

# Preliminary Analysis on Characteristics of the Wastes From the Pyro-processing of SFR SNFs Based on the Material Balance of SFR FSv5.1

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## 1. Introduction

To reuse valuable materials in SNFs and reduce volume and toxicity of SNFs, the P&T technology based on the pyro-processing and the SFR has been under development in KAERI. SFR burners are necessary to transmute long-lived actinides and fission products and inevitable SNFs generation is accompanied. Thus, characteristics of SFR SNFs and wastes from the pyro-processing of SFR SNFs must be identified for accurate fuel cycle analyses. In this study, preliminary analysis on characteristics of wastes from the pyro-processing of SFR SNFs based on the material balance of SFR FS v5.1 is conducted.

## 2. Methods and Results

### 2.1 Assumptions and Methods

The reference reactor and fuel type described below are considered [1]. The characteristics of wastes from the pyro-processing of SFR SNFs had been evaluated using the Origen-arp in the SCALE6.1 and the problem dependent cross-section library for reference reactor [2] is used.

- Reference reactor: 400 MWe annular type burner
- Average discharge burnup: 133 GWd/tHM
- Fuel cycle length: 332 EFPD/cycle
- Driver fuel type: U-TRU-10Zr
- TRU inventory of BOEC/EOEC: 3.485/3.276 ton

The material balance of SFR FS v5.1 had been used to analyze characteristics of wastes from the pyro-processing of SFR SNFs. The brief information about wastes from the pyro-processing of 2.46 ton initial heavy metal of SFR SNFs based on SFR FSv5.1 is listed in Table 1.

Table 1. Wastes from the pyro-processing of SFR SNFs based on SFR FSv5.1 (basis: 2.46 tHM/SNF) [3]

	Nuclide+filter mass [kg]	Total mass [kg]	Major Nuclides
Metal Waste	1.36E+02	9.0E+03	Duct, Clad, Shield, U, NM, Tc
I-Filter Waste	4.60E+00	4.60E+00	I, Br
Te-Filter Waste	6.10E+00	1.22E+01	Tc, Te, Se, Sb
H-Filter Waste	1.60E+02	4.80E+02	H-3
Cs-Filter Waste	2.80E+02	4.20E+02	Cs, Rb, Cd, Ag
Sr Waste	3.66E+01	2.34E+02	Sr, Ba, RE, Se, Te
REE Waste	7.88E+01	9.34E+01	RE/TRU
Salt Waste	6.21E+01	7.65E+02	Sr, Cs, I, RE, LiCl-KCl salt

### 2.2 Results

Figure 1-3 show evaluated decay heat, radioactivity, and radiotoxicity of outputs from the pyro-processing of SFR SNFs based on SFR FSv5.1. Table 2 shows decay heat, radioactivity, radiotoxicity of wastes and products at the disposal time. Total cooling time before the disposal is 40 years. Most of decay heat, radioactivity, and radiotoxicity are generated from the U/TRU ingot. Therefore, heat load of repository can be reduced by complete reuse of the U/TRU ingot.

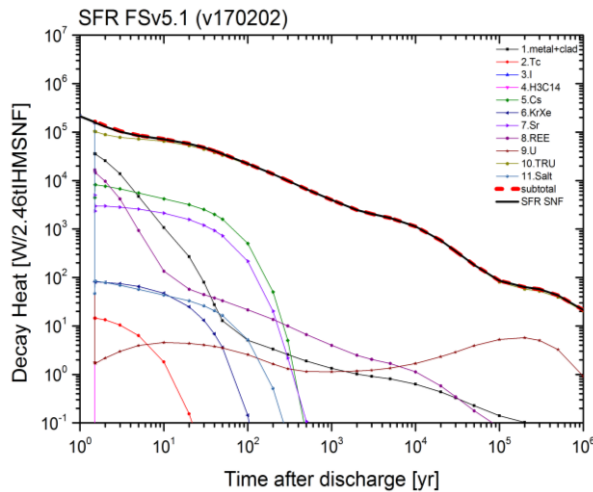


Fig. 1. Decay heat of wastes and products from the pyro-processing of SFR SNFS based on FSv5.1.

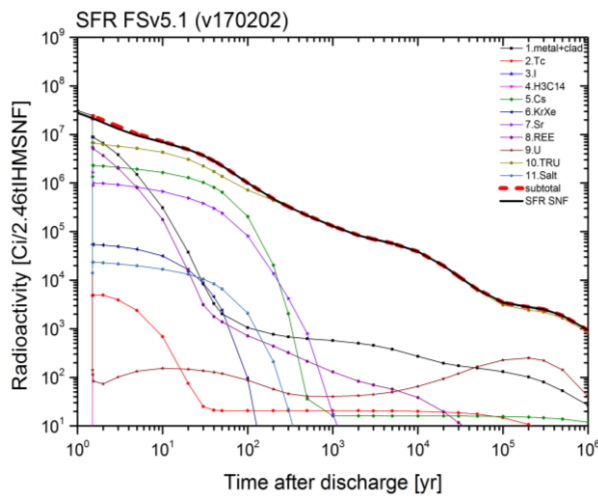


Fig. 2. Radioactivity of wastes and products from the pyro-processing of SFR SNFS based on FSv5.1.

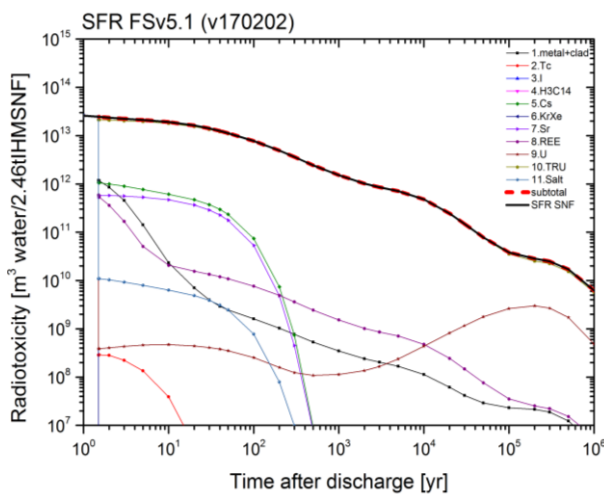


Fig. 3. Radiotoxicity of wastes and products from the pyro-processing of SFR SNFS based on FSv5.1.

Table 2. Decay heat, radioactivity, radiotoxicity of wastes and products at the disposal time (basis: 2.46 tIHMSNF)

Basis: 2.46 tIHMSNF	Decay heat		Radioactivity		Radiotoxicity	
	[W/basis]	[%]	[Ci/basis]	[%]	[m <sup>3</sup> water/basis]	[%]
Metal Waste	2.75E+01	0.07%	3.30E+03	0.12%	2.93E+09	0.02%
I-Filter Waste	1.57E-05	0.00%	3.59E-02	0.00%	2.14E+05	0.00%
Tc-Filter Waste	7.70E-03	0.00%	2.10E+01	0.00%	7.34E+05	0.00%
H-Filter Waste	8.60E-07	0.00%	2.55E-02	0.00%	5.79E+01	0.00%
Cs-Filter Waste	2.01E+03	4.92%	8.17E+05	28.54%	2.96E+11	2.37%
Sr Waste	9.30E+02	2.28%	3.02E+05	10.53%	2.26E+11	1.80%
REE Waste	3.79E+01	0.09%	1.79E+03	0.06%	1.20E+10	0.10%
Salt Waste	2.06E+01	0.05%	8.37E+03	0.29%	3.08E+09	0.02%
U ingot	3.77E+00	0.01%	1.28E+02	0.00%	3.79E+08	0.00%
U-TRU ingot	3.77E+00	92.59%	1.73E+06	60.37%	1.20E+03	95.68%
SNF	4.08E+04	100.00%	2.86E+06	100.00%	1.25E+03	100.00%

### 3. Conclusion

Characteristics of wastes and products from the pyro-processing of SFR SNFs based on material balance of SFR FSv5.1 are evaluated in this study. The large reduction in heat load of repository at the disposal time can be achieved by complete reuse of the U/TRU ingot because most of the decay heat, radioactivity, and radiotoxicity are generated from the U/TRU ingot. Characteristics of SFR pyro-wastes identified in this study will be used to design disposal system for comparison between direct disposal scenario and closed fuel cycle scenario.

### REFERENCES

- [1] Myung Hyun Kim et. al., Conceptual Design of Future Commercial TRU Burner Cores, KAERI/CM-1880/2013, KAERI, 2013.
- [2] Dong-Keun Cho, Problem dependent library of the 400 MWe annular type SFR burner for the Origen-arp, KAERI, 2018.
- [3] Hun Suk Im, et. al., Flowsheet for Pyro-processing Facility with 2.46 tHM capacity for SFR SNFs (SFR FS v.5.1), KAERI, 2017.