Recent Developments in the Use of Californium-252 Sources for Neutron Brachytherapy

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The Radiochemical Engineering Development Center (REDC) at Oak Ridge National Laboratory is one of two production centers for the radioisotope ^{252}Cf, the other being the Research Institute of Atomic Reactors (RIAR) in Dimitrovgrad, Russia. Californium-252 is a unique radioisotope in that a significant fraction decays via spontaneous fission with 2.645-year average decay half-life, releasing on average 3.77 neutrons per fission. After encapsulation, ^{252}Cf provides a compact, portable, intense source of neutrons with 1 mg of ^{252}Cf emitting 2.3×10^9 neutrons/s.

Both the REDC and RIAR produce ^{252}Cf sources for neutron brachytherapy. Brachytherapy is a form of tumor therapy in which the radioactive source(s) are placed internally in or near the tumor site. Although photon brachytherapy is more common, ^{252}Cf neutron brachytherapy has been shown in clinical trials to have several advantages over photon brachytherapy, in particular better response of radioresistant tumors such as hypoxic (oxygen-deficient) and bulky tumors. Cancers typically targeted by ^{252}Cf brachytherapy are those of the cervix, head and neck, anus, and soft tissue sarcomas. A fundamental advantage of neutron brachytherapy is that a single neutron hit typically ensures death of the cancerous cell, unlike photon brachytherapy.

This presentation will discuss production of ^{252}Cf radioisotope and brachytherapy sources, compare neutron vs photon brachytherapy, discuss past and current brachytherapy practice and source designs in the United States and around the world, and speculate on future directions for ^{252}Cf brachytherapy. Other radiotherapy-related applications of ^{252}Cf, including experiments related to boron neutron capture therapy at the REDC's Californium User Facility for Neutron Science, will be briefly discussed.

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