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Used mixed oxide fuel reprocessing at RT-1 plant

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Abstract

Reprocessing of the mixed uranium-plutonium spent nuclear fuel of the BN-600 reactor was performed at the RT-1 plant twice, in 2012 and 2014. In total, 8 fuel assemblies with a burn-up from 73 to 89 GW day/t and the cooling time from 17 to 21 years were reprocessed. The reprocessing included the stages of dissolution, clarification, extraction separation of U and Pu with purification from the fission products, refining of uranium and plutonium at the relevant refining cycles. Dissolution of the fuel composition of MOX UNF in nitric acid solutions in the presence of fluoride ion has occurred with the full transfer of actinides into solution. Due to the high content of Pu extraction separation of U and Pu was carried out on a nuclear-safe equipment designed for the reprocessing of highly enriched U spent nuclear fuel and Pu refining. Technological processes of extraction, separation and refining of actinides proceeded without deviations from the normal mode. The output flow of the extraction outlets in their compositions corresponded to the regulatory norms and remained at the level of the compositions of the streams resulting from the reprocessing of fuel types typical for the RT-1 plant. No increased losses of Pu into waste have been registered during the reprocessing of BN-600 MOX UNF an compare with VVER-440 uranium UNF reprocessing.

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1. Introduction

The RT-1 complex has been operating since 1977. The main task of the plant is the regeneration of the irradiated nuclear fuel in order to extract useful components, and the transfer of the fission products into a safe disposal form. Extracted target components include some radionuclides as well as the fissile materials. The regenerated actinides are sent to the fresh fuel fabrication plants. Therefore the complex activity allows for closing the nuclear fuel cycle. Flow-sheet of the UNF reprocessing at RT-1 plant is shown on Fig. 1.

Nomenclature

BN-600	fast neutron reactor with Na cooling
C_U, C_{Pu}	concentration of U, Pu
HLW	high level radioactive waste
ILW	intermediate level radioactive waste
MOX	mixed uranium-plutonium oxides
RT-1	reprocessing plant
UNF	used nuclear fuel
TBP	tributylphosphate

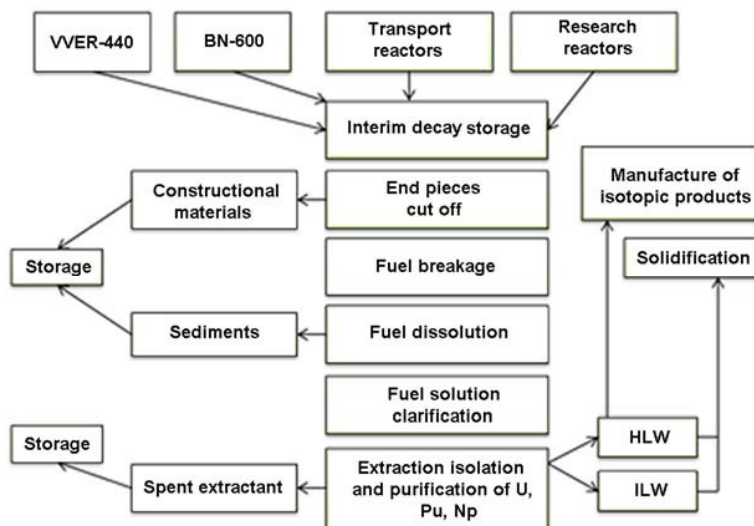


Fig. 1. Reprocessing of UNF at RT-1 plant.

2. Reprocessing of MOX UNF at RT-1 plant

Reprocessing of MOX at the RT-1 plant was performed twice, in 2012 and 2014. 8 MOX UNF assemblies (4 operations with 1 assembly at a time in 2012 and 2 operations with 2 assemblies in 2014) were reprocessed. The initial fuel composition for these assemblies is a chemically-deposited mixture of U and Pu. The powders were produced on the RT-1 plant at the "Granat" facility, the pellets were produced by chemical and metallurgical plant at the "Paket" facility. The main characteristics of the reprocessed fuel are shown in table 1.

The first stage of the reprocessing is cutting off the assembly top and bottom fittings that do not contain fuel. Then the assembly part containing UNF is cut into pieces. Chopped pieces are transferred into the dissolver, where the next stage — dissolving the fuel in nitric acid — takes place. The resulting fuel solution is passed to the clarification and extraction separation of actinides. The undissolved fuel claddings are moved out from the dissolver

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