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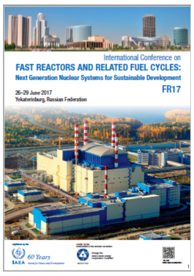

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Examination of ChS-68 Steel Used as a BN-600 Reactor Cladding Material

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Austenitic stainless steel has been used as a standard material for BN-600 fast reactor claddings for many years. High-temperature strength is one of the advantages of austenitic steels over ferritic-martensitic ones. Nevertheless, corrosion damages, radiation-induced swelling, creep, embrittlement, and strength reduction are topical problems for claddings made of austenitic steels. In this respect at high burn-up levels swelling is the main problem limiting operation of the material.

Originally thoroughly studied EI-847 steel was used for developing new austenitic steels. After boron modification EP-172 steel was obtained. ChS-68 steel doped with elements reducing radiation-induced swelling, such as boron, silicon, and titanium, was based on EI-847 steel.

At the initial stage significant radiation-induced deformation of fuel assembly elements was one of the factors limiting fuel burnup to 7.2 % FIMA and damage dose to 44 dpa. Transition to new steels and reactor core modifications made it possible by 2000 to attain burnup level of 9.2 % FIMA and damage dose level of 73 dpa per cladding.

ChS-68 properties optimization was carried out by High-technology Research Institute of Inorganic Materials (VNIINM) using the results of post irradiation examination made by Beloyarsk NPP and ROSATOM materials testing enterprises, including Institute of Nuclear Materials (INM).

Irradiated in BN-600 claddings of standard and test fuel assemblies, as well as materials test assembly samples (ChS-68 and other austenitic steels, similar in composition) were examined at INM hot cells. Characteristics and properties of claddings made with variation of steel chemical composition within specifications, at different cold work levels, according to different metal manufacturing and tube production technologies, were determined.

Results of post irradiation examination of physical, mechanical and corrosion properties, and structural characteristics were used to analyze processes leading to structure and properties changes and to predict residual life. On the basis of the examination INM researchers have published a number of articles and presented a number of papers at the conferences of different levels.

Using the obtained results VNIINM in collaboration with Machine-Building Plant (MSZ) has improved cladding manufacturing technology. It resulted in a stepwise (during 15 years) extension of standard fuel assembly service life up to 73, 78, 82, 87 dpa with burnup increase from 9.2 to 13.2 % FIMA. It is expected to increase damage dose at least to 92 dpa and fuel burnup to 14-15% FIMA.

Country/Int. Organization

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