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Environmental Load Reduction of Geological Repository by Minor Actinide Separation; Utilization of MOX Fuel in Future Fuel Cycle System

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The current direction of energy politics adopted by the Japanese government is the utilization of nuclear energy, therefore, the argument of radioactive waste management is becoming increasingly important. To promise a safe, and less environmental load disposal repository for the high-level radioactive waste (HLW), it is necessary to look ahead of future fuel cycle system which intends to use plutonium by the introduction of mixed oxide (MOX) fuel together with the extended cooling period of UO2 spent nuclear fuel (SF), which are not much considered until now. If such fuels are reprocessed and vitrified in near future, it will have much impact on the heat generation of the vitrified waste arisen from 4-year-cooled UO2 spent fuel from discharge and will lead to an increase in the footprint of the geological repository.
To reduce the volume of HLW and the footprint of the geological repository, partitioning technology is considered as an option to help to solve the issue. By undertaking partitioning, separation of the heat generating and radiologically harmful nuclides such as minor actinide (MA: Np, Am, Cm) from HLW is expected and the related development of technology is promoting for the advanced nuclear fuel recycling. Then, it leads to higher waste loading ratio of vitrified waste and consequently the less space needed for final disposal due to the less amount of heat generation from vitrified wastes. In this study, the evaluation of effects of MA separation on spent MOX fuels and spent UO2 fuels with prolonged cooling period were performed since one of the major factors hindering the higher loading is 241Am and its decay heat affects adversely to the geological repository. Therefore, heat transfer calculation was carried out to evaluate the temperature of buffer material in a geological repository. For the UO2 SF which cooling period is longer than 50 years, the reduction of the maximum temperature of the surface of the buffer material due to the MA separation was large, and it was lower than the upper limit of buffer material temperature of the surface, 100℃, by 70% separation of MA. This indicates that when the cooling period of SF is prolonged, MA separation impacts more on the reduction of the surface temperature of buffer material. However, the introduction of MA separation was not sufficiently effective in terms of the thermal property of a repository for spent MOX fuels because the amount of 241Am was increased by beta decay of 241Pu. Through this study, the relation among fuel type, cooling period of SF, waste loading, MA separation, and the disposal repository was revealed.

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