



Designation: D5114/D5114M – 90 (Reapproved 2018)^{ε1}

Standard Test Method for Laboratory Froth Flotation of Coal in a Mechanical Cell¹

This standard is issued under the fixed designation D5114/D5114M; 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.

^{ε1} NOTE—The designation was editorially updated to dual and other editorial changes were made throughout in March 2019.

INTRODUCTION

Froth flotation of coal, the separation of ash-bearing minerals from combustibles via differences in surface chemistry, has been steadily increasing in use as a means to treat 600 μm (No. 30 U.S.A. Standard Sieve Series) or finer coal. The process is one in which many variables need to be monitored and regulated. Because of this complexity, rigorous laboratory testing is difficult to standardize.

This test method outlines the types of equipment and procedures to apply on a laboratory scale to isolate key process variables and minimize the variations associated with the design and execution of a froth flotation test. The objective of the test method is to develop a means by which repeatable grade/recovery results are ascertained from froth flotation testing of coal without imposing unnecessary limitations on the applicability of the test results in coal preparation practice.

It is recognized that sample preparation, particularly comminution, has a significant impact on froth flotation response. This test method does not attempt to define sample preparation and size reduction practices as part of a froth flotation testing program.

This test method also does not completely cover specific procedures for the investigation of flotation kinetics. Such a test is specialized and is highly dependent upon the end use of the data.

1. Scope

1.1 This test method covers a laboratory procedure for conducting a single froth flotation test on fine coal (that is, nominal top size of 600 μm (No. 30 U.S.A. Standard Sieve Series) or finer) using a defined set of starting point conditions for the operating variables.

1.2 This test method does not completely cover specific procedures for the investigation of flotation kinetics. Such a test is specialized and highly dependent upon the objective of the data.

1.3 Since optimum conditions for flotation are usually not found at the specified starting points, suggestions for development of grade/recovery curves are given in [Appendix X1](#). Such a procedure is very case-specific and involves running a series of flotation tests in which some of the operating variables are changed in order to optimize conditions for either yield or grade.

1.4 Laboratory flotation results need not be representative of the flotation response of coal in full-scale situations, but a consistent baseline can be established against which full-scale performance can be compared.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.6 Material Safety Data Sheets (MSDS) for reagents used are to be obtained from suppliers who are to be consulted before work with any chemicals used in this test method.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This test method is under the jurisdiction of ASTM Committee D05 on Coal and Coke and is the direct responsibility of Subcommittee D05.07 on Physical Characteristics of Coal.

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2. Referenced Documents

2.1 ASTM Standards:²

D121 Terminology of Coal and Coke

D2013 Practice for Preparing Coal Samples for Analysis

D3174 Test Method for Ash in the Analysis Sample of Coal and Coke from Coal

D4749 Test Method for Performing the Sieve Analysis of Coal and Designating Coal Size

3. Terminology

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

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *collector*—a reagent used in froth flotation to promote contact and adhesion between particles and air bubbles.

3.2.2 *combustibles*—the value obtained by subtracting the dry weight (in percent) of the ash (as determined in Test Method **D3174**) from 100 % representing the original weight of the analyzed sample.

3.2.3 *concentrate*—the froth product recovered in coal froth flotation.

3.2.4 *conditioning agents*—all chemicals that enhance the performance of the collectors or frothers. Conditioning agents change the characteristics of the surface of the minerals or the environment. There are many subgroups according to function: activators, depressants, emulsifiers, dispersants, flocculants, chelating reagents, froth depressants, pH modifiers, and so forth.

3.2.5 *flotation cell*—the vessel or compartment in which the flotation test is performed.

3.2.6 *froth*—a collection of bubbles and particles on the surface of a pulp in a froth flotation cell.

3.2.7 *froth flotation*—a process for cleaning fine coal in which hydrophobic particles, generally coal, attach to air bubbles in a water medium and rise to the surface to form a froth. The hydrophilic particles, generally the ash-forming matter, remain in the water phase.

3.2.8 *frother*—a reagent used in froth flotation to control the size and stability of the air bubbles, principally by reducing the surface tension of water.

3.2.9 *grade/recovery*—the relationship between quality and quantity of the clean coal product. The quality can be defined in terms of ash, sulfur, or Btu content. The quantity can be designated as yield or heating value recovery (Btu or combustibles).

3.2.10 *mechanical cell*—a type of flotation cell that employs mechanical agitation of a pulp by means of an immersed impeller (rotor) and stator stirring mechanism. Aeration to the cell can be from an external pressurized air source or self-induced air.

3.2.11 *natural pH*—the measured pH of the pulp prior to the addition of collector, frother, or any conditioning agents.

3.2.12 *pulp*—a fluid mixture of solids and water, also known as slurry.

3.2.13 *recovery*—the percent of the valuable component (that is, Btu or combustible) from the feed that reports to the froth concentrate product.

3.2.14 *solids concentration*—the ratio, expressed as a percent, of the weight (mass) of solids to the sum of the weight of solids plus water.

3.2.15 *tailings*—the underflow product from coal froth flotation.

3.2.16 *yield*—the weight percent of the feed that reports to the concentrate.

4. Significance and Use

4.1 This test method uses specific starting point conditions for the froth flotation response to accomplish the following:

4.1.1 Assess responses of one or more coals or blends of coal, and

4.1.2 Evaluate and determine froth flotation circuit performance.

5. Apparatus

5.1 *Laboratory Flotation Machine*, with a minimum volume of 2 L and a maximum volume of 6 L. **Fig. 1** schematically depicts a batch mechanical flotation cell which can be used in conjunction with this test method. The major criterion is that the unit must be able to provide for constant mechanical removal of froth from the cell. In addition, the laboratory unit must have some means of automatic liquid level control.

5.1.1 An example of a mechanical paddle laboratory froth flotation apparatus is shown in **Fig. 1**. The froth paddles are

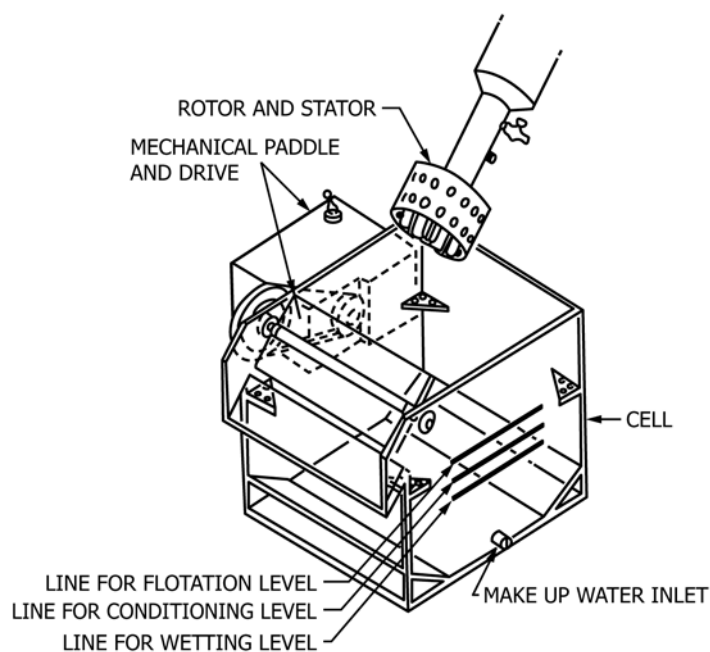


FIG. 1 5.5 L Mechanical Paddle Laboratory Froth Flotation Cell

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.