Contribution ID: **41** Type: **Poster**

Cross Section Calculations of (n, p) reaction on 175Lu for the production of medically important radioisotope 175Yb

Tuesday, 9 July 2024 17:42 (1 minute)

Among the prospective nuclear reactor-produced radionuclides, ytterbium-175 (175Yb) is found to be suitable for the preparation of therapeutic radiopharmaceuticals due to its decay characteristics (T1/2 (4.18d), Emax (480 keV)). It is an important metal that belongs to the rare earth metal family. However, a major constraint for its production via the (n, γ) reaction is the presence of lutetium-177 (177Lu) impurity alongside the 175Yb, which is co-produced upon irradiation of a natural ytterbium (Yb) target [1]. In this study, the reaction cross-section via the (n, p) reaction is calculated using lutetium-175 (175Lu) as the target material. We have considered neutron energies ranging from the threshold value to energies where the compound nuclear reaction mechanism has a significant contribution. This energy range corresponds to the maximum yield of 175Yb production. For the production of 175Yb, the Q-value for the neutron-induced reaction is 312 keV and, its half-life makes it feasible for easy transportation to remote locations from production sites to nuclear medicine sites. Among the two natural lutetium (Lu) isotopes, 175Lu has the highest abundance (97.40%). The produced 175Yb is then converted back to the parent stable nuclei 175Lu through beta decay (100%), leaving no co-produced impurities behind during the production of 175Yb. Therefore, it is feasible to prepare a radiotherapeutic agent with easily recoverable 175Yb via the studied reaction, and waste generation is also minimized. In the study, deterministic codes EMPIRE [2] and TALYS [3] were utilized with their default input parameters as well as with optimized input parameters. Experimental data [4-6] were taken for comparison from the EXFOR library [7]. Using both codes, calculations were performed based on the Hauser Feshbach statistical model, including width fluctuation corrections (WFC) with different expressions for the compound nuclear reaction mechanism. This study aims to enhance the nuclear data bank and its quality for further development to meet the increasing demand for medically important radionuclides [8]. For comparison, major evaluated nuclear data libraries, ENDF, JEFF, and TENDL, were also consulted. The calculated results, available experimental data, and evaluated results were found to be comparable with some discrepancies.

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Primary author: NADEEM, Muhammad (Pakistan institute of Nuclear Science and Technology)

Co-authors: Mr ATTA, Muhammad (Pakistan institute of Nuclear Science and Technology); Mr HAMEED QAISER, Syed (Pakistan institute of Nuclear Science and Technology); Mr MALIK, Tayyab Mahmood (Pakistan institute of Nuclear Science and Technology); Mr SAJJAAD, Muhammad (Pakistan institute of Nuclear Science and Technology)

Presenter: NADEEM, Muhammad (Pakistan institute of Nuclear Science and Technology)

Session Classification: Poster Session

Track Classification: Nuclear applications