CURRENT STATUS AND FUTURE DEVELOPMENTS OF THE TRANSURANUS CODE: OXIDE FUELS FOR MINOR ACTINIDES RECYCLING

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Abstract

Nuclear energy thanks to its competitiveness and low carbon technology is playing a significant role in the global energy market. While nowadays nuclear plants are almost entirely based on thermal reactors technology, a new generation of fast reactors is investigated pursuing an improvement of the effectiveness in the use of natural uranium resources in parallel with an increase in proliferation resistance and a reduction in radiotoxicity of used fuel, achieved through the transmutation of minor actinides (MA). These innovative nuclear plants, conceived in the framework of the Generation IV International Forum (GIF), have a deployment time horizon beyond 2030.

The transmutation of minor actinides is achieved through two main options: homogeneous recycling, where small quantities of MA are diluted in the driver fuel (MOX), and heterogeneous recycling, where MA are dispersed in high concentration in a UO_2 matrix and irradiated at the periphery of the core. The addition of minor actinides in oxide fuels has an impact on various aspects of in-pile performance such as the degrading of thermal conductivity and melting temperature, a higher fuel swelling rate and a higher helium production. These aspects need to be carefully studied to fulfill safety criteria as a key requirement to support the expansion of nuclear business. The description and modelling of MA-bearing oxide fuels is therefore challenging and investigations are ongoing in various projects undertaken in the EURATOM framework e.g. FAIRFUELS, PELGRIMM.

With regard to fuel with a standard fabrication route, the paper discusses the current status and future modelling needs of the TRANSURANUS fuel performance code, with particular attention to following aspects:

- helium generation;
- integral fission gas release of xenon, krypton and helium;
- solid and gaseous fuel swelling;
- fuel thermal conductivity;
- re-distribution of plutonium at high temperatures.