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Separation of actinium-225 for nuclear medicine purposes from thorium targets irradiated by high energy protons

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Due to high linear energy transfer (LET) of about 100 keV/μm and low path of about 50-100 μm in biological tissue of alpha particles, alpha-emitters are promising for targeted radiotherapy of cancer. The number of potential alpha-emitters that could be used in medical applications is limited by the requirements of half-life, availability of these alpha-emitters and experimental difficulties in their separation. The most promising candidates for clinical applications are 211At, 212Bi, 213Bi, 225Ac. Among these alpha-emitters, 211At could be easily obtained by irradiation of bismuth by 28-29 MeV alpha-particles on a cyclotron. However its application is limited by the synthetic preparation of astatineorganic compounds and weakness of At-C chemical bond. Actinium-225 could be used either directly for preparation of radioimmunoconjugates or could be used as a parent radionuclide in 213Bi isotope generator. However wide application of 213Bi and 225Ac is limited by the low availability of these radionuclides. Several methods are proposed for 225Ac production while most frequently it is separated from mother 229Th or by irradiation of 226Ra with protons in a cyclotron. Both methods have some practical limitations to be applied routinely.
The aim of this investigation was to develop the separation method of 225Ac from natural thorium irradiated with protons with the energy of around 100 MeV at linear accelerator of Institute of Nuclear Research RAS. Thorium foil was irradiated by protons with the energy of 104 MeV. The radionuclide composition was determined by gamma-spectrometry. Irradiated thorium target was dissolved in minimal volume of 6 M HCl upon heat. Thorium and some fission products were separated by solvent extraction by TPB in toluene (1:1) (twice) and by 0.15 M TOPO in toluene. In some experiments dissolution was done by 7 M HNO3 and extraction was also done from this solution. Aqueous phase containing actinium was evaporated near dryness and dissolved in 0.05 M HNO3. These solutions was transferred to the extraction chromatographic column filled with Ln Resin (Eichrom) After adding the sample to the column, it was sequentially washed by 0.05 M HNO3 and 3 M HNO3 solutions. Actinium and REE containing fraction were loaded to the extraction chromatographic column filled with TRU Resin (Eichrom). To determine the impurities of 227Ac in actinium fraction the alpha-spectrometry was employed. Other radionuclidic impurities were assessed by gamma ray spectrometry. It was shown that most significant impurity is 227Ac (less than 0.1% on EOB) but it could not interfere in application of the product in Ac/Bi generators.

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