Reduction of Spent Fuel Storage by Coupling Strategy of PWR and KALIMER

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1. Introduction

In 2005, 16 PWRs and 4 PHWRs are operating in Korea. It is estimated that the low and intermediate level radioactive waste storage will be full in 2008. Also, even though considering the expansion of storage pools at each nuclear power sites, the spent fuel storage will be full at least in 2016. But it is not easy to decide the waste disposal site in the view point of public acceptance. In Korea nuclear society, the radioactive waste disposal becomes a hot issue. The toxicity of PWR spent fuel can be reduced below the level of natural uranium after more than 300,000 years. But the toxicity can be drastically reduced by the transmutation and will be below than that of natural uranium within 1,000 years. Therefore the re-use of PWR spent fuel by coupling of PWR and KALIMER is indispensable to reduce the amount of spent fuel and the environment burden by decrease of toxicity of high level waste.

In this study, we evaluate the amount of spent fuel reduction when KALIMER is deployed by coupling with PWR, namely TRU recycling from PWR and CANDU spent fuel.

2. Scenarios and Evaluation

In this study, three kinds of nuclear scenarios are adopted to evaluate the total amount of spent fuel accumulated.

Case-1 Once-through strategy; the spent fuel from PWR and CANDU is directly disposed.

Case-2 Partially deployment of KALIMER; PWR will be gradually replaced with KALIMER from 2020 and reach the 21% fraction of total nuclear energy demand in 2100.

Case-3 Fully deployment of KALIMER; KALIMER is deployed gradually instead of PWR from 2020 and reach the 76% fraction of total nuclear energy demand in 2100. All new constructing plants to meet the demand will be KALIMER after 2090.

2.1 Electric Growth in Korea

According to the Korea long term electricity supply and demand plan, the electricity generating capacity by nuclear energy in 2000 was 13,716 MWe and become 25,237 MWe in 2015. The yearly growth rate of nuclear capacity between 2000 and 2015 years is about 4.3%. The nuclear sharer will be about 33.0% of the total generating capacity of electricity in 2017. When we assume the growth rate after 2015 is 1.0%, the nuclear power demand is expected to increase 58.8GWe. Figure 1 shows the nuclear electric energy demand growth in Korea.

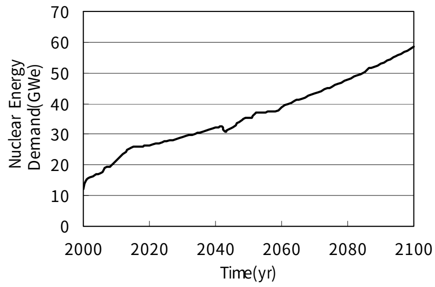

Figure 1. Nuclear Electric Growth in Korea

2.2 Assumptions

The DYMOND code is used in this analysis. This code employs the ITHINK dynamic modeling platform to create 100-year dynamic evolution scenarios for postulated nuclear energy systems based on the nuclear energy demand growth.

Table 1 shows the assumptions and the typical data of PWR and CANDU, and assumptions as input dada of DYMOND code for our analysis.

Table 1. Assumptions used in analysis

Items	PWR	CANDU	KALIMER
Power(GWe)	1.00	0.7	0.6
Load Factor	0.85	0.85	0.85
BU (GWthD/t)	40	7	93.9
Thermal Efficiency	0.35	0.35	0.393
Cycle length(years)	1.5	0.7	1.67
Number of Batches	3	1	4
Fresh Fuel Fraction			
- Pu	0	0	0.1981
- MA	0	0	0.0066
- U	100	100	0.7945
Spent Fuel Fraction			
- Pu	0.01201	0.01201	0.1728
- MA	0.00125	0.93500	0.0063
- U	0.93500	0.00149	0.7286
Reprocessing			
Method	Pyro	Pyro	Pyro
Capacity(ktHM/yr)	0.5	0.1	1.0
Ex-core time (years)			
- Construction	4	4	4
- Enrichment	1	0	0
- Fabrication	1	1	2
- Cooling	5	5	5
- Reprocessing	1	1	1
Reactor Life (years)	40	40	60
Others	Typical CE type PWR	Operation only until 2045	TRU burner

