Designation: C1220 – 21

Standard Test Method for Static Leaching of Monolithic Waste Forms for Disposal of Radioactive Waste[1]

This standard is issued under the fixed designation C1220; 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 test method provides a measure of the chemical durability of a simulated or radioactive monolithic waste form, such as a glass, ceramic, cement (grout), or cermet, in a test solution at temperatures <100 °C under low specimen surface-area-to-leachant volume (S/V) ratio conditions.

1.2 This test method can be used to characterize the dissolution or leaching behaviors of various simulated or radioactive waste forms in various leachants under the specific conditions of the test based on analysis of the test solution. Data from this test are used to calculate normalized elemental mass loss values from specimens exposed to aqueous solutions at temperatures <100 °C.

1.3 The test is conducted under static conditions in a constant solution volume and at a constant temperature. The reactivity of the test specimen is determined from the amounts of components released and accumulated in the solution over the test duration. A wide range of test conditions can be used to study material behavior, including various leachant composition, specimen surface area-to-leachant volume ratios, temperatures, and test durations.

1.4 Three leachant compositions and four reference test matrices of test conditions are recommended to characterize materials behavior and facilitate interlaboratory comparisons of tests results.

1.5 Specimen surfaces may become altered during this test. Although not part of the test method, it is recommended that these altered surface regions be examined to characterize chemical and physical changes due to the reaction of waste forms during static exposure to solutions.

1.6 This test method is not recommended for evaluating metallic materials, the degradation of which includes oxidation reactions that are not controlled by this test method.

1.7 This test method must be performed in accordance with all applicable quality assurance requirements for acceptance of the data.

1.8 The values stated in SI units are to be regarded as standard. Other units of measurement are included for reference only, with the following exceptions:

1.8.1 Grit size used in this standard can be converted to the corresponding μm values using the current revision of Guide E3.

1.8.2 Appendix X2 describes the usage of a model of saw for which components and instruments are imperial unit based; imperial units are used in this section.

1.9 *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.* For a specific hazard statement, see 7.3.2.

1.10 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C859 Terminology Relating to Nuclear Materials

C1109 Practice for Analysis of Aqueous Leachates from Nuclear Waste Materials Using Inductively Coupled Plasma-Atomic Emission Spectroscopy

C1174 Guide for Evaluation of Long-Term Behavior of Materials Used in Engineered Barrier Systems (EBS) for Geological Disposal of High-Level Radioactive Waste

D1193 Specification for Reagent Water

D1293 Test Methods for pH of Water

E3 Guide for Preparation of Metallographic Specimens

[1] This test method is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.13 on Spent Fuel and High Level Waste.

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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.

2.2 *EPA Standard:*[3]
SW-846A Test Methods for Evaluating Solid Waste, Physical/Chemical Methods

3. Terminology

3.1 Refer to Terminology C859 for additional terminology that may not be listed below.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accumulated dose, n*—the sum of the absorbed doses received by the system considered regardless of whether it is exposed to radiation in a continuous or discontinuous fashion.

3.2.2 *actinide, n*—any element with atomic number of 89 to 103.

3.2.3 *high-purity water, n*—purified water conforming with the requirements given in Specification D1193 for Type I or Type II water.

3.2.4 *leachate, n—in leach tests*, general term for the solution resulting from a test in which a solid is contacted by a solution and leaches or dissolves.

3.2.5 *leaching, v*—the preferential loss of soluble components from a solid material into a solution leaving a residual phase that is depleted in those components, but structurally unchanged.

3.2.6 *monolithic specimen, n*—specimen that is physically one coherent piece, as opposed to powdered specimens that consist of many small pieces of irregular configuration. A monolithic specimen may consist of several individual phases, but they must be bound in a stable coherent configuration.

3.2.7 *nuclear waste form, n*—solid material in which radioactive wastes have been immobilized.

3.2.8 *precision of a measurement process, n*—the expected dispersion of values obtained using a measurement process under prescribed conditions, usually represented as a standard deviation or relative standard deviation.

3.3 *Abbreviations:*

3.3.1 *EDX*—energy-dispersive x-ray fluorescence (instrument or analysis).

3.3.2 *ISE*—ion selective electrode.

3.3.3 *PTFE*—polytetrafluoroethylene.

3.3.4 *SEM*—scanning electron microscopy (or microscope).

3.3.5 *TEM*—transmission electron microscopy (or microscope).

3.3.6 *XRD*—x-ray diffraction (or diffractometer).

4. Summary of Test Method

4.1 A specimen of known geometric surface area (S) is immersed in a known volume of leachant (V) in a test vessel that is sealed and placed in an oven (or other controlled-temperature device) set at a defined temperature for a defined time period without agitation. After the prescribed time interval, the vessel is removed from the oven and allowed to cool before being opened. Aliquots of the leachate solution are removed and analyzed for pH and various dissolved and colloidal components that were released from the specimen during the test. The concentrations of dissolved soluble components are used to determine the extent of reaction. A separate test is conducted to provide data for each test condition (duration, temperature, S/V ratio, leachant composition, etc.). Although it is not a part of the test method, it is recommended that the reacted test specimens be examined for changes in the composition and structures of the near-surface regions for correlations with the solution results and to study the reaction mechanism.

5. Significance and Use

5.1 This test method can be used to provide a measure of the reactivity of a material in a dilute solution in which the test response is dominated by the dissolution or leaching of the test specimen. It can be used to compare the dissolution or leaching behaviors of candidate radioactive waste forms and to study the reactions during static exposure to dilute solutions in which solution feed-back effects can be maintained negligible, depending on the test conditions.

5.2 The test is suitable for application to natural minerals, simulated waste form materials, and radioactive waste form material specimens.

5.3 Data from this test may form part of the larger body of data that is necessary in the logical approach to long-term prediction of waste form behavior, as described in Practice C1174. In particular, measured solution concentrations and characterizations of altered surfaces may be used in the validation of geochemical modeling codes.

5.4 This test method excludes the use of crushed or powdered specimens and organic materials.

5.5 Several reference test parameter values and reference leachant solutions are specified to facilitate the comparison of results of tests conducted with different materials and at different laboratories. However, other test parameter values and leachant solution compositions can be used to characterize the specimen reactivity.

5.5.1 Tests can be conducted with different leachant compositions to simulate groundwaters, buffer the leachate pH as the specimen dissolves, or measure the common ion effect of particular solutes.

5.5.2 Tests can be conducted to measure the effects of various test parameter values on the specimen response, including time, temperature, and S/V ratio. Tests conducted for different durations and at various temperatures provide insight into the reaction kinetics. Tests conducted at different S/V ratio provide insight into chemical affinity (solution feed-back effects) and the approach to saturation.

5.6 Either aerated or deaerated solutions may be used in this test method except when testing highly radioactive specimens. Deaerated solutions are mandatory in tests conducted with highly radioactive specimens to minimize the effects of nitrogen radiolysis. Preparation of deaerated leachants is addressed in 7.2.2.

[3] Available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov.