Future Nuclear Fuel Cycles: Meeting Sustainability Through Actinide Recycling

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Abstract

Nuclear energy stands as a sustainable way to answer the worldwide increase in energy needs, while limiting green-house gas emissions. Considering the post Fukushima context, societal acceptance is closely associated to enhanced safety, by improving the technical and organizational measures of the highest standards taking into account the management of extreme situations for all nuclear facilities. Reactors and fuel cycle offering the best safety features while staying economically competitive have to be promoted in the next decades in order to recycle valuable materials, such as plutonium, and to better manage highly radioactive nuclear waste by partitioning and transmutation of minor actinides and particularly americium.

This paper aims to depict what are these fuel cycle options and the corresponding supportive French R and D program strategy, with the objective of increasing the sustainability of nuclear energy within the scopes of the 1991 and 2006 French Waste Management Acts requesting in particular the study of applicable solutions for still minimizing the quantity and the hazardousness of final nuclear waste.

For the future, the long term sustainable nuclear systems will be fast reactors which allow full use of uranium with no enrichment needs, efficient burning of plutonium and potentialities for improving waste management. They will be initially fuelled with plutonium coming from spent LWR MOX fuels, then the corresponding fuel cycle main features will be full plutonium/uranium multi-recycle, with advanced recycling concepts (no separated pure plutonium with COEX™, on-line recycling and co-location of processing and fuel fabrication plants, appropriated international safeguards measures using a systemic approach based on accountancy and monitoring). Regarding waste management, most of the research in France has been conducted towards the assessment of industrial potentialities of the diverse P and T options by 2012 and the construction of the sodium cooled ASTRID reactor allowing minor actinide transmutation demonstration by 2025. This paper gives an overview of the current status of the research and main outcomes obtained at CEA on these topics.

In the coming years, next steps will involve both better in-depth understanding of the scientific basis of MAs recycling processes, and an engineering scale demonstration test of the Am recycling based on the innovative EXAm process (from spent fuel dissolution to UAm transmutation target fabrication).