3. Result

Figure 2 shows the spent fuel accumulation when the once-through strategy and no-reprocessing is adopted

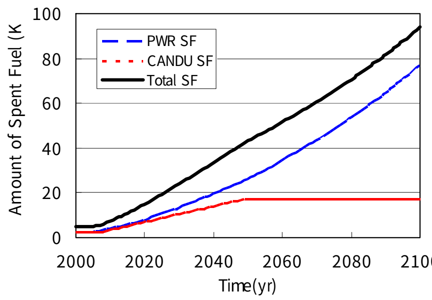

Figure 2. Accumulation of Spent Fuel in Case-1

Figure 3 displays the fraction of each power plant occupied within the total nuclear energy demand. It is assumed that CANDU reactors will not be constructed any more and be retired in 2045.

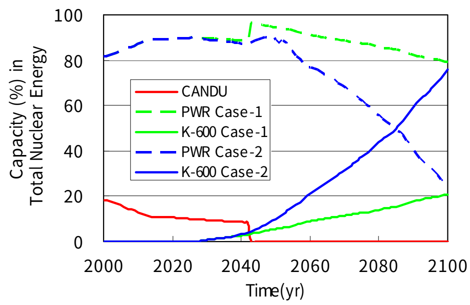

Figure 3. Capacity Fraction of Each Power Plant

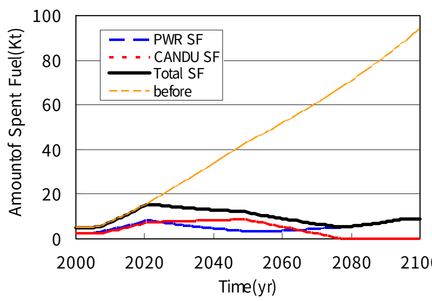

Figure 4. Accumulation of Spent Fuel in Case-2

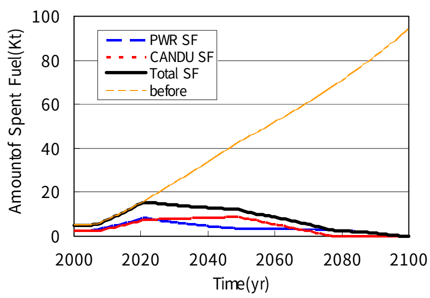

Figure 5. Accumulation of Spent Fuel in Case-3

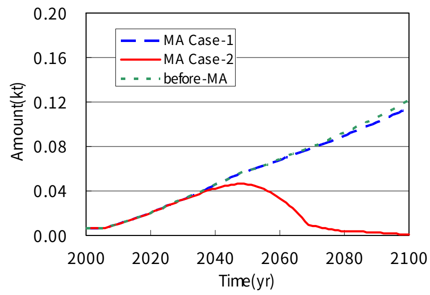

Figure 6. Accumulation of MA

The amount of spent fuel reduction for Case-2 and Case-3 can be found in Figure 4 and Figure 5 respectively. Figure 6 shows the amount of Minor Actinides (MA) disposed as high level waste.

4. Conclusion

As a result of PWR/KALIMER coupling study, it is found that the amount of domestic spent fuel from PWR and CANDU can be drastically reduced when KALIMER is deployed from 2020 until 2100. The amount of PWR spent fuel will not be increased any more. And the amount of MA disposed as high level waste is decreased to zero if KALIMER is replaced instead of PWR completely.

The result of PWR/KALIMER coupling study will be used as a basic data for the management plan of domestic PWR spent fuels, fuel cycle study in pursuit of reducing spent fuel storage and high level waste.

5. Acknowledgement

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