Application on the Methodology for the Determination of Pyroprocessing DF Range

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1. Introduction

One of the alternative ideas to solve the spent fuel issues, the partitioning and transmutation (P&T) technology has been developed for decades. Moreover, the concept of LILW production from P&T are proposed by Bowman[1]. A PEACER (Proliferation-resistant, Environmental-friendly Accident-tolerant, Continuable and Economical Reactor), based on pyrochemical process and Pb-Bi coolant transmutation reactor, has been conceptually designed to be able to convert all PWR spent fuel into low and intermediate level waste for near-surface disposal. In this study, the acceptance criteria for near-surface disposal facility is derived by the methodology for establishment of acceptance criteria. Then acceptable TRU decontamination factor (DF) and LLFP removal efficiency in order to meet acceptance criteria is evaluated.

2. Methods and Results

In this section, the characteristics of PEACER & pyroprocessing waste and methodology for derivation of acceptance criteria are described. The acceptance criteria for near-surface disposal facility include a concentration limit by on-site human intrusion scenario and the total inventory limit by off-site radionuclide migration scenario, respectively.

2.1 Decontamination Factor

Overall DF is defined as the ratio of mass of TRU load into the process to TRU lost into waste stream expressed as follows:

$$DF_t = \frac{\text{The loaded TRU into pyrochemical process}}{\text{The lost TRU into waste stream}}$$

Among the LLFP, Tc, I, Cs and Sr are removed from the waste stream because of its high solubility in ground water, heat-load and toxicity. Total TRU and LLFP waste mass is calculated by ORIGEN2 and REBUS3 computer code with the conceptually value of TRU DF=1.0E+05 and 95% of LLFP removal efficiency[2].

2.2 Derivation of acceptance criteria

In order to derive the acceptance criteria for near-surface disposal facility, methodology studied by KINS/NETEC and conceptual design of disposal facility are used [3][4]. Figure 1 and 2 show the concentration limit by human intrusion scenario and the total inventory (activity) limit by radionuclide migration scenario, respectively.

500mrem/yr and 100rem/yr are assumed as the dose constraint in each scenario. It is assumed that human intrusion occurs at time after end of institutional control of 500 years.

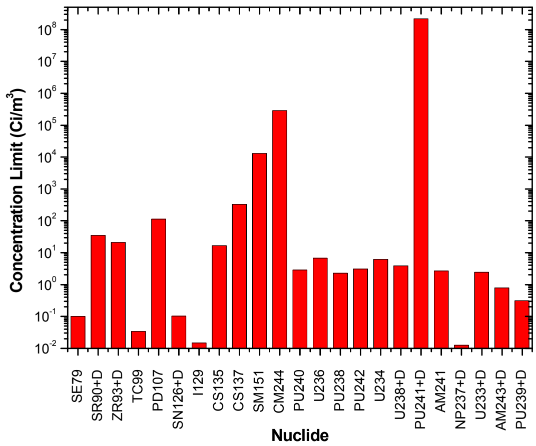

Figure 1. Concentration limit for radionuclide from pyroprocessing

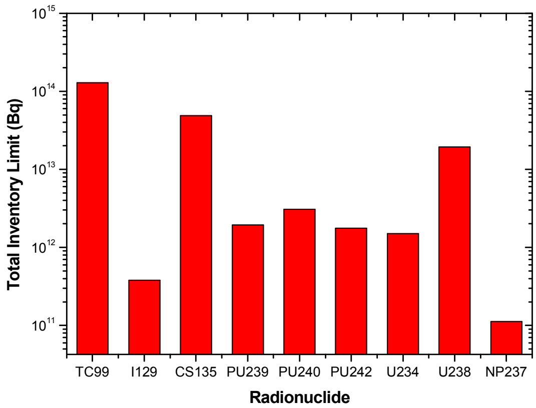

Figure 2. Total inventory limit

In deriving total inventory limit, borosilicate glass matrix for waste stabilization is considered as a source term analysis [5]. Additionally, the sum of the fraction rule for mixture of radionuclide is applied to determine DF values [6].

3. Conclusion

The concentration limit and total inventory limit for PEACER final waste to dispose it into near-surface disposal facility are derived. In order to satisfy these acceptance criteria, TRU DF and LLFP removal efficiency have to be achieved more than 1.0E+04~1.0E+05 and 96%, respectively. Figure 3 and 4 show DF value for each radionuclide and table 1 shows the combined result considering two criteria together. Acceptable TRU DF is located within possible DF range. However, comparing to conceptual design factor, LLFP, especially Tc-99 and I-129, have to be removed from the waste stream 3~4% more than designed factor.

Table 1. Acceptable range of TRU DF and LLFP removal efficiency

Nuclide		Possible DF	Concentration Limit	Total Inventory Limit	Acceptable DF
LLFP	Sr	-	96%	-	90%
	Tc			98.5%	98~99%
	I			98.5%	98~99%
	Cs			92%	92%
TRU	U	1.43E+4	1.0E+4	1.0E+3	1.0E+4
	Pu	1.67E+5		1.0E+5	1.0E+5
	Np	1.43E+5		1.0E+4	1.0E+4
	Am/Cm	2.94E+4		-	1.0E+4

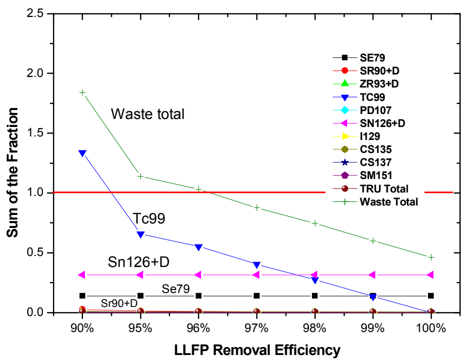

Figure 3. TRU DF and LLFP removal efficiency by concentration limit

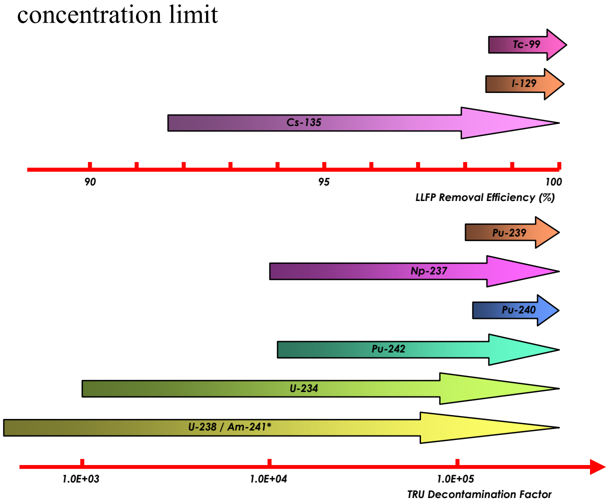

Figure 4. TRU DF and LLFP removal efficiency by total inventory (activity) limit

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