# ANALYSIS OF THE MINOR ACTINIDES RECYCLE IN THERMAL REACTORS

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## Abstract

Nuclear power generation is inevitably accompanied by the formation of a mass of spent fuel which contains, apart from the short-lived fission products, a significant amount of actinides and fission products with high toxicity and very long half-lives. These nuclides constitute the long-term radiotoxic inventory, which remains as a hazard far beyond human perception.

Conventional reprocessing (MOX) recycles most of the major actinides (uranium and plutonium), while the minor actinides (MA) (mainly neptunium (Np), americium (Am), and curium (Cm)) with half-lives of up to 2 million years remain with the fission products and constitute over a very long time period (hundred thousand years) a significant radiological source term within a spent fuel repository.

The solution of the waste problem at the back end of the cycle is crucial for a continued and sizeable use of nuclear energy from fission.

Nuclear transmutation of long-lived nuclides into shorter-lived nuclides is an attractive option which may alleviate the burden of geologic disposal scenario reducing the environmental impact of nuclear energy to few hundred years. Various methods of transmutation have been proposed: transmutation can be carried out in thermal reactors, in fast neutron reactors and in accelerator-driven subcritical reactors (ADS).

In the middle-time, the recycle of minor actinides into thermal reactors seems to be the most appropriate option until ADS and fast neutron “incinerator” technology becomes industrially available.

In this paper we investigate the effects of minor actinides recycle in different thermal reactors to evaluate the performance of these systems and verify the possibility of reducing the storage time for nuclear wastes in the final repository. To achieve such goal we first evaluate the parameters that influence the actinide transmutation; and then, we compare the potential risk due to the wastes produced by each system, with that associated with radioactive materials existing in nature. The aim is to find the optimum transmutation system, or the optimum minor actinides quantity and composition to recycle for each system. The analysis here reported is performed by using ORIGEN 2.2 computer code. The Chemical Technology Division at Oak Ridge National Laboratory (ORNL) developed this code. The code was principally intended for use in estimating spent fuel and waste characteristics for the design and study of fuel reprocessing plants, waste treatment and disposal facilities.