NON-PROLIFERATION ASPECTS OF ADVANCED RECYCLING FOR FAST REACTORS FUEL CYCLE. OVERVIEW.

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ABSTRACT:

The brief overview summarizes the main approaches for the fast reactor's plutonium-contained fuel. Some aspects related to nuclear fuel recycling technologies are considered from a nonproliferation point of view, including safeguardability of these technologies developed as a part of Nuclear Energy Systems based on Closed Nuclear Fuel Cycle with Fast reactors.

Advanced and innovative technological approaches to the recycling of nuclear fuel are considered in comparison with the current approach applied for current industrial reprocessing of spent fuel based on the Purex-process. Trends in the improvement of current technologies are briefly considered, but also in terms of the use of innovative technologies, such as high-temperature processes. The first approach is based on recovery of purified components (with high decontamination factors from fission products) for fuel refabrication. The second approach is more focused on restoring the physical properties of the fuel with low purification (low decontamination factor from fission products) and based on refabriacation of new nuclear fuel by remote methods.

The infrastructural aspect of Fast Reactors' closed fuel cycle is an essential element for consideration. Current processes can be adapted for reprocessing of FR SNF, but it requires a centralized reprocessing plant with integration of transport operations for SNF and separated Pu throughout the whole cycle and fuel re-fabrication from highly purified fuel. Innovative technologies and facilities can be implemented as part of one complex with the reactor at the same site.

So-named Pyro-processes, simple technological procedures can be implemented for oxide and metallic fuels with a minimum number of chemical processing stages. These processes are the "batch" processes that include two chemical transformations only. The specific features of batch pyro-processes in molten salts are considered and basic flowsheets are considered.

Two key features of the molten salt pyro-processes are the following: the fuel is processed in certain batches and the final product ready for refabrication of nuclear fuel has low decontamination factor from fission products. Low purification of fuel significantly reduces the attractiveness of the material since the main products retain the standard of irradiated fuel and cannot be "attractive" without application of other purification technologies. The high radioactivity of the fuel and recovered products significantly improves the ability to control their relocation/movement in technological system. Batch processing also contributes to a more advanced option of fissile material accounting and control, as weighing and sampling are implemented at every stage.

In practice, several options for molten salt technologies have been demonstrated - for MOX fuel and for metallic U-Pu-Zr fuel. The results of R&D programs and the pilot tests demonstrated the considered specifics of these pyro-processes. The overview described some key results of mentioned R&D and pilot tests fulfilled at the Argonne National Laboratory (USA) and Research Institute of Atomic Reactors (USSR/Russia), which demonstrate mentioned features of FR spent fuel recycling through pyro-processes.

The overview includes the brief analysis of IAEA/INPRO studies connected with advanced and innovative recycling technologies from the point of view of the sustainability of Nuclear Power System with FR regarding non-proliferation aspects.