TRU Inventory Estimation for Fast Reactor Scenarios in Korea

Chang Joon Jeong, Hangbok Choi, and Won Il Ko
Korea Atomic Energy Research Institute, 150 Deokjin-dong, Yuseong, Daejeon
cjjeong@kaeri.re.kr

The transuranic elements (TRU) inventory has been analyzed for symbiotic fast reactor scenarios with existing nuclear power systems in Korea. In this study, a sodium-cooled fast reactor (SFR) and an accelerator driven system (ADS) are considered as the representative fast reactor systems. The material flows of each scenario including the TRU inventory are calculated and compared each other.

The number of operating pressurized water reactors (PWRs) and Canada deuterium uranium (CANDUs) reactors in 2000 were 14 and 4, respectively. The total nuclear capacity in 2000 was 17.3 GWe which will increase to 27.3 GWe in 2020 based on the current nuclear power plant construction plan in Korea [1]. From the year 2020 to 2100, the growth rates of nuclear power are assumed to be 1% for 2020 – 2030, 0.8% for 2031 – 2050, 0.6% for 2051 – 2070, and 0.5% for 2071 – 2100 [2]. In the fuel cycle model, the pyro process is assumed for all the spent fuel recycling process. In this process all the actinides are recovered and some fraction of the fission product is removed. The fuel cycle calculation was performed by the modified DYMOND code [3], which has been used for an analysis of the Generation-IV roadmap studies.

From the analysis results of the once-through fuel cycle, the nuclear power demand is expected to grow to 51.2 GWe in the year 2100. As shown in Fig. 1, the total spent fuel inventory will be 92000 t in 2100. The TRU inventory is estimated to be 660 t in 2100.

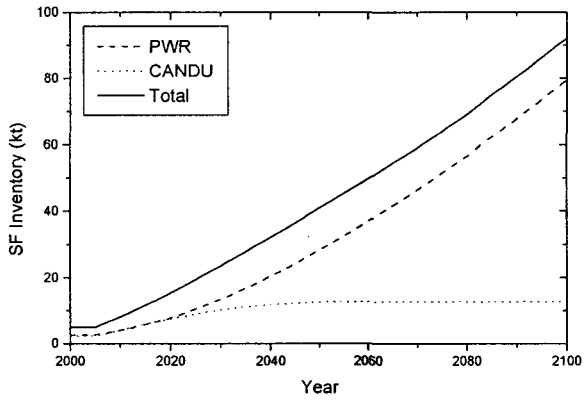

Fig.1 Spent fuel inventory for once-through cycle

The SFR burner (conversion ratio ~0.77) deployment fractions are 50% from 2040. In order to feed the fast reactor systems, it was also assumed that the PWR spent fuel is reprocessed from 2035 and the fast reactor spent fuel reprocessing begins in 2040. The number of PWR and SFR will be ~27 and ~41, respectively, in 2100. The PWR SF decreases with time and becomes 11400 t in 2100, while the CANDU SF remains at a constant value of 12600 t after 2050 since it is assumed that it will not be reprocessed. Therefore, the total SF inventory will be 24000 t in 2100. The variations of the TRU inventories are shown in Fig. 2. The total inventory, which includes the in-core and out-core inventories, will be ~650 t in 2100.

In the ADS scenario, the ADS is deployed with the SFR break-even system (conversion ratio ~1.0). The deployment fraction of the ADS is 25% for the period of 2060 – 2100. In this scenario, the fractions of the SFR are 50 and 25% for the periods of 2040 – 2059 and 2060 – 2100,

respectively. It was assumed that the PWR SF is reprocessed from 2035 and that the SF of the SFR and ADS are reprocessed from 2040 and 2060, respectively. The number of PWR, SFR and ADS will be ~27, ~25 and ~27, respectively, in 2100. The total SF slowly increases with time and becomes 44000 t in 2100. As shown in Fig. 3, the total TRU inventory, which includes the in-core and out-core inventories, will be ~470 t in 2100. Until 2100, this scenario can transmute the TRU at ~270 t.

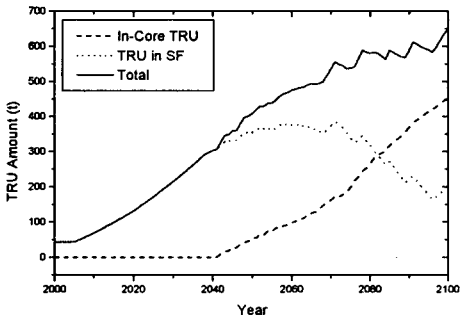

Fig. 2 TRU Inventory (SFR cycle)

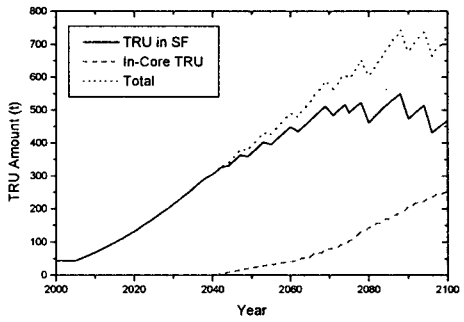

Fig. 3 TRU Inventory (ADS cycle)

From the above results, it is found that both the SFR and ADS scenarios can reduce the amount of TRU. Also, the ADS seems to be better than the SFR from a transmutation point of view. However, in the future, the technical difficulty and economic aspects of the ADS should be considered.

References

1. "The Third Basic Plan of Electricity Demand and Supply in Korea", Ministry of Commerce, Industry and Energy, Dec. 2004.

2. S. W. PARK, "The Prospects of Spent Fuel Management – View of Research Field," Korea Radioactive Waste Society, Jeju, Korea, 2006. 11.16 - 17, 2006.

3. J. H. PARK, C. J. JEONG and H. CHOI, "Implementation of a Dry Process Fuel Cycle Model into the DYMOND Code," *Journal of Korean Nuclear Society*, **36** (2), pp175-183, 2004.