Designation: D 5759 – 95

Standard Guide for Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses[1]

This standard is issued under the fixed designation D 5759; 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 guide recommends standards for the characterization of fly ash from the combustion of coal, fly ash from coal combusted in the presence of alkaline materials, and fly ash from combusted coal in which the flue gases have been treated with alkaline materials in the presence of the fly ash.

1.2 This guide provides recommended and optional test methods for fly ash evaluation. Acceptance criteria can be negotiated between the producer and the user according to the potential end use.

1.3 The coal fly ash and clean coal combustion fly ash of this guide do not include the following:

1.3.1 Dusts from kilns producing products such as lime, portland cement, activated clays, etc.;

1.3.2 By-products of flue gas desulflurization that are not collected with the primary fly ash removal equipment such as the baghouse or electrostatic precipitator; and

1.3.3 Fly ash or other combustion products derived from the burning of waste; municipal, industrial, or commercial garbage; sewage sludge or other refuse, or both; derived fuels; wood; wood waste products; rice hulls; agriculture waste; or other non-coal fuels or other such fuels blended with coal, or some combination thereof.

1.4 Fly ash may contain some trace elements that may affect performance or potential end use.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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]

C 22 Specification for Gypsum

C 25 Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime

C 51 Terminology Relating to Lime and Limestone (As Used by the Industry)

C 109 Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)

C 110 Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone

C 114 Test Methods for Chemical Analysis of Hydraulic Cement

C 150 Specification for Portland Cement

C 191 Test Method for Time of Setting of Hydraulic Cement by Vicat Needle

C 311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete

C 400 Test Method for Testing Quicklime and Hydrated Lime for Neutralization of Waste Acid

C 593 Specification for Fly Ash and Other Pozzolans for Use with Lime

C 595 Specification for Blended Hydraulic Cements

C 602 Specification for Agricultural Liming Materials

C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

D 546 Test Method for Sieve Analysis of Mineral Filler for Road and Paving Materials

D 1973 Guide for Design of a Linear System for Containment of Wastes

D 2795 Method for Analysis of Coal and Coke Ash

[1] This guide is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.03.03 on Industrial Recovery and Reuse.

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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.

D 3178 Test Method for Carbon and Hydrogen in the Analysis Sample of Coal and Coke
D 3682 Test Method for Major and Minor Elements in Coal and Coke Ash by the Atomic Absorption Method
D 3683 Test Method for Trace Elements in Coal and Coke Ash by the Atomic Absorption Method
D 4326 Test Method for Major and Minor Elements in Coal and Coke by X-Ray Fluorescence
D 5239 Practice for Characterizing Fly Ash for Use in Soil Stabilization
E 1266 Practice for Processing Mixtures of Lime, Fly Ash, and Heavy Metal Wastes in Structural Fills and Other Construction Applications

2.2 *Other Document:*

USEPA Method 9100-SW846 Falling Head or Constand Head[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *clean coal combustion*—the burning of coal, coal culm, or coal fines in a furnace designed to operate to minimize emissions (that is, a fluidized bed or aerated fluidized bed, etc.) or coal burned in the presence of alkaline materials, which combine to reduce these emissions.

3.1.2 *fly ash*, *n*—residual material that exits a combustion chamber in the flue gas.

4. Significance and Use

4.1 This guide provides guidance for the characterization of coal fly ash or clean coal combustion fly ash for potential uses in which absorption, cementitious activity, pozzolanic activity, pH adjustment, heat rise, or stabilization and solidification properties may be desired.

5. Chemical Composition

5.1 Fly ash from coal and clean coal combustion can be characterized by the recommended chemical tests of Table 1 and may be characterized further by the optional chemical tests of Table 2. Limits may be specified by the purchaser if required for a specific application. The most recent limits established by the appropriate regulatory agency shall govern if no specific parameters are required. See Appendix X1 for possible non-mandatory information for various end uses of fly ash.

6. Physical Tests

6.1 Fly ash from coal and clean coal combustion can be tested further in accordance with the optional physical tests of Table 3, if required by the purchaser.

7. Shipments for Delivery to Purchaser

7.1 Fly ash shipped for delivery to the purchaser should be from a single combustion unit or a blend from multiple combustion units, as agreed upon between the purchaser and the supplier, such that the delivered fly ash complies with the provisions of Sections 8 and 9 herein.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

8. Sampling and Testing

8.1 Take individual, representative samples of at least 0.5 lb (227 g) from each 100 tons (100 Mg) of fly ash delivered to the purchaser.

TABLE 1 Recommended Chemical Tests

Test Method	Component(s)	Limit[A]
C 114	sulfur trioxide (SO_3),%[B]	
C 311	moisture content, %	
C 311	loss on ignition, %	
D 2795, D 3682, or D 4326	calcium oxide (CaO),%	
D 2795, D 3682, or D 4326	magnesium oxide (MgO), %	
D 2795, D 3682, or D 4326	silicon dioxide (SiO_2) plus aluminum oxide (Al_2O_3) plus iron oxide (Fe_2O_3), %	

[A] On specific projects, a minimum or maximum may be applicable.
[B] Fly ash replaces hydraulic cement in method.

TABLE 2 Optional Chemical Tests[A] (Limits to be Specified Only if Applicable, by the Purchaser)

Test Method	Component(s)	Limit[B]
C 25	available lime index (ALI), %[C]	
C 311	available alkalies as Na_2O, %	
C 400	pH[D]	
C 602	calcium carbonate equivalent ($CaCO_3$), %	
D 3178	carbon (C),%	
D 3683	trace elements (totals) (for example, sulfide, sulfite, and sulfate)	

[A] Individual requirements may be specified by the purchaser if applicable to the project for which fly ash is to be used.
[B] On specific projects, a minimum or maximum may be applicable.
[C] Fly ash replaces limestone in analysis.
[D] Fly ash replaces quicklime in method.

TABLE 3 Optional Physical Tests[A] (To be Specified Only as Required by the Purchaser)

Test Method	Component(s)
C 109	compressive strength of hydraulic cement mortars, psi[B]
C 110	heat rise (slaking rate), °C[C]
C 191	time of set, min[B]
C 311	amount retained on No. 325 sieve, %
C 311	strength activity index with portland cement 7 days, % of control 28 days, % of control
C 311	water requirement, % of control[D]
C 311	specific gravity
C 311	increase in drying shrinkage, %
C 311	reactivity with cement alkalies, mortar expansion, % of control
C 311	soundness
C 593	amount retained on No. 200 sieve,%
C 593	amount retained on No. 30 sieve, %
C 593	lime pozzolan strength 7 days, psi lime pozzolan strength 28 days, psi
USEPA Method 9100-SW846	

[A] Individual requirements may be specified by the purchaser if applicable to the project for which fly ash is to be used.
[B] Modification of Test Method C 109 to approximate proportion(s) of fly ash instead of cement; or fly ash in combination with other materials to be used on the project (that is, cement, lime, etc.) should be used.
[C] Modify Test Methods C 110 to a proportion of fly ash instead of lime. The fly ash to water ratio may need to be modified further to obtain measurable results.
[D] Comparisons of water requirements to a control material, used at an equal flow, may be useful to determine the relative water requirement.

8.2 Samples are composites of 0.5-lb (227-g) individual samples of fly ash taken from each 100 tons (100 Mg) shipped. The minimum composite sample size should not be less than 8