ANALYSIS OF A FAST REACTOR TRANSITION SCENARIO WITH EVOLCODE/TR_EVOL

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Abstract

A specific scenario of European Sodium Fast Reactor technology (ESFR) penetration in a European fleet has been analyzed by the Innovation Group at CIEMAT by means of two kind of computational tools, a parametric fast running computer code named ECC, under development to explore cost-benefit strategies for advanced nuclear fuel cycles, and a more accurate tool named TR-EVOL (module of the EVOLCODE 2.0 simulation system), in which reactor physics is more realistically considered.

The considered scenario assumes that there will be a European low energy-demand scenario of electricity. The same main assumptions as in the EU FP6 PATEROS project were taken into account concerning the initial condition: an association of seven European countries, together with their nuclear material stocks, is considered in 2010. Also, the electricity production is assumed to be constant during the period of reference, being 800 TWhe per year.

The main objective is to address the possibility of substitution of the light water reactor technology (LWR) by SFR over a period of 90 years (2010-2100). Also, a variation to the base case is considered for Minor Actinide (MA) management in the reactors.

Four reactor technologies are considered, including the present LWR-UOX and LWR-MOX fleets, Gen II type, both to be replaced by the European Pressurized water Reactor (EPR) design after 2020; EPR technology, Gen III+ type, each unit having 60 years operational lifetime to be replaced, in turn, in 2100 by ESFR; and the ESFR technology, assumed to be available for deployment in the year 2040. Therefore, it is introduced in that year and it should coexist with the EPR type for a number of years. In the coexistence period, the electricity contributions coming from both technologies are kept constant after the ESFR introduction phase, i.e., as of 2050: 1/3 comes from ESFR, 2/3 from EPR. After that, in 2080, the EPR technology starts to be fully replaced by the ESFR.

Both kinds of codes complement the analysis and results indicate that a successful scenario of full replacement of LWR technology by ESFR in a 90-year time frame is possible. On the one hand, the requirements for Pu breeder reactors are moderate enough for the reactor design to avoid blankets. On the other hand, the amount of Pu to be managed is very large.

When an alternative case with homogeneous transmutation strategy having a constant 2.5%w of MA content in the fuel at loading is assumed, the Np+Am stock is nearly reduced to zero after about a

century (except for a small amount coming from reprocessing losses), while the Cm stock is decreased but not fully eliminated. The strategy, however, would require the fabrication of large amounts of MA-bearing subassemblies.