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Decommissioning Combustible Waste Treatment using Oxygen-Enriched Incinerator

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1. Introduction

The aim of the paper is current status of treatment for the decommissioning combustible waste in KAERI. For the purpose of the volume reduction and clearance for decommissioning combustible wastes generated by the decommissioning projects