Improvement study for Kipros system's neutron shielding used for iodine-123 production at IEN

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The Radiopharmaceuticals Division of Institute of Nuclear Engineering - DIRAD/IEN, produces ultrapure iodo-123 for medical aplications, using the CV- cyclotron accelerator. To produce this radionuclide, the CV-28 produces proton beams of 24 MeV energy and 20 µA current. This beam is driven to the target sample to be irradiated, that is placed in a own concret cave placed 15 m away from CV-28. This target cave, where a xenon-124 gas target is positioned, reaches the dose level limits set out by the Brazilian National Nuclear Energy Commission Standard 3.01 [1] in its surrounding area. At its the access door there is a need to use a protection block formed by lead and polyethylene doped with boron, but this shield does not meet the minimum exposure limits of the standard in some specific points of the facilities. This report presents a methodology to determine the neutron flow in the area external to the block and study the use of materials for neutron shielding, allowing the reconstruction of the protection block with characteristics that make it more efficient, aiming mainly to reduce the dose rate in occupationally exposed individuals. During the irradiation procedure, with the bombardment of protons accelerated in the CV-28 at the ^{124}Xe target, the nuclei become unstable by excess protons and disintegrate by emission of positron ($^{+}\beta$) or electronic capture with gamma radiation emission. The improvement of this shield is being developed through analysis of materials able to moderate, capture and absorb the neutrons, using the MCNPX code [2]. The initial model was based on a ^{241}Am-Be neutron source.

A sphere was simulated with a radius of 100 cm and 10 cm thick, representing the iron door, two more spheres were added, modifying in each simulation the composition of them according to the material to be analyzed: boron polyethylene, paraffin and water.

A point detector was positioned on the outside of the sphere on the same axis of the source one meter away. Tally F5 was used to estimate the flow in a point detector (neutron.cm^{-2}) and in the input file a quantity converter was used to transform the flow values into environmental dose equivalent. Figure 1 shows the three spectra that were created according to the results of the simulations.

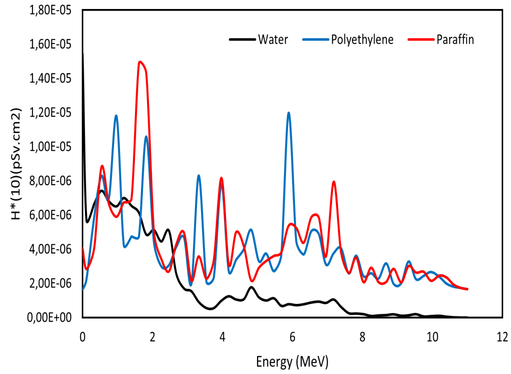

Figure 1. Spectra generated from results of the moderator materials

Paraffin was the best moderator of the three materials under study, with a great reduction in the environmental dose equivalent when compared to boron polyethylene (water did not present satisfactory results), using the conversion coefficient recommended by publication 74 of the ICRP [3]. The project aims to study other materials to improve the shielding. Subsequently, the experimental validation of the neutron flow will be performed using neutronic activation analysis.

References

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