Status of the EC-FP7 project ARCAS: Comparing the economics of Accelerator Driven Systems and Fast Reactors as Minor Actinide burners

Gert Van den Eynde[1], Vincenzo Romanello[2], Tim Abram[3], Colin Zimmerman[4], Aliki van Heek[5]
[1]SCK•CEN, Belgium
[2]KIT, Germany
[3]University of Manchester, United Kingdom
[4]NNL, United Kingdom
[5]NRG, The Netherlands

Abstract

The ARCAS project aims to compare, on a technological and economical basis, Accelerator Driven Systems and Fast Reactors as Minor Actinide burners. In order to be able to perform this comparison, one needs to have a sufficient idea on the expected minor actinide stream for a reasonably large nuclear park. The assessment of this stream was the subject of the first work package. A literature study of several previous projects focusing on fuel cycle scenario analyses was performed together with an analysis of the current legal framework on spent fuel management and a review of current fuel reprocessing and fabrication techniques; some relevant data were obtained by some further elaboration of available simulations. This resulted in a reference minor actinide mass flow (a lower and a higher boundaries were estimated) and isotopic vector that can be expect based on the first PATEROS (EC-FP6) reference scenario.

In parallel, work packages 2 and 3 are establishing the reference Fast Reactor and Accelerator Driven System to be used in the ARCAS project. The main concern here is the maximal loading (from the point of view of safety and operations) of minor actinides in the core of either system. A brief overview of open studies has been done with a special emphasis on the EU project CP-ESFR (3600 MWth SFR concept), for which a set of activities are being directed towards MA transmutation. For the ADS, the EFIT design (EC-FP6 IP-EUROTRANS) has been selected by work package 3 as the reference case. A parametric study on relevant safety parameters (delayed neutron fraction, void effect) has been performed as a function of the minor actinide loading using the reference minor actinide vector from work package 1.

The fourth work package is responsible for a schematic design of the fuel reprocessing facilities and fuel fabrication facilities in support of the fuel cycle involving the fast reactors and accelerator driven systems. One critical component, and often overlooked in other studies, is the transportation issue: the cost and safety of the transportation of fuel with (high) minor actinide content.

Finally, the last work package has to gather all information from the other work packages in order to able to present a comparison between the two options of fast reactors or accelerator driven systems. With the number of units needed per GWe of LWR installed and the investment cost of a transmutation unit, the investment cost per GWe is determined. For selected nuclear evolution scenarios, the total investment cost needed for transmutation can be determined. Also, the total generating costs are compared, giving an answer to the question on how much

the MA transmutation would add to the cost of kWh. These costs would include both the investment, operational and fuel cycle costs. The fuel cycle costs consist of all the parts of the closed cycle, including reprocessing and fuel/target fabrication.