The use of GFR dedicated assemblies in the frame of advanced symbiotic fuel cycles: an innovative way to minimize the long-term spent fuel radiotoxicity

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Abstract

Am and Cm are mainly created by U and Pu transmutation. In terms of radiotoxicity, these MA are (potentially) quite dangerous for a long period. In addition, most of their isotopes are not fissile, so for their elimination only the transmutation process seems to be effective.

However while fast reactors are characterized by a high and hard neutronic flux (very good for burning Pu), Am and (above all) Cm cross sections are generally higher in a (epi-)thermal spectrum. So, in order to achieve both the targets, it is possible to introduce particular dedicated ("over-moderated") elements in a fast reactor core. The idea is to maximize the transmutation rate by using the high fluence (typical of a fast rector) in combination with a spectrum (thermal or slightly epi-thermal) optimized for burning those MA. By adopting the proposed solution it could be possible to strongly reduce Am and Cm and to produce energy at the same time.

In this respect, we found that the possibility of using dedicated assemblies (DAs) in a GFR seems to be a good solution for increasing MA elimination. The choice of positioning DAs both in central and in peripheral core zones allows a sufficient (from safety point of view) delayed neutron fraction with an adequate transmutation rate. Furthermore to load a greater MA mass in the core is preferable from the transmutation point of view.

To further improve the transmutation performance (particularly concerning the Cm^{244} elimination), the exploitation of the spontaneous decay of some MA before reprocessing the spent fuel has been studied, too.

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