

An Estimation of the Spent Fuel Inventory for the Fuel Cycle Scenarios with a Low Nuclear Demand Growth Rate

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Recently, many studies have been performed as the advanced fuel cycles such as the DUPIC (Direct Use of Spent PWR Fuel in CANDU Reactors), KALIMER (Korea Advanced Liquid Metal Reactor), and HYPER (Hybrid Power Extraction Reactor). In this study, the symbiotic fuel cycle scenarios between once-through and advanced fuel cycles are analyzed. In the once-through cycle, the nuclear power is expected to grow from 13.716 GWe in 2000 to 25.2 GWe in 2015 based on a nuclear power plant construction plan. From the year 2016 to 2100, the growth rate of nuclear power was assumed to be 0%. According to the nuclear demand, the number of operating PWRs increases with time and becomes ~25 in 2100 for the reactor power of 1.0 GWe, while the number of CANDU reactors becomes zero after 2030. The total SF will be 67 kt in the year 2100. After 2040, the CANDU SF remains constant at ~12kt. The total amount of U, Pu, MA and FP in SF will be 62.9, 0.8, 0.09 and 3.5kt, respectively. The DUPIC cycle is assumed to be adopted through the life extension of the current CANDU reactors. By the DUPIC scenario, the total SF in 2100 is expected to be ~66 kt which is reduced by ~12% compared with that of the once-through case. According to the SF inventory, the amount of Pu, MA, and FP are 0.79 and 0.09, and 3.38 kt, respectively. In the KALIMER scenario, the deployment fractions are assumed to be 15, 25 and 35% for the period of 2040 - 2060, 2060 - 2080 and 2081 - 2100, respectively. The number of PWR and KALIMER will be ~17 and ~14, respectively, in 2100. The total inventory of Pu and MA will be ~0.6 and 0.06 kt, respectively in 2100. Until 2100, the KALIMER can transmute the Pu and MA by ~0.05 and 0.005 kt, respectively. From the HYPER scenario with the same deployment strategy of the KALIMER, it is shown that the HYPER can transmute the Pu and MA by ~0.15 and 0.02 kt, respectively. Also, the HYPER can transmute the I-129 and Tc-99 by 0.004 and 0.016 kt, respectively. From the above results, it is known that the advanced fuel cycles can reduce the SF, Pu and MA inventories.