

Introduction

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Nuclear power has become an important source of energy in the world. The increase in energy demand expected in the coming years and the depletion of fossil resources will be a real challenge. Nuclear energy has several advantages, given the considerable amount of energy it can produce. Moreover, it has made it possible to reduce dependence on hydrocarbons. Nevertheless, nuclear energy poses two major challenges to the scientist: nuclear waste and the use of its resources.

The separation of long-lived radionuclides is based on the industrial maturity of various processes which are currently in use in reprocessing plants, we cite PUREX, DIAMEX, SANEX and SESAME. These processes are a satisfactory means that can be developed for recovery of iodine-129 contained in spent fuel. Radionuclides can be trapped using : activated carbons and zeolites. Type of management can theoretically be envisaged : conditioning for deep geological disposal.

Currently, storage appears as a reference solution for the management of nuclear waste, but another way is being considered: separation followed by transmutation. The latter is based on the principle of transforming the long-lived radiotoxic element, by a nuclear reaction, into another element that is less radioactive or even stable. Among the most important long-lived radio-elements, we distinguish iodine-129 with a half-life of $1,57 \times 10^7$ years. The other stable isotope available in spent fuel is iodine-127. Iodine is found in the form of metal iodides as irradiation targets. Transmutation of iodine-129 is applicable in nuclear reactors by neutron capture. Transmutation efficiency depends on neutron flux, neutron-cross section and irradiation time in reactors.

In order to show the potential interest of HFR (High Flux Reactor) reactors for the transmutation of iodine-129, we evaluate in the framework of this thesis, the transmutation performances in four research reactors namely: Petten (Netherlands), BR2 (Belgium), SM3 (Russia) and JOYO (Japan). This evaluation is based on the use of the transmutation calculation code ChainSolver 2.34. Other parameters calculated

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from this code are: transmutation rate R , transmutation amount C , transmutation support ratio TSR , average transmutation acceleration A to select the best reactor which provides a better rate.

The present manuscript is structured in four chapters. In the first chapter, some nuclear concepts are described and some basic notions of nuclear waste are presented as well as the three aspects of its long-term management.

In the second chapter, we describe the characteristics and methods of separation and transmutation of the long-lived fission product iodine-129.

The third chapter starts with the Bateman equation; the basis of the code, then the `ORIP_XXI` collection is explained in details. Its programs are: `NKE`, `ChainFinder` and `ChainSolver`. This collection is used for the creation and evaluation of the transmutation efficiency of iodine-129.

The fourth chapter is devoted to the numerical evaluation of the transmutation efficiency such as R , C , TSR and A .