FUEL CYCLE OF TWO-COMPONENT NUCLEAR POWER & SNF MANAGEMENT

A. Yu. Shadrin

Private enterprise, «Science and Innovation», Moscow, Russia

The strategy for the next decades development of nuclear power in Russia envisages a two-component nuclear power industry with thermal and fast neutron reactors (respectively, TNR and FNR) with a closed nuclear fuel cycle (CNFC). CNFC allows to:

• provide an almost unlimited resource base for nuclear power development, due to the involvement of 238U, as well as regenerated U and Pu in the NFC;

• stop accumulation of spent nuclear fuel (SNF);

• propose options for reducing the volume of RW subject to deep burial through fractionation.

The prerequisites for industrial closing of the NFC emerged only in 2021–2023. In particular, the use of Pu recovered at Production Association “Mayak” (PA “Mayak”) for fabrication of the BN-800 reactor mixed oxide U-Pu has started at Mining and Chemical Combine (MCC). At the same time, there is no industrial fractionation of HLW at present. In the late 1990s – early 2000s there were however successful tests on Cs and Sr separation conducted at PA Mayak.

At present, Russia has accumulated about 26.5 thousand tonnes of spent nuclear fuel. The forecast of SNF accumulation is shown in Figure 1 below. The main objectives of SNF reprocessing are set as follows:

• PA “Mayak” RT-1 plant productivity increase to 4 tonnes of Pu to ensure the reprocessing of BN-800 SNF;

• achievement of the MCC Pilot and Demonstration Centre (ODC) design capacity – 220 tonnes of heavy metal per year;

• plutonium provision for the energy industry development with use of FNRs;

• creation of the SNF reprocessing module of the pilot demonstration energy complex (PDEC) with BREST-OD-300 reactor;

• industrial development of HLW fractionation technologies;

• separation of regenerated U.

Over the past 20 years, when developing technologies for SNF reprocessing for the ODC and the PDEC reprocessing module, quite a few innovative technological solutions for individual operations have been proposed. However, all these operations have been tested only at the laboratory level and therefore, do not have workable and reliable hardware. The development of radiochemical equipment is a complex, time-consuming and highly expensive task. The use of digital twin (DT) technology can reduce the cost and

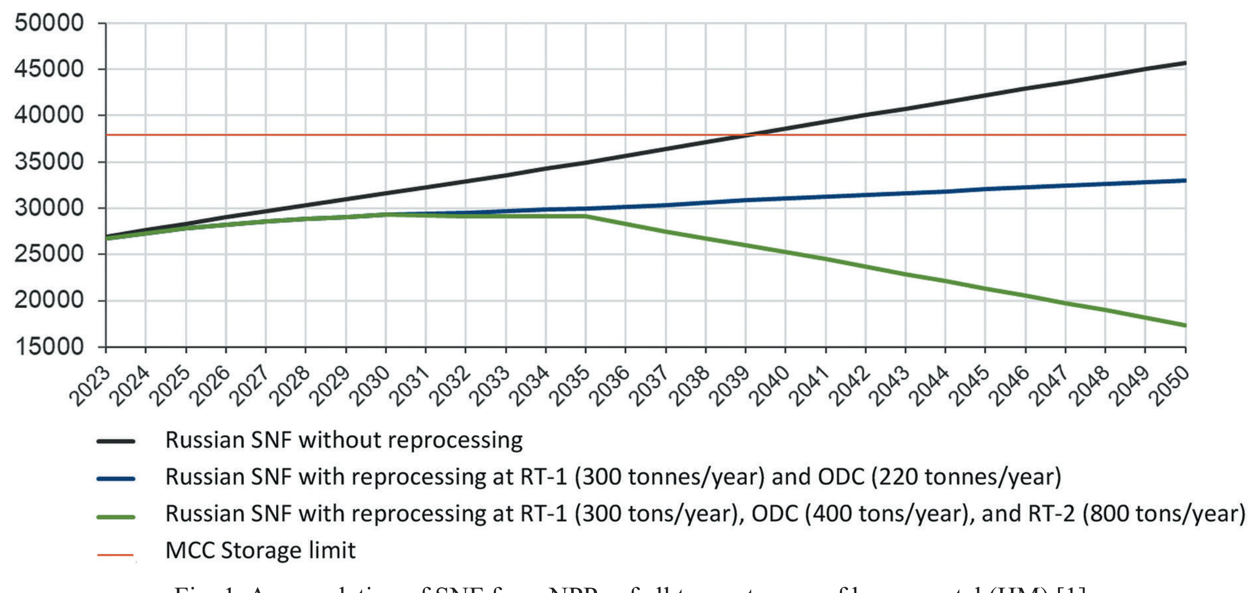

Fig. 1. Accumulation of SNF from NPPs of all types, tonnes of heavy metal (HM) [1]

development time of new technologies and equipment. However, in the development of radiochemical equipment the use of DT is extremely limited, primarily due to the lack of mathematical description of chemical and many other radiochemical processes.

References

1. **Tinin, V. V.** Two-component nuclear power: challenges of radiochemical technology devel-opment [Text] / V. V. Tinin, A. Yu. Shadrin // XXII Mendeleev Congresson general and applied chemistry : book of abstracts. – 2024. – Vol. 5. – P. 113.