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Separation of Ac-225 from lanthanide fission products using a reverse phase chromatographic process incorporating a solvent impregnated resin

Targeted α-particle therapy (TAT) has been shown in recent years to be a promising route for the treatment of various forms of cancer, and may serve as an alternative to more traditional cancer treatment options. TAT takes advantage of an α-emitting radionuclide's ability to deliver cytotoxic doses of radiation to tumor cells while causing minimal damage to surrounding healthy tissue. This is possible because of the short path length and high linear energy transfer associated with
α -particles, which are on the order of 100 μm or less and around 100 keV/μm, respectively. To this end, a number of α-emitting radionuclides have explored for therapeutic applications including Ac-225, Bi-213, Bi-212, At-211, and Ra-223 with others currently in development. Of these, Ac-225 in particular has proven itself to be an especially appealing isotope for the treatment of some cancers.

The value of Ac-225 is derived in part from its four alpha decay chain, which includes Bi-213 (t1/2 = ~46 minutes), which is in itself a desirable isotope for TAT. The targeted delivery of Ac-225 to tumor sites has been shown in a number of instances to be highly effective for the treatment of several forms of cancer when a conjugate with an antibody, peptide, or protein is produced which can carry the isotope to the target site. One of the more notable instances of the successful treatment of human cancer with Ac-225 has been in the treatment of prostate cancer, for which Ac-225 may be conjugated with Prostate Specific Membrane Antigen for targeted doses to prostate cancer tumor cells. Because of the proven efficacy of Ac-225-containing conjugate species in anticancer treatment applications, demand for this isotope is expected to rise above current production capabilities.

The work presented herein describes a new method for the separation of Ac-225 from radiolanthanide impurities resulting from fission of proton irradiated Th-232 target foils. The process incorporates a solvent impregnated resin to achieve the separation, and is the first in a series of resins to be tested as alternatives to current technologies incorporating branched DGA resin. The current resin is comprised of an Amberlite XAD7HP resin that has been loaded with the ionic liquid 1-butyl-3-methylimidazolium bis(trifluoromethane)sulfonamide ([Bmim][NTf2]) and the extractant N,N-dioctyldiglycolamic acid (DODGAA). Going forward, the resin will be tuned to achieve optimum results by loading the Amberlite scaffold with varying combinations of ionic liquids and extractants. Data presented will include batch extraction experiments including the solvent impregnated resin with complex matrices of metals (La-Lu, Sc, Y, U, Th, Ac) in HCl, HNO3, and citrate-phosphate buffer media over a range of pH. Additionally, results of dynamic column experiments will be presented, and comparisons will be made to separations technologies currently in use.

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