EPJ Web of Conferences **253**, 04006 (2021) https://doi.org/10.1051/epjconf/202125304006
ANIMMA 2021

Numerical and experimental characterization of the reaction rates in the core of the CNESTEN's TRIGA Mark II research reactor

H. Ghninou[1] (hamza.ghninou@cea.fr), A. Gruel[1], A. Lyoussi[1], C. Reynard-Carette[2], C. El Younoussi[3], B. El Bakkari[3], B. Nacir[3], Y. Boulaich[3], H. Bounouira[3]
[1]CEA, DES, IRESNE, DER (SPESI/LP2E), Cadarache F-13108 Saint-Paul-Lez-Durance, France
[2]Aix Marseille Univ, Université de Toulon, CNRS, IM2NP, Marseille, France
[3]CNESTEN/CENM, POB 1382, Rabat, Morocco

***Abstract*— Education, training and isotopes production are the most important uses of the Moroccan 2 MW TRIGA Mark II reactor situated at the National Center for Energy Sciences and Nuclear Techniques (CNESTEN, Morocco). To develop new R&D projects in research reactors, the particular and advanced knowledge of neutron and photon flux distribution, within and around the reactor core, is crucial. In order to precisely preparing the experiments in the CNESTEN's TRIGA reactor, a detailed model was developed using the 3D continuous energy Monte Carlo code TRIPOLI-4 and the continuous energy cross-section data from the JEFF3.1.1 nuclear data library. This new model was used to carry out preliminary neutron and photon calculations to estimate flux levels in the irradiation channels as well as to calculate kinetic parameters of the reactor, core excess reactivity, integral control rods worth and power peaking factors. As a first step of the validation of the model, the obtained results were compared with the experimental ones available in the Final Safety Analysis Report (FSAR) of the TRIGA reactor. A study is being carried out at the end of which the results will be published as an evaluated benchmark. Furthermore, this work aims at experimentally characterize the reaction rates in various irradiation channels inside and outside the reactor core. The measurements are carried out using the neutron activation technique. To set up the experimental design for the activation experiments a series of preliminary calculations were performed using the TRIPOLI-4 model to calculate the expected gamma flux/intensity levels of various materials after irradiations in different positions in the irradiation facilities. Different activation foils with known characteristics are then irradiated and the activity of several isotopes is measured with the Gamma Spectrometry Method. The measured relative reaction rates are then compared with the calculated ones evaluated through the new TRIPOLI-4 reactor model. Fairly good agreement was found, which indicates that the new computational model is accurate enough to reproduce experiments.**

***Keywords* —TRIGA reactor, neutron activation analysis, TRIPOLI-4 simulation, γ spectrometry.**

I. INTRODUCTION

THE precise and advanced knowledge of the neutron flux is crucial to develop new R&D projects in research reactor and to benchmark the computational models of the reactor. The Moroccan TRIGA MARK-II research reactor, operated by the CNESTEN in Rabat, is a pool type light-water reactor, with a maximum steady state power of 2 MW.

A relevant effort has been made by the CNESTEN in the past few years to accurately model the reactor to support planning, designing and implementing new experiments in various fields of nuclear research as well as to interpret and analyze the corresponding experimental results [1] [2] [3] [4].

The present paper describes the preliminary characterization of reaction rates in various irradiation and experimental channels of the CNESTEN's TRIGA Mark II research reactor. For this purpose, different metallic foils were irradiated and the resulted activities were analyzed *via* γ spectrometry method. Through comparisons of measured and calculated reaction rates, the computational scheme of the reactor can be experimentally validated.

This study was conducted in the framework of the bilateral collaboration between the CEA-Cadarache and the CNESTEN.

II. THE CNESTEN'S TRIGA MARK II REACTOR

The 2 MW TRIGA (Training Research and Isotope production General Atomics) Mark II is a research reactor designed and manufactured by General Atomics. It is a pool-type light water moderated and cooled reactor. The reactor core is immerged into an 8 m high and 2.52 m diameter tank filled with water, it is a hexagonal array type consisting of seven concentric rings where the cylindrical fuel elements (FEs) are arranged, and two aluminum grid plates which provide accurate spacing between the FEs.

The reactor core assembly is composed of 101 FEs, including 5 fuel-follower control rods, 17 graphite elements, a central channel and a pneumatic transfer system (Fig. 1). The FEs of the TRIGA reactor are contained within cylindrical rods made of stainless steel. The height of the active fuel region of the FE is 38.1 cm, the upper and lower endcaps are designed to enable safe positioning in the core. Two cylindrical graphite elements, serving as axial neutron reflectors, are stoppered on the top and bottom end of the fuel region (Fig. 1 A).