



PRODUCTION OF SN-117M IN THE BR2 HIGH-FLUX REACTOR

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Introduction

Tin-117m is a theranostic radioisotope characterized by a half-life of 13.6 days and two significant energy emissions: a low energy 159 keV gamma photon (86%) suitable for imaging and dosimetry, and low-energy conversion electrons (~140 keV) that have a well-defined penetration range in tissues of ~300 μm , limiting their therapeutic effect to the desired tissues without damaging adjacent healthy tissues. Successful results have been achieved with Sn-117m for the treatment of bone metastases, inflammatory cardiovascular diseases, osteoarthritis and rheumatoid arthritis.

Reactor production and radiochemical preparation

While very high specific activities (>1,000 Ci/g) of Sn-117m can be achieved in accelerators by reactions such as $\text{Cd-116}(\alpha,3n)\text{Sn-117m}$ or $\text{Sb-nat}(p,xn)\text{Sn-117m}$, research reactors are able to produce large quantities of low specific activities suitable for various applications in nuclear medicine by the inelastic scattering reaction $\text{Sn-117}(n,n'\gamma)\text{Sn-117m}$. As this reaction is characterized by a threshold of 318 keV, suitable irradiation positions have been selected in the BR2 High-Flux Reactor providing fast neutron fluxes of $6.0 \times 10^{14} \text{ n/cm}^2\cdot\text{s}$ above an energy of 100 keV. Several irradiation campaigns of ~93% Sn-117 enriched metal have been successfully performed during single full reactor operating cycles of 21 to 35 days. These were performed inside standard reactor fuel elements loaded in the central irradiation channels of the reactor core. Specific activities of Sn-117m in the range of 4-10 Ci/g have been achieved at the end of irradiation (EOI). The multi-Ci scale of reactor produced Sn-117m satisfies the demands for clinical trial and commercial uses. Specifically, the product being evaluated to treat arthritis requires a specific activity of 0.5 Ci/g at manufacturing and has a two-week shelf-life. Therefore, the specific activity of the Sn-117m should be at least 4 Ci/g at EOI to allow for several weeks of treatments between irradiation cycles. The targets irradiated in the BR2 reactor are transported to the facilities of IsoTherapeutics Group, LLC in TX, USA where the tetraiodide form of irradiated tin is readily prepared with HI or other reagents as basis of the colloidal radiosynoviorthesis product currently used for canine osteoarthritis and for human rheumatoid arthritis trials.

Conclusions

Suitable irradiation conditions have been achieved at the BR2 High-Flux Reactor to produce the requested specific activities of Sn-117m by the inelastic scattering reaction. Radiochemical preparations of Sn-117m with specific activities of up to ~7 Ci/g have been obtained. The quantities and specific activities produced are sufficient to support commercial product demands.

Keywords: nuclear medicine, Sn-117m, theranostics, reactor produced isotopes, high-flux reactor