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Treatment of Decommissioning Combustible Wastes with Incineration Technology

B. Y. Min*, D. S. Yang, G. S. Yun, K. W. Lee, J. K. Moon

Korea Atomic Energy Research Institute, 1045 Daedeok-daero, Yuseong-gu, Daejeon, 305-353
**Corresponding author: bymin@kaeri.re.kr*

1. Introduction

The aim of the paper is current status of management for the decommissioning radioactive combustible and metal waste in KAERI. In Korea, two decommissioning projects were carried out for nuclear research facilities (KRR-1 & KRR-2) and a uranium conversion plant (UCP). Through the two decommissioning projects, lots of decommissioning wastes were generated. Decommissioning waste can be divided into radioactive waste and releasable waste [1]. The radioactive waste was packed into 200 L drums and 4m^3 containers. Some of the releasable waste was freely released and utilized for non-nuclear industries. In case of KRR, Releasable metal waste was generated about 212 tons, Total combustible waste was generated 43 tons. The concrete wastes of seven teen hundred fifty five tons were reused the land backfill of road. In case of UCP, a total of metal waste was generated 208 tons, combustible waste was generated about 18 tons. For the purpose of the volume reduction for decommissioning combustible and metal wastes, KAERI choose the incineration and melt decontamination technology. The combustible wastes have been incinerating by OEI having the capacity 25kg/hr and the metal wastes have been melting by high-frequency induction furnace having the capacity 350kg/batch.

2. Facility Description

2.1 Incineration facility

Decommissioning combustible waste represents a considerable storage volume as well as significant cost since it must be maintained and monitored indefinitely in secure storage. The high cost of either disposal or storage requires that the volume of the material be minimized. 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.3 shows a process diagram Oxygen-Enriched Incineration (OEI). An incinerator has a sub burner for preheating and a main burner for incineration. Combustion air is blown down into the incinerator through many small holes tangentially arranged. Gases leaving the incinerator pass and enter the afterburner where air and fuel are added to increase the gas temperature to 900 ℃. The off-gas cooling system is composed of a heat exchanger and air diluter. The off-gas cooling system is divided into two sections, hot and cold. The heat exchanger cools the gas from the afterburner rapidly to about 400℃ by contacting the atmospheric temperature. Before the air diluter equipment, the temperature in the lines is above 400℃. In addition, the off-gas cooled down to less than 200℃ when using the diluter for proper operation of the cold filtering units. The air diluter is a mixer of hot flue gas and cold ambient air. The exhaust gas is rapidly cooled to approximately 200℃. The incineration building is equipped with a HVAC system, which was designed to provide ventilation capacity for the incineration facility operation. The primary area of the ventilation is the incineration room, which is the major source of heat and radioactivity.

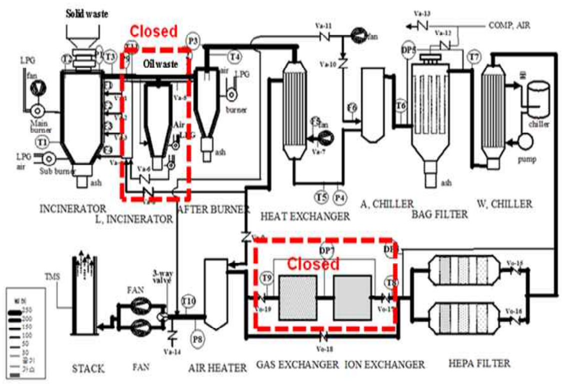

Fig. 1. Incineration facility

2.2 Decommissioning Waste

The decommissioning combustible waste consists of lumber, paper, cotton, cloth, gloves, vinyl, and PVC. A summary of the incineration material is shown in Table 1. After incinerating the radioactive waste, bottom and fly ash collected at bottom of incinerator, afterburner and bagfilter which was used to estimate the volume and weight reduction ratio.

Table 1. Incineration material

Materials	Waste composition (kg)	Ratio (%)
Lumber, paper	45.0	90
Cotton, Cloth, Glove	3.5	7
Vinyl	0.25	0.5
PVC	1.25	2.5

3. Results and Discussion

3.1 Major operation parameters

Table 2 shows the measured major parameter when decommissioning radioactive combustible waste ncineration. The bottom position of the combustion chamber temperature ranged between 820℃ and 830℃ and that of the afterburner between 970℃ and 980℃. The temperature, pressure and differential pressure of filters were satisfied with operation condition.

