CONTINUOUS, EFFICIENT PRODUCTION OF MEDICAL RADIOISOTOPES

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OTHER INFORMATION

KEYWORDS

Szilard-Chalmers, Prompt gamma recoil, radioisotope separation, Specific activity, Medical radioisotopes, Radiopharmaceuticals, Cancer treatment, Radioisotope power systems

CATEGORIZED AS

- **Energy**
  - Other
- **Imaging**
  - Medical
- **Materials & Chemicals**
  - Chemicals
  - Other
- **Medical**

- Diagnostics
- Disease: Cancer
- Imaging
- Research Tools
- Therapeutics

BRIEF DESCRIPTION

The invention is a method for instantaneous and efficient extraction of radioactive isotopes with high specific activity, during continuous production at research reactors. The proposed method allows advantageous production of radioisotopes for various applications, including nuclear medicine uses (diagnostics, imaging, cancer treatments). In addition, the invention has the potential for applications related to isotopes used in thermoelectric generators (i.e. 238Pu) that power both medical devices, such as cardiac pacemakers, and deep space missions.

RELATED CASES

2016-761-0

FULL DESCRIPTION

Radioactive isotopes are an important diagnostic and therapeutic tool in the medical field. Although every medical application requires compounds of exceptional purity in order to reduce toxicity and ensure that a minimum amount can be administered for a maximum effect, radioactive therapeutics and imaging agents necessitate especially stringent quality criteria (high specific activity in the case of radioactive isotopes). In addition, the desirable properties of a medical radioisotope include:

• Short half-life, to ensure timely after-use decay without causing excess damage to the surrounding organs and tissues

• Image-able gamma ray emission for diagnostic applications

• Beta or alpha emissions with appropriate energy levels to deliver a therapeutic dose to the target tissue for therapeutic applications

• Efficient production methods that provide high specific activity isotopes in a form that facilitates their further incorporation into radiopharmaceuticals.

Several of the lanthanide elements, as well as over 30 isotopes of other chemical elements, have these desirable nuclear properties, as well as some beneficial chemical properties, and, thus, are suitable for use as medical radionuclides.

Medical radioisotopes are typically produced via nuclear reactors. However, the specific activity of radioisotopes generated by direct neutron capture [(n,gamma) reaction] in nuclear reactors is highly dependent on the target material and irradiation conditions. Consequently, the obtained radioisotopes of interest are contaminated with the stable isotope carrier and undesirable by-products, which conventional separation techniques are often unable to remove. Nevertheless, high purity of the radioisotope is crucial for any medical application in order to develop a high purity radiopharmaceutical and avoid chemical toxicity effects.

The inventors at UCI have developed an innovative setup to continuously produce and efficiently isolate radioisotopes with high specific activity in any research reactor. This method yields low carrier radioisotopes with increased specific activity, as compared to the products of typical direct neutron activation procedures. Per the disclosed method, upon irradiation, the desired radionuclide is instantly and permanently (chemically) separated from the bulk of the inactive starting material. When used in tandem with custom-made irradiation target resins, the method can result in a substantial decrease in the amount of lanthanide needed for a typical medical procedure. This method drastically reduces formation of undesired radioisotope byproducts, eliminating the need for exotic and costly hot cell facilities used in typical post-irradiation processing.

The invention addresses the need for production of quality radionuclides for medical applications ranging from diagnostic imaging to radiation therapies. Other potential applications include radioisotope power systems to address the challenges encountered in efficiently producing plutonium-238 (238Pu), which is used as a heat source to power both nuclear powered cardiac pacemakers and space missions.

SUGGESTED USES

• Production of medical radioisotopes for imaging/diagnostic and therapeutic applications.

• Isotope production for thermoelectric generators (238Pu) to power cardiac pacemakers or deep space missions.

ADVANTAGES

• Highly efficient method decreases the need for exotic and costly post-irradiation processing of radioisotopes.

• Production of isotopes at research reactors addresses supply and distribution challenges, as such facilities exist in multiple locations around the world (246 worldwide with 31 operational in the US).

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	10,804,000	10/13/2020	2016-761

STATE OF DEVELOPMENT

Prototype developed and experimentally tested

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Applied Innovation

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