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Fabrication and reprocessing of mixed uranium-plutonium nitride fuel for reactor BREST

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Dense nuclear fuel for fast reactors (FR) is the preferred option. In the Russia, as part of the "PRORYV" project, the development of key technologies of closed nuclear fuel cycle (CNFC) for FR with dense mixed nitride uranium-plutonium fuel (MNUP) is underway. MNUP is a new complex product in the field of nuclear power technologies. CNFC with FR ensures:
– no spent nuclear fuel (SNF) accumulation;
– radiwaste management based on the principles of radiation-equivalence;
– technological support for the non-proliferation regime;
– competitiveness with other large-scale energy technologies.
For industrial implementation FR CNFC on the basis of MNUP fuel an experimental demonstration energy complex (EDEC) is being created at the Siberian Chemical Combine site. It consists of BREST-300 reactor with lead coolant and CNFC facilities. The latter includes a MNUP fuel fabrication/refabrication module (FRM) and SNF reprocessing module (RM). In 2022 it is planned to put into operation the FRM and in 2024 to begin construction of RM of EEDC. At the FRM the technology of carbothermal synthesis of MNUP fuel will be implemented. At the RM the technology of combined (pyro+hydro) and hydrometallurgical reprocessing of FR SNF are under development.
To date, R&D have been conducted to justify the use of MNUP fuel in FR. Over 1000 fuel pins with MNUP fuel have been successfully irradiated in BN-600. A complex of post-reactor studies, including destructive radiochemical studies, has been conducted.
R&D on the reprocessing of MNUP SNF includes the fundamental possibility of using pyroelectrochemical technological operations have been shown. The technical feasibility of the following hydrometallurgy operation has been demonstrated experimentally:
• Voloxidation of the MNUP SNF (recovery > 99.9 % tritium and 98 % 14C);
• Extraction and crystallization refining of U+Pu+Np mixture (purification factor of 5*106);
• Recovery >99.9 % of actinides including Am and Cm;
• Microwave denitration for mixed U-Pu-Np, U-Am, U-Cm oxides preparation;
• Separation 1 g of Am and 0,1 g of Cm;
• Waste vitrification in borosilicate glass in a remotely removable cold crucible.
An integrated system of models and codes for all technological modifications of the non-reactor part of CNFC and for coordinated modelling of heterogeneous processes and phenomena are under development. The system under development uses both existing and newly developed models and codes designed to describe technological processes and apparatuses, nuclear and radiation safety, criteria of ignition, combustion, behaviour of structures and engineering systems under critical loads, etc.

Country/Int. organization

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