Environmental Samples](#)³

3. Terminology

3.1 *Definitions*—Definitions applicable to these test methods are listed in Terminology [D121](#).

4. Summary of Test Method

4.1 The coal or coke to be analyzed is ashed under controlled conditions, digested by a mixture of aqua-regia and hydrofluoric acid, and finally dissolved in 1 % nitric acid. Combustion residues are digested on an as-received basis. The concentration of individual trace elements is determined by either inductively coupled atomic emission spectrometry (ICPAES) or inductively coupled plasma mass spectrometry (ICPMS). Selected elements that occur at concentrations below the detection limits of ICPAES can be quantitatively analyzed by graphite furnace atomic absorption spectrometry (GFAA).

5. Significance and Use

5.1 Coal contains several elements whose individual concentrations are generally less than 0.01 %. These elements are commonly and collectively referred to as trace elements. These elements primarily occur as part of the mineral matter in coal. The potential release of certain trace elements from coal combustion sources has become an environmental concern.

³ Available from Superintendent of Documents, U.S. Printing Office, Washington, DC 20402.