CONCEPTUAL DESIGN OF FUEL AND RADIAL SHIELDING SUB-ASSEMBLIES FOR ASTRID

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Track 5. Fast Reactor Materials (Fuels and Structures) and Technology

ABSTRACT

The French 600 MWe Advanced Sodium Technological Reactor for Industrial Demonstration (ASTRID) project reached in 2015 the end of its Conceptual Design phase. The core design studies are being conducted by the CEA with support from AREVA and EDF. Innovative design choices for the core have been made to comply with the GEN IV reactor objectives, marking a break with the former Phénix and SuperPhénix Sodium Fast Reactors.
The CFV core of ASTRID demonstrates an intrinsically safe behavior with a negative sodium void worth achieved thanks to a new fuel sub-assembly design. This one comprises (U,Pu)O2 and UO2 axially heterogeneous fuel pins, a large cladding versus small spacer wire bundle, a sodium plenum above the fuel pins, and an upper neutron shielding with both enriched and natural boron carbide. The upper shielding also maintains a low secondary sodium activity level and is made removable on-line through the sub-assembly head for washing compatibility. Calculations have been performed to increase the stiffness of the stamped spacer pads in order to analyse its effect on the core mechanical behaviour during hypothetical radial core compaction events.
Concerning the radial shielding sub-assemblies surrounding the fuel core, heavy iterative studies were performed in order to fulfill ASTRID requirements of minimising the secondary sodium activity level and maximising the in-core life-time. Evaluated options were reflectors sub-assemblies made of steel or MgO rods, and radial neutron shielding sub-assemblies made of B4C or borated steel, with different configurations in the design and in the core layout.
This paper describes the design of the fuel and radial shielding sub-assemblies for the ASTRID CFV v4 core at the end of the Conceptual Design phase. Focus is placed on innovations and specificities in the design compared with former French SFRs.

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