Table 2. Major parameters during operation

	Incinerator	Bag-filter	Offgas fan
Temperature (℃)	820~830 (800~950)	160~180 (150~200)	75~80 (60~85)
Pressure (mmH_2O)	-36 ~ -45 (-30 ~ -50)	-331 ~ -340 (-250 ~ -350)	-578 ~-590 (-500 ~ -650)
Differential pressure (mmH_2O)		Criteria	Measured
	Bagfilter	< 100	< 85
	Medium	< 30	< 16
	HEPA	< 50	< 16
	Chalcoal	< 50	< 15

Note: ( ) Norman operation condition value

3.2 Emission concentration of radionuclides

The emission concentration of alpha (α) and beta (β) radionuclide in stack by iCAM is shown in Fig. 2 and Fig. 3.

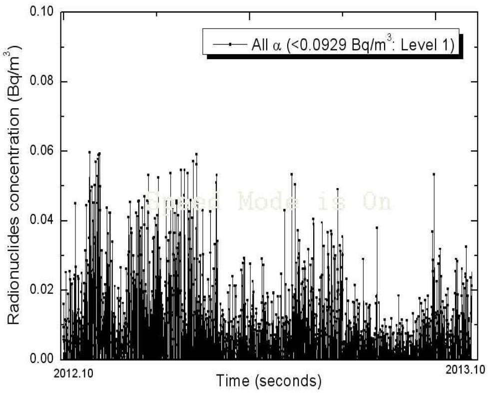

Fig. 2. Alpha radionuclides concentration.

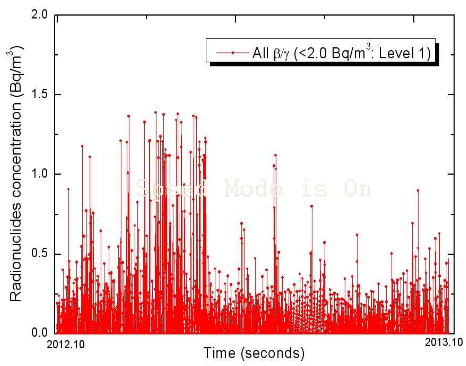

Fig. 3. Beta radionuclides concentration.

An α and β radionuclide measurement line shows the current dose rate as measured by the external detector, and the current unit of measurement. This line is normally updated at 1 second intervals. The measured α and β radionuclide activities are less than 0.06 Bq/m^3 and 1.5 Bq/m^3 during incineration facility operation. The regulatory limit is 0.1 Bq/m^3 and 0.4 Bq/m^3 for α-nuclide and β-nuclide, respectively. The concentration of radionuclide was well controlled to below the regulatory limit.

3.3 Volume Reduction

Volume reduction ratio, defined as volume of total waste/volume of ash after incineration. A volume reduction ratio is shown the different depending on the composition of the combustible wastes and operation condition when an incineration. Decommissioning combustible wastes are composed of wood, paper, cotton, vinyl, plastic, rubber and mixed waste. Volume reduction was enhanced in 2013 year than in 2012 due to operation transfer system for complete combustion, which is fresh air supply system into incinerator. Average Ash density is 0.88 g/cm^3. The achieved average volume reduction ratio was about 65 through incineration for four years (Table 3).

Table. 3 Volume reduction.

Year	Incineration Wastes		Ash	V.R
	kg	L	L	
2011	818	5,192	170	31
2012	4,452	19,523	594	33
2013	7,808	38,760	341	114
2014	6,691	26,732	232	115
Total	16,359	90,207	1,337	67

4. Conclusions

Incineration with decommissioning radioactive combustible waste is possible with moderate oxygen enrichment of 22 vol.% (dry basis) into the supply air. The incineration facility was operated quite smoothly through the analysis of the major critical off-gas parameters. The negative pressure of the incineration chamber remained constant within the specified range. Off-gas flow and temperature were maintained constant or within the desired range. The measures gases and particulate materials in the stack were considerably below the regulatory limits. The achieved average volume reduction ratio during facility operation is about 1/65.

REFERENCES

[1] Min B. Y., Lee, K. W., Yun, K. S., Moon, J. K., 2012, Presents Status of the Decommissioning Combustible & Metallic Waste Treatment in KEARI, JAPC-KAERI Scientific and Technical Exchange Meeting on Decommissioning, Korea.