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Experimental study and simulation of 64Cu production via neutron induce reaction

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Among verity of copper, radioisotope copper-64 is one of the beneficial radioisotopes with an appropriate half-life (T1/2 = 12.7 h) which can be used as a therapeutic and diagnostic ("Theranostic") agent by the unique emission of beta particles and gamma annihilations. The purpose of this study is to achieve the experimental and theoretical production yield of 64Cu from the natZnO and natZnONPs targets to develop the application of nanoparticles in radionuclide productions. In this study, zinc oxide nanoparticles (natZnONPs) and zinc oxide (natZnO) powder were irradiated with fast neutrons flux of 1.4 1013 n.cm-2.s-1 in Tehran Research Reactor (TRR) to produce 64Cu via the 64Zn(n,p)64Cu reaction. Scanning Electronic Microscopy (SEM) analysis of zinc oxide nanoparticles was used for samples characterizations before and after irradiation. Cross sections of this reaction were calculated by using TALYS-1.8, EMPIRE-3.2.2 and ALICE/ASH nuclear codes and the results were compared with experimental and theoretical databases. The theoretical production yield of 64Cu from the mentioned reaction was done with MCNPX-2.6 code. The production yields of 64Cu were measured at 49.98 MBq and 55.96 MBq from bulk and nano targets respectively which shows the increment activity of Nano-scale product. The calculated cross-section results showed good agreement between experimental and theoretical data. The SEM analysis represented there was no considerable difference in the size and shape of zinc oxide nanoparticles before and after irradiation. The calculated production yield with MCNPX was 50.73 MBq and shows good agreement with the experimental value. From these results, it's concluded that 64Cu can be produced in Tehran Research Reactor. The production yield of 64Cu from nano target was increased. The MCNPX code can be used as a tool to predict and optimize the production conditions in the reactor.

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