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Nuclear fuel technology — Determination of the isotopic and elemental uranium and plutonium concentrations of nuclear materials in nitric acid solutions by thermal-ionization mass spectrometry

Technologie du combustible nucléaire — Détermination de la teneur isotopique et des concentrations en matériaux nucléaires de l'uranium et du plutonium dans une solution d'acide nitrique par spectrométrie de masse à thermoionisation



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Contents

Page

Forev	word	iv
1	Scope	1
2	Normative references	1
3	Principle	1
4	Reagents and materials	2
5	Apparatus	4
6	Apparatus for mass spectrometry	4
7	Sampling	5
8	Preparation of the filaments	7
9	Instrument calibration	
10	Isotopic mass spectrometric measurements	9
11	Calculation of the results	
12	Blanks	
13	BlanksQuality control	13
14	Repeatability of the measurements	14
15	Accuracy of the method	14
16	Interferences	
Anne	ex A (normative) Preparation and standardization spike solutions	
Bibliography		
	ex A (normative) Preparation and standardization spike solutions	

Foreword

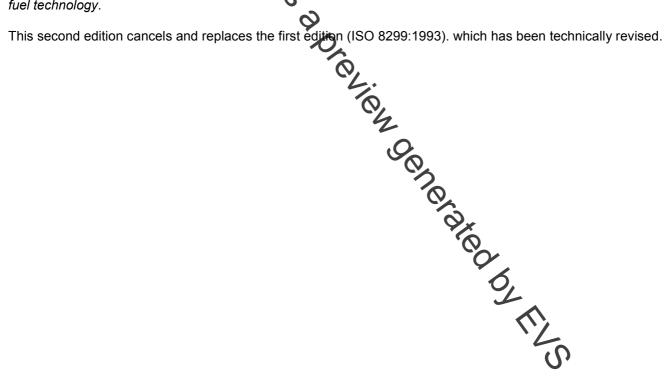
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ISO 8299 was prepared by Technical Committee ISO/TC 85, Nuclear energy, Subcommittee SC 5, Nuclear fuel technology.



Nuclear fuel technology — Determination of the isotopic and elemental uranium and plutonium concentrations of nuclear materials in nitric acid solutions by thermal-ionization mass spectrometry



1 Scope

This method applies to the measurement of the isotopic composition and the concentration of uranium and plutonium in input solutions of irradiated Magnox and light water reactor fuels (boiling water reactor or pressurized water reactor), in that products at spent-fuel reprocessing plants and in feed and products of MOX and uranium fuel fabrication. The method is applicable to other fuels, but the chemical separation and spike solution are, if necessary, adapted to suit each type of fuel.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10980:1995, Validation of the strength of reference solutions used for measuring concentrations

ISO 11483, Preparation of plutonium sources and determination of ²³⁸Pu/²³⁹Pu isotope ratio by alpha spectrometry

3 Principle

The described method is based on isotope ratio measurements by thermal ionization mass spectrometry (TIMS). TIMS analysis requires separation of the element to be analysed from all other elements. Two methods of separation for Pu and U using anion exchange columns are described in Clause 7. Other separation methods may be used provided that they lead to a separation of similar quality. Column extraction chromatography described in ISO 15366 is an example of a suitable alternative.

The described method consists of two separate TIMS measurements.



- a) One measurement is made to determine the isotopic composition of the element. The ²³⁸Pu isotope abundance is determined by combining mass spectrometry following the present method and alpha spectrometry as described in ISO 11483, if the interference of the isobar ²³⁸U is not eliminated by chemical separation.
- b) A second measurement is made on a mixture of the sample and a spike consisting of an artificially enriched isotope of the element to be analysed. This method of measuring an element's concentration is called isotope dilution mass spectrometry (IDMS). The spiking can be made using a spike isotope that either is present in the sample or not. The use of ²³³U or ²⁴⁴Pu spikes eliminates the need for an isotopic measurement in the unspiked sample to determine uranium and plutonium concentration. Although it is normally of interest to measure both the isotopic composition and the element concentration, it is however more common to use the less expensive ²³⁹Pu, ²⁴⁰Pu and ²³⁵U spike solutions., Accurate measurements