

Standard Test Method for Air Oxidation of Carbon and Graphite in the Kinetic Regime¹

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1. Scope*

1.1 This test method recommends a standard procedure for measuring oxidation rates in air of various grades of nuclear graphite and/or manufactured carbon. Following the standard procedure recommended here, one can obtain kinetic parameters that characterize the oxidation resistance of tested materials and that can be used to for materials selection and qualification, and for quality control purposes in the fabrication process.

1.2 This test method covers the rate of oxidative weight loss per exposed nominal geometric surface area, or per initial weight of machined test specimens of standard size and shape, or both. The test is valid in the temperature range where the rate of air oxidation of graphite and manufactured carbon is limited by reaction kinetics.

1.3 This test method also provides a standard oxidation temperature (as defined in 3.1.7), and the kinetic parameters of the oxidation reaction, namely the activation energy and the logarithm of pre-exponential factor in Arrhenius equation. The kinetic parameters of Arrhenius equation are calculated from the temperature dependence of oxidation rates measured over the temperature range where Arrhenius plots (as defined in 3.1.8) are linear, which is defined as the “kinetic” or “chemical control” oxidation regime. For typical nuclear grade graphite materials it was found that the practical range of testing temperatures is from about 500 °C to 550 °C up to about 700 °C to 750 °C.

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

1.5 *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 This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.F0 on Manufactured Carbon and Graphite Products.

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2. Referenced Documents

2.1 ASTM Standards:²

- C559 Test Method for Bulk Density by Physical Measurements of Manufactured Carbon and Graphite Articles
- E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
- E898 Test Method of Testing Top-Loading, Direct-Reading Laboratory Scales and Balances
- E1582 Practice for Calibration of Temperature Scale for Thermogravimetry
- E1970 Practice for Statistical Treatment of Thermoanalytical Data

3. Terminology

3.1 Definitions:

3.1.1 Definitions are ordered by oxidation rates first, followed by activation energy as calculated from oxidation rates.

3.1.2 *area-normalized oxidation rate* (OR_a)—rate of weight loss due to oxidation of a machined test specimen at a given temperature, divided by the nominal geometric surface area of the specimen.

3.1.2.1 *Discussion*—The rate of weight loss is determined by a linear fit of the weight loss plotted against time in the range from 5 % to 10 % loss of original specimen weight. The units of area-normalized oxidation rate, OR_a , are $\text{g h}^{-1} \text{m}^{-2}$.

3.1.3 *weight-normalized oxidation rate* (OR_w)—rate of weight loss due to oxidation of a machined specimen at a given temperature, divided by the initial weight of the specimen.

3.1.3.1 *Discussion*—The rate of weight loss is determined by a linear fit of the weight loss plotted against time in the range from 5 % to 10 % loss of original specimen weight. The units of weight-normalized oxidation rate, OR_w , are:

$$[g_{(\text{oxidized})}] [g_{(\text{specimen})}]^{-1} \text{h}^{-1} \text{ (or, equivalent, h}^{-1}\text{)} \quad (1)$$

3.1.4 *nominal geometric surface area*—exposed area (A) of the test specimen determined by measuring its diameter (D) and height (H) before testing and using the formula:

$$A = 2\pi D^2/4 + \pi DH \quad (2)$$

The units of nominal geometric surface area are m^2 .

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.