УДК 621.039.7

Discriminating the Characteristics of Spent MOX Fuel and LEU Fuel for Safeguards Purposes, Security and Non-Proliferation of Weapons

V.M. Demin[1], M.A. Abu Sondos[2], H.H. Nimer[3]

National Research Nuclear University MEPHI, Moscow

Nuclear energy is currently one of the world's main sources of electricity. Closely connected to the use of nuclear energy are important issues such as the nonproliferation of fissile material that may potentially use in nuclear weapons (safeguards), and the management of the highly radioactive nuclear waste. Safeguards are a set of technical measures applied by the IAEA on nuclear material and activities, through which the Agency seeks to independently verify that nuclear facilities are not misused and nuclear material not diverted from peaceful uses. States accept these measures through the conclusion of safeguards agreements, for the safeguards issue, it is important to experimentally verify the presence and identity of nuclear fuel assemblies and also that the fuel has experienced normal, civilian reactor operation.

Plutonium-rich mixed oxide fuel (MOX) is increasingly used in thermal reactors. However, spent MOX fuel could be a potential source of nuclear weapons material and a safeguards issue is therefore to determine whether a spent nuclear fuel assembly is of MOX type or of LEU (Low Enriched Uranium) type. A technique has been demonstrated, utilizing the ratio of $^{134}Cs/^{154}Eu$, with which it is possible to determine whether a fuel assembly is of MOX or LEU type. This is of interest for safeguards as well as for the safe operation of a final storage facility. The suggested technique is based on using the ratio of $^{134}Cs/^{154}Eu$ because ^{154}Eu is produced more extensively in the case of MOX fuel irradiation while the production of ^{134}Cs is essentially the same or even less as compared with a LEU fuel. The aim of this work is to Study the influence of enrichments of fuel (LEU) and the powers of reactor on the accumulation of ^{134}Cs and ^{154}Eu, which are used to determine the type of initial fuel in safeguard field. A number of simulations have been performed in This work using Serpent computer code "A continuous -energy Monte Carlo reactor physics burnup calculation code" to measure the amount of ^{134}Cs and ^{154}Eu generated and accumulated during the "VVER-1200" reactor operation.

In this work, depending on burnup and cooling time, the masses ^{134}Cs ,^{154}Eu and the ratio of their masses (^{134}Cs /^{154}Eu) were calculated for MOX fuel with 3% enrichment and LEU fuel in many variants of enrichments and powers of reactor, which presented in table 1.

Table 1 – Description of tasks in this work

Task 1 with a constant power	Fuel Enrichment				
	2% LEU	3% LEU	4% LEU	5% LEU	3% MOX
Task 2 with a constant enrichment of 3% LEU	The power of Fuel Assembly				
	3% enriched LEU				3% MOX
	1.96E+7	6.63E+6	5.63E+6	6.13E+6	6.03E+6	1.96E+7

REFERENCES

1. *Willman, C., Håkansson, A., Osifo, O., Bäcklin, A., & Svärd, S. J.* (2006). A nondestructive method for discriminating MOX fuel from LEU fuel for safeguards purposes. Annals of Nuclear Energy, 33(9), 766-773. doi:10.1016/j.anucene.2006.04.006
2. INTERNATIONAL ATOMIC ENERGY AGENCY, Safeguards and Verification, www.world-nuclear.org/.

Различия в характеристиках отработавшего MOX-топлива и LEU-топлива для обеспечения безопасности и гарантии нераспространения ядерного оружия

В.М. Демин[1], М.А. Абу Сондос[2], Х.Х. Нимер[3]

Национальный исследовательский ядерный университет «МИФИ», Москва
[1]VMDemin@mephi.ru
[2]MAbusondos@mephi.ru
[3]jheba20@gmail.com

Аннотация – В работе изучали влияние влияния обогащения топлива (LEU) и мощности ТВС в работных реакторах ВВЭР-1200 на накопление изотопов ^{134}Cs и ^{154}Eu, и сравнивать результаты топлива LEU с топливом (MOX). Расчета концентрации этих изотопов играют важную роль в гарантий использование ядерных реакторах в мирных целях, по определению типа топлива используется в АЭС. с помощью этой расчетов, можно обнаружить некорректные декларации свойств топлива, предоставляемых операторами ядерных реакторов для определения вида топлива, используемого на установке.

Ключевые слова: Гарантия МАГАТЭ, Безопасность, Serpent (монти карло методы), Нераспространение Ядерного Оружия.