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PLUTONIUM RECYCLING THROUGH LWR MOX FUEL: TODAY AND TOMORROW

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Recycling operations have been mastered for long in France, from the plutonium separation to the irradiation of MOX fuel, as France committed itself towards recycling plutonium in PWRs since 1987. Today, the French reactors using MOX are operated according to fuel management allowing equivalent performance of energy supplied with the same reliability as those using UO2 fuels.
The paper first presents the experience feedback obtained up to 65 GWd/tHM (rod average). Fuel microstructural evolutions under operations as well as the behavior of fission products have been thoroughly examined. A somewhat higher fission gas release is observed compared to UO2 fuel mainly due to the higher power levels of the MOX fuel and its more heterogeneous microstructure. To keep the parity with UO2 in the future, MOX evolution based on advanced microstructures is considered to provide the required performance. In that respect, the CHROMOX microstructure obtained by Cr2O3 doping shows an enhanced homogeneity notably with smaller primary blend agglomerates and increased matrix grain size. With these evolutions, internal pressure margins are anticipated and better retention of gaseous fission products in accidental conditions by reduction of restructured areas.
To sustain the use of MOX fuel in the future, the second part of the paper presents the adaptations to be implemented at the MELOX production plant to face the inherent degradation of the Pu isotopic vector of MOX fuel and its higher Pu content from increased core management cycle length.
In addition, Pu multi-recycling strategies in LWRs are studied with new fuel technologies. In order to be able to use low quality Pu in a PWR spectrum, fissile uranium needs to be added. With the CORAIL-A option, developed by Framatome and Orano, the assembly contains about half of MOX fuel rods and the remaining as UO2 rods. By contrast, the MIX fuel assembly contains only MOX rods with an enriched uranium matrix that compensates the Pu degradation. Development of those fuel technologies, that could be coupled with the most advanced Framatome fuel assembly design GAIA, will offer flexibility to switch to future technically and economically robust advanced cycles in current or future LWRs with a limited impact to the reactor design and its performance. These developments will allow implementing efficient solutions bridging the gap with the potential development of GEN IV reactors.

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