PLUTONIUM AND MINOR ACTINIDES MANAGEMENT IN THERMAL HIGH-TEMPERATURE REACTORS - THE EU FP6 PROJECT PUMA

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ABSTRACT

The High Temperature gas-cooled Reactor (HTR) can fulfil a very useful niche for the purposes of Pu and Minor Actinide (MA) incineration due to its unique and unsurpassed safety features, as well as to the attractive incentives offered by the nature of the coated particle (CP) fuel. No European reactor of this type is currently available, but there has been, and still is, considerable interest internationally. Decisions to construct such a reactor in China and in South Africa have already been made or are about to be made. Apart from the unique and unsurpassed safety features offered by this reactor type, the nature of the CP fuel offers a number of attractive characteristics. In particular, it can withstand burn-ups far beyond that in either LWR or FR systems. Demonstrations as high as 75% FIMA have been achieved. The coated particle itself offers significantly improved proliferation resistance, and finally with a correct choice of the kernel composition, it can be a very effective support for direct geological disposal of the fuel.

The overall objective of the **PUMA project**, a Specific Targeted Research Project (STREP) within the European Union 6th Framework (EU FP6), is to investigate the possibilities for the utilisation and transmutation of plutonium and especially minor actinides in contemporary and future (high temperature) gas-cooled reactor designs, which are promising tools for improving the sustainability of the nuclear fuel cycle. This contributes to the reduction of Pu and MA stockpiles, and also to the development of safe and sustainable reactors for CO_2-free energy generation.

A number of important issues concerning the use of Pu and MA in gas-cooled reactors have already been dealt with in other projects, or are being treated in ongoing projects, e.g. as part of EU FP6. However, further steps are required to demonstrate the potential of HTRs as Pu/MA transmuters based on realistic/feasible designs of CP Pu/MA fuel and the PUMA focuses on necessary key elements, which are not covered by these other projects. Earlier projects indicate favourable characteristics of HTRs with respect to Pu burning. So, core physics of Pu/MA fuel cycles for HTRs will be investigated to optimise the CP fuel and reactor characteristics and to assure nuclear stability of a Pu/MA HTR core, under both normal and abnormal operating conditions. The starting point of this investigation comprises the two main contemporary HTR designs, viz. the pebble-bed type HTR, represented by the South-African PBMR, and hexagonal block type HTR, represented by the GT-MHR.

It is also envisaged to optimise present Pu CP design and to explore feasibility for MA fuel. New CP designs will be explored that can withstand very high burn-ups and are well adapted for disposal after irradiation. The project benefits greatly from access to past knowledge from

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Belgonucléaire's Pu HTR fuel irradiation tests of the 1970-s, and also secures access to materials made at that time.

(Very) High Temperature Reactor (VHTR) Pu/MA transmuters are envisaged to operate in a global system of various reactor systems and fuel cycle facilities. Fuel cycle studies are envisaged to study the symbiosis to LWR, GCFR and ADS, and to quantify waste streams and radiotoxic inventories. The technical, economic, environmental and socio-political impact will be assessed as well. The PUMA project runs from September 1, 2006, until August 31, 2009, and is being executed by a consortium of 15 European partner organisations and one from the USA. The paper presents an overview of planned activities and preliminary/expected results.