



Standard Test Method for Oxygen Content Using a 14-MeV Neutron Activation and Direct-Counting Technique¹

This standard is issued under the fixed designation E385; 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 covers the measurement of oxygen concentration in almost any matrix by using a 14-MeV neutron activation and direct-counting technique. Essentially, the same system may be used to determine oxygen concentrations ranging from under 10 $\mu\text{g/g}$ to over 500 mg/g , depending on the sample size and available 14-MeV neutron fluence rates.

NOTE 1—The range of analysis may be extended by using higher neutron fluence rates, larger samples, and higher counting efficiency detectors.

1.2 This test method may be used on either solid or liquid samples, provided that they can be made to conform in size, shape, and macroscopic density during irradiation and counting to a standard sample of known oxygen content. Several variants of this method have been described in the technical literature. A monograph is available which provides a comprehensive description of the principles of activation analysis using a neutron generator (1).²

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

1.4 *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.* Specific precautions are given in Section 8.

2. Referenced Documents

2.1 ASTM Standards:³

¹ This test method is under the jurisdiction of ASTM Committee E10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.05 on Nuclear Radiation Metrology.

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² The boldface numbers in parentheses refer to a list of references at the end of the text.

³ 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.

E170 Terminology Relating to Radiation Measurements and Dosimetry

E181 Test Methods for Detector Calibration and Analysis of Radionuclides

E496 Test Method for Measuring Neutron Fluence and Average Energy from $^3\text{H}(d,n)^4\text{He}$ Neutron Generators by Radioactivation Techniques

2.2 U.S. Government Document:

Code of Federal Regulations, Title 10, Part 20⁴

3. Terminology

3.1 Definitions (see also Terminology E170):

3.1.1 *accelerator*—a machine that ionizes a gas and electrically accelerates the ions onto a target. The accelerator may be based on the Cockcroft-Walton, Van de Graaff, or other design types (1). Compact sealed-tube, mixed deuterium and tritium gas, Cockcroft-Walton neutron generators are most commonly used for 14-MeV neutron activation analysis. However, “pumped” drift-tube accelerators that use replaceable tritium-containing targets are also still in use. Reviews of operational characteristics, descriptions of accessory instrumentation, and applications of accelerators used as fast neutron generators for activation analysis are available (2,3).

3.1.2 *comparator standard*—a reference standard of known oxygen content whose specific counting rate ($\text{counts min}^{-1} [\text{mg of oxygen}]^{-1}$) may be used to quantify the oxygen content of a sample irradiated and counted under the same conditions. Often, a comparator standard is selected to have a matrix composition, physical size, density and shape very similar to the corresponding parameters of the sample to be analyzed.

3.1.3 *14-MeV neutron fluence rate*—the areal density of neutrons passing through a sample, measured in terms of neutrons $\text{cm}^{-2} \text{s}^{-1}$, that is produced by the fusion reaction of deuterium and tritium ions accelerated to energies of typically 150 to 200 keV in a small accelerator. Fluence rate has been commonly referred to as “flux density.” The total neutron fluence is the fluence rate integrated over time.

3.1.3.1 Discussion—The $^3\text{H}(d,n)^4\text{He}$ reaction is used to

⁴ Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.