Designation: E 262 – 03

Standard Test Method for Determining Thermal Neutron Reaction and Fluence Rates by Radioactivation Techniques[1]

This standard is issued under the fixed designation E 262; 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 The purpose of this method is to define a general procedure for determining an unknown thermal neutron-fluence rate by neutron activation techniques. It is not practicable to describe completely a technique applicable to the large number of experimental situations that require the measurement of a thermal-neutron fluence rate. Therefore, this method is presented so that the user may adapt to his particular situation the fundamental procedures of the following techniques.

1.1.1 Absolute counting technique using pure cobalt, pure gold, or cobalt-aluminum or gold-aluminum alloy.

1.1.2 Standard foil technique using pure gold, or gold-aluminum alloy, and

1.1.3 Secondary standard foil techniques using pure indium, indium-aluminum alloy, and dysprosium-aluminum alloy.

1.2 The techniques presented are limited to measurements at room temperatures. However, special problems when making thermal-neutron fluence rate measurements in high-temperature environments are discussed in 8.2. For those circumstances where the use of cadmium as a thermal shield is undesirable because of potential spectrum perturbations or of temperatures above the melting point of cadmium, the method described in Test Method E 481 can be used in some cases. Alternatively, gadolinium filters may be used instead of cadmium. For high temperature applications in which aluminum alloys are unsuitable, other alloys such as cobalt-nickel or cobalt-vanadium have been used.

1.3 Table 1 indicates the useful neutron-fluence ranges for each detector material.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods[2]

E 181 Test Methods for Detector Calibration and Analysis of Radionuclides[3]

E 261 Practice for Determining Neutron Fluence Rate, Fluence, and Spectra by Radioactivation Techniques[3]

E 481 Test Method for Measuring Neutron Fluence Rate by Radioactivation of Cobalt and Silver[3]

3. Significance and Use

3.1 This method can be extended to use any material that has the necessary nuclear and activation properties that suit the experimenter's particular situation. No attempt has been made to fully describe the myriad problems of absolute counting techniques, neutron-fluence depression, and thick-foil self-shielding. It is assumed that the experimenter will refer to existing literature on these subjects. This method does offer a referee method (the standard gold foil irradiation at National Institute of Standards and Technology (NIST) to aid the experimenter when he is in doubt of his ability to measure an absolute thermal fluence rate.

3.2 The standard foil technique uses a set of foils that are as nearly identical as possible in shape and mass. The foils are fabricated from any material that activates by an (n, γ) reaction, preferably having a cross section approximately inversely proportional to neutron speed in the thermal energy range. Some of the foils are irradiated in a known neutron field (at NIST) or other standards laboratory). The foils are counted in a fixed geometry on a stable radiation-detecting instrument. The neutron induced reaction rate of the foils is computed from the counting data, and the ratio of the known neutron fluence rate to the computed reaction rate is determined. For any given foil, neutron energy spectrum, and counting set-up, this ratio is a constant. Other foils from the identical set can now be exposed to an unknown neutron field. The magnitude of the fluence rate in the unknown field can be obtained by comparing

[1] This 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] *Annual Book of ASTM Standards*, Vol 14.02.

[3] *Annual Book of ASTM Standards*, Vol 12.02.

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