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Dissolution of carbide fuel materials

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As part of the strategic research agenda for sustainable nuclear energy in Europe [1], carbide fuel is proposed as a potential candidate fuel for sodium cooled fast reactors and is the fuel of choice for gas cooled fast reactors. Carbide fuels have also been demonstrated to achieve high burn-up (> 155 GWd/t) in the sodium cooled Fast Reactor Fuel Reprocessing technology being pursued at the Indira Gandhi Center for Atomic Research (IGCAR), Kalpakkam. There are a number of issues that need to be addressed in the reprocessing of carbide fuel in order to demonstrate a sustainable closed nuclear fuel cycle.

Carbide fuel can be problematic when applying the traditional PUREX reprocessing technology of solvent extraction from a nitric acid solution. The dissolution of uranium carbide (UC) in hot nitric acid can lead to the formation of soluble organic molecules that can interfere with the extraction of uranium and plutonium reducing their extraction and recovery efficiencies. The organics can also lead to emulsions causing difficulties within industrial processes. Even when the U and Pu have been removed from the soluble organics the remaining liquor contains highly radioactive fission products in the presence of organic material that requires volume reducing before immobilising in a glass matrix. The presence of organics can present a safety issue and needs to be effectively managed.

In this paper we present the dissolution results from first titanium carbide (a potential barrier material in GCFRs) and then from unirradiated uranium carbide fast reactor blanket fuel pellets.

The kinetics of dissolution will be discussed together with comments on the organic materials produced and carbon mass balance.

[1] SNETP Strategic Research Agenda May 2009; Strategic Research and Innovation Agenda, Feb 2013.

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