Core Design Study on Reduced-Moderation Water Reactors (RMWRs)

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Abstract

Light water reactors are considered to be one of the main electric power sources at least for several decades in the first half of the 21st century. For the effective utilization of uranium resources with well-experienced LWR technology, conceptual core design study of reduced-moderation water reactors (RMWRs) has been carried out at Japan Atomic Energy Research Institute (JAERI) in cooperation with electric power companies.

The RMWR concept is based on a tight pitched MOX fueled lattice which can realize a conversion ratio of 1.0 or larger. The tight fuel lattice, however, makes it difficult to keep coolant void coefficient negative. In the design study of RMWRs, it is aimed to achieve both conversion ratio of 1.0 and negative void coefficient. There have already been proposed several different RMWR core concepts to meet with the aim, based on both BWR and PWR type cores.

The high conversion BWR type core can realize as high conversion ratio as 1.1. The long operation cycle of more than two years and the high burnup of more than 60 GWd/t is achievable with a different design of BWR type core. By utilizing heavy water coolant, the high conversion ratio of 1.1 is also possible in PWR type core, while a conversion ratio of 1.0 can be obtained even with a light water coolant PWR type core, by adopting a seed-blanket type fuel assembly.

Together with these RMWR concepts, there was also proposed the 1350 MWe class ABWR compatible core without blanket, which has fuel assemblies of square cross section with square fuel pin lattice. Although the conversion ratio of this core is 1.0 and the void coefficient is negative, the discharge burnup of the fuel is only about 25GWd/t. To improve the burnup characteristics of this core, triangular fuel pin arrangement in the square assembly is now being considered for the reduction of water to fuel volume ratio (Vm/Vf). The void reactivity increase in the tighter fuel lattice is to be avoided by using an axially heterogeneous core which consists of 3 or 4 layers of high enriched (up to 20 wt.% fissile Pu) regions and the same number of low enriched (1.0 or a few wt.% fissile Pu) regions. The axial blanket is not considered here to reduce the axial power peaking.

The outline of the RMWR core design study, as well as the result of the improvement of ABWR compatible core, will be presented at the workshop.

Technical area : 3. Evolutionary Water Reactors & Modular Water Reactors