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Volume Reduction of Decommissioning Radioactive Burnable and Metal Wastes

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1. Introduction

The aim of the paper is current status of treatment for the decommissioning radioactive burnable and metal waste in KAERI. In Korea, two decommissioning projects have been carried out owing to the retiring of nuclear research facilities (KRR-1 & KRR-2) and a uranium conversion plant (UCP). A large quantity of radioactive waste was generated during the decommissioning projects. For the purpose of the volume reduction and clearance for decommissioning wastes from decommissioning projects, the incineration and high melting technology has been selected for the decommissioning wastes treatment. The volume reduction of the combustible wastes through the incineration technologies has merits from the view point of a decrease in the amount of waste to be disposed of resulting in a reduction of the disposal cost. Incineration is generally accepted as a method of reducing the volume of radioactive waste. The incineration technology is an effective treatment method that contains hazardous chemicals as well as radioactive contamination [1]. Incinerator burns waste at high temperature. Incineration of a mixture of chemically hazardous and radioactive materials, known as "mixed waste," has two principal goals: to reduce the volume and total chemical toxicity of the waste. Incineration itself does not destroy the metals or reduce the radioactivity of the waste. A proven melting technology is currently used for low-level waste (LLW) at several facilities worldwide. These facilities use melting as a means of processing LLW for unrestricted release of the metal or for recycling within the nuclear sector.

2. Facility Description

2.1 Incineration facility

An incineration facility was built to demonstrate the applicability of this technology to hazardous and low-level radioactive waste treatment from a nuclear facility. **Fig. 1** shows a process diagram of Oxygen-Enriched Incineration (OEI). The system consists of a waste preparation system, an incineration system, an off-gas cooling system, and an off-gas treatment system. The oil incinerator, gas exchanger, and ion exchanger equipment were closed during normal operation because the decommissioning waste did not include oil or high chlorine content waste. The Incineration facility, with a capacity of 25kg of mixed waste per hour, was constructed in 1997. The operation license of the incineration facility was authorized by KINS in August 2011 Decommissioning radioactive combustible waste were packaged in about 0.7kg/package and put into paper bag to be fed easily into the incineration chamber through the sliding double gate at upper position of incinerator. The concentrations of O_2, CO, CO_2, NOx, SOx and HCl in the flue gas were measured at the stack using multi-gas analyzer (MIR 9000).

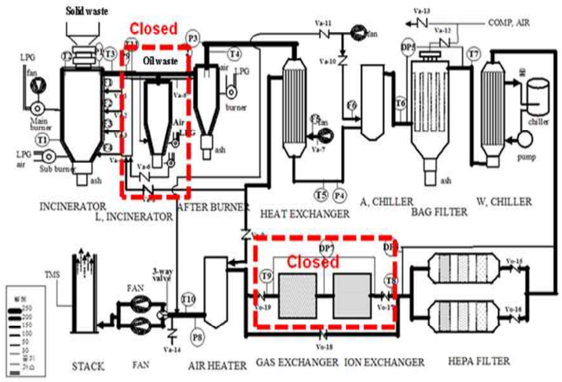

Fig. 1. Incineration facility

2.2 Melting facility

Fig. 2 shows a melting facility with high frequency induction furnace. The melt facility consists of four systems i.e., a preparation system, a melting system, ingot treatment, and an off-gas treatment system. Metal waste will be melted for self-disposal and volume reduction by an induction furnace. Metal wastes are treated by an induction furnace. After stabilization and immobilization, generated secondary waste i.e., ash and slag will be disposed permanently site. The ingots will be reused in nuclear sector.

Fig. 2. Melting facility

3. Results and Discussion

3.1 Burnable Waste

Table 1 shows the measured major parameter when decommissioning radioactive combustible waste incineration. The bottom position of combustion chamber temperature ranged between 820℃ and 830℃ and that of the afterburner between 970℃ and 980℃. Each measured major parameter temperature and pressure was acceptable as good related to normal operation condition. The differential pressure of each filter was acceptable as good related to criteria condition. Volume reduction ratio, defined as the volume of total waste fed into the combustion chamber divided by the volume of ash. Decommissioning combustible waste has treated about 16 tons (78 m^3) using incineration technology from 2011 to July, 2014. The achieved volume reduction ratio is about 1/65 through for years (Table 2).

Table 1. Measured major parameters

		Incinerator	Afterburner	Bag-filter	Offgas fan
Temp.(℃)		820~830	970~980	160~180	75~80
pressure (mmH_2O)		-36 ~ -45	-92 ~ -100	-331 ~ -340	-578 ~-590
Differential pressure (mmH_2O)			Criteria	Measured	
	Bagfilter		< 100	< 85	
	Medium		< 30	< 16	
	HEPA		< 50	< 16	
	Chalcoal		< 50	< 15	

Table. 2 Volume reduction of burnable waste

Year	Wastes		Ash	V.R
	Weight(kg)	Volume(L)	Volume(L)	
2011	818	5,192	170	31
2012	4,452	19,523	594	33
2013	7,808	38,760	341	114
2014	3,280	15,505	105	147
Total	16,359	78,981	1,210	65

3.1 Metal Waste

Nowadays, melting facilities are in operation in several countries for the treatment of low level metallic wastes. To be cost effective, these installations must have a sufficient throughput. Until 2012, Korea does not have any available commercial melting facility. The melting facility, with a capacity of 350kg per batch, was installed in 2012. The demonstration license using decommissioning metal waste was authorized by KINS in August 2013. The decommissioned metal waste was melted for self-disposal and volume reduction by an induction furnace (Fig. 3). To evaluate the homogeneity of nuclides in the ingot phase, a melting test was performed using slag. The melting temperature was raised up to 1400℃ and the power was then turned off. The ingot samples were taken by molten metal. Most of the specific activity for the ingot is below 10^{-3} Bq/g. All the ingots produced could be unconditionally cleared. Up to now, produced secondary waste (slag) was about 6 drums (200L). The weight reduction ratio is about 1/52 through (Table 3).

Fig. 3. Melting processing and ingot

Table. 3 Weight reduction of metal waste

Year	Amount of meting (kg)	Slag(kg)	W.R.
2013	26,327	793	33
2014	40,804	499	82
Total	67,131	1292	52

4. Conclusions

About 16.4 tons of decommissioning combustible waste has been treated using Oxygen Enriched incineration. The incineration facility operated quite smoothly through the analysis major critical parameters of off-gas. The pressure, off-gas flow and temperature of major components remained constant within the range specified. The measures gases and particulate materials in stack were considerably below the regulatory limits. The achieved volume reduction ratio through incineration and melting is about 1/65, 1/52 respectively.

REFERENCES

[1] C. R. Brunner, and P.E., Dee, Incinerator System Air Emissions Control, POHengineer.com, Course No. EN-3007, 2012