Designation: E266 – 11

Standard Test Method for Measuring Fast-Neutron Reaction Rates by Radioactivation of Aluminum[1]

This standard is issued under the fixed designation E266; 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 procedures measuring reaction rates by the activation reaction $^{27}Al(n,\alpha)^{24}$ Na.

1.2 This activation reaction is useful for measuring neutrons with energies above approximately 6.5 MeV and for irradiation times up to about 2 days (for longer irradiations, see Practice E261).

1.3 With suitable techniques, fission-neutron fluence rates above 10^6 $cm^{-2}\cdot s^{-1}$ can be determined.

1.4 Detailed procedures for other fast neutron detectors are referenced in Practice E261.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E170 Terminology Relating to Radiation Measurements and Dosimetry

E181 Test Methods for Detector Calibration and Analysis of Radionuclides

E261 Practice for Determining Neutron Fluence, Fluence Rate, and Spectra by Radioactivation Techniques

E844 Guide for Sensor Set Design and Irradiation for Reactor Surveillance, E 706 (IIC)

E944 Guide for Application of Neutron Spectrum Adjustment Methods in Reactor Surveillance, E 706 (IIA)

E1005 Test Method for Application and Analysis of Radiometric Monitors for Reactor Vessel Surveillance, E 706 (IIIA)

E1018 Guide for Application of ASTM Evaluated Cross Section Data File, Matrix E706 (IIB)

3. Terminology

3.1 *Definitions:*

3.1.1 Refer to Terminology E170.

4. Summary of Test Method

4.1 High-purity aluminum is irradiated in a neutron field, thereby producing radioactive ^{24}Na from the $^{27}Al(n,\alpha)^{24}$Na activation reaction.

4.2 The gamma rays emitted by the radioactive decay of ^{24}Na are counted (see Test Methods E181) and the reaction rate, as defined by Practice E261, is calculated from the decay rate and irradiation conditions.

4.3 The neutron fluence rate above about 6.5 MeV can then be calculated from the spectral-weighted neutron activation cross section as defined by Practice E261.

5. Significance and Use

5.1 Refer to Guide E844 for the selection, irradiation, and quality control of neutron dosimeters.

5.2 Refer to Practice E261 for a general discussion of the determination of fast-neutron fluence rate with threshold detectors.

5.3 Pure aluminum in the form of foil or wire is readily available and easily handled. ^{27}Al has an abundance of 100 % (**1**)[3].

5.4 ^{24}Na has a half-life of 14.9574 h (**2**) and emits gamma rays with energies of 1.368626 and 2.754007 MeV(**2**).

5.5 Fig. 1 shows a plot of cross section versus neutron energy for the fast-neutron reaction $^{27}Al(n,\alpha)^{24}$Na (**3**) along with a comparison to the current experimental database (**4**). This figure is for illustrative purposes only to indicate the range of response of the $^{27}Al(n,\alpha)$ reaction. Refer to Guide E1018 for descriptions of recommended tabulated dosimetry cross sections.

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

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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.

[3] The boldface numbers in parentheses refer to a list of References at the end of this standard.