A Preliminary Decay Heat Evaluation for Radwaste from Pyroprocessing of PWR Spent Fuels

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1. Introduction

It is indispensible to settle the spent fuel related problem so that the nuclear energy can be maintained as a sustainable, safe and economical energy source. Worldwide roughly 10,000 tHM spent fuel is discharged yearly from nuclear power plant. While some 15% of it is being reprocessed, a once through cycle is currently the official selection for a majority of the spent fuel tonnage, either because the residual fissile content is too low to justify recuperation or because of political decisions in a few large countries [1]. Currently, a wet process technology to recycle the spent fuel is developed and commercialized in some countries. However, it has problems concerned with nuclear proliferation, environment and cost.

Because of these shortcomings and political situations, a dry process called pyroprocess is being developed in Korea. But the empirical data is insufficient due to the incompleteness of the demonstration.

In this paper, decay heat of the radwaste from pyroprocess is preliminarily evaluated to derive the characteristics of the radwaste from pyroprocess.

2. Decay Heat Evaluation of Radwaste

2.1 Radwaste from pyroprocess

Pyroprocess considered in this paper is proposed by a Department of Advanced Fuel Cycle Development and shown in Figure 1[2].

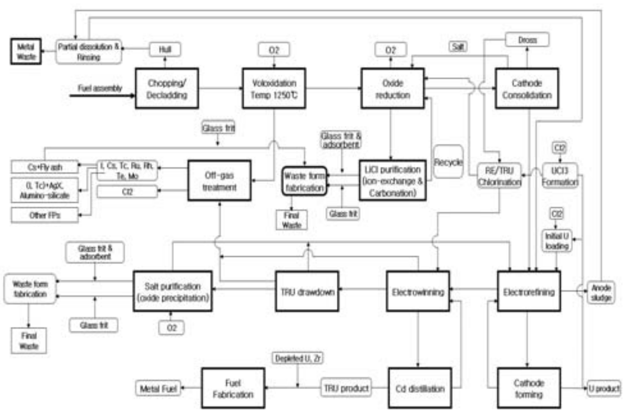

Fig 1. Pyroprocess Flowsheet

And the brief classification of the radwaste produced from each process is shown in Figure 2. In this paper, radwaste from 4 processes is considered. The first waste is the metal waste produced from chopping and decladding process. Sescond waste is off-gas absorbent material from voloxidation process. And the third and fourth waste is produced from reduction and refining process where the impurities are gathered through the purification of used molten-salts. And these wastes are be divided into three categories such as metal, CWF(Ceramic Waste Form), and VWF(Vitrified Waste Form).[3]

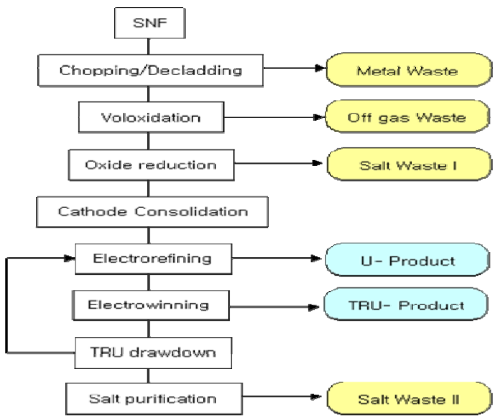

Fig 2. Radwaste from pyroprocess

2.2 Decay Heat evaluation for Pyroprocess Waste

After categorizing the waste forms from each process, major nuclides for the reference PWR spent fuel listed in Table 1 are derived using ORIGEN-ARP program[4] in aspect of decay heat since considering all nuclides are inefficient. As shown in Figure 3 and 4, 42 major nuclides according to fission product elements and actinide elements are screened. And these nuclides are distributed into the waste categories based on their physical and thermodynamic properties.

Table 1. Specification of reference PWR Spent fuel

Parameter	PWR
	KOFA
Fuel Type	17 X 17
Number of fuel pins	264
Number of guide thimbles	25
Initial enrichment of 235U(wt.%)	4.5
Fuel rod pitch(mm)	12.60
Fuel rod diameter(mm)	9.5
Zry-4 clad thickness(mm)	0.57
Pellet diameter(mm)	8.19
Active fuel length(mm)	3658

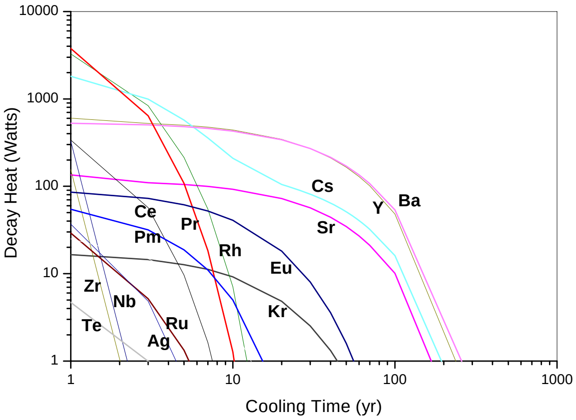

Fig 3. Decay Heat for Dominant Fission Product Elements

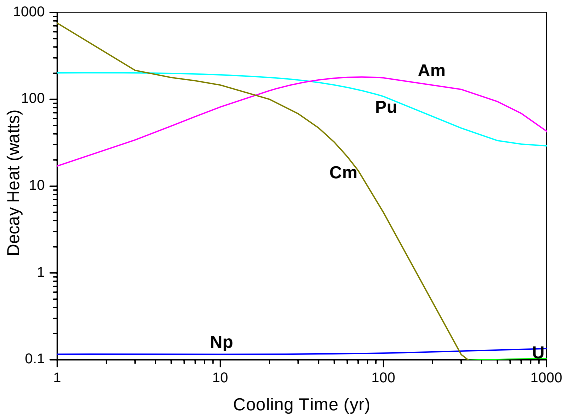

Fig 4. Decay Heat for Dominant Actinide Elements

After deriving the major nuclides, decay heat for each waste form is evaluated assuming that 10 MtU reference PWR spent fuel is pyroprocessed 5 years after the reactor discharge.

Decay heat for each waste produced from pyroprocess is evaluated and shown in Figure 5. Decay heat of CWF waste which mainly contains Cs revealed to be 12,500 W/10MtU and the VWF waste mainly containing Sr waste revealed to be 6,000 W/10MtU.

And waste produced from refining the LiCl-KCl waste revealed to be 4,200 W/10MtU.

From the results, wastes can divided into two categories based on its decay heat and half-life:waste with long-half life and waste generating high heat.

Among the waste forms, decay heat from off-gas(Ceramic Waste Form) was shown to be most high and classified into the waste generating high heat. And the CWF and VWF from the LiCl-KCl molten salt in electro-winning process was shown to be the waste with long half life

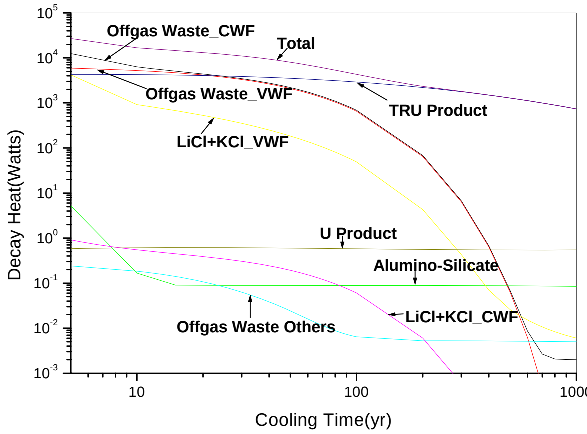

Fig 5. Decay Heat for Radwaste from Pyroprocess

3.Conclusion

In this paper, decay heat for each waste produced from pyroprocess is evaluated. Data evaluated from this paper will be very helpful when designing a layout for KRS(Korea Reference high level disposal System) since it can be used as critical inputs in thermal analyses.

REFERENCES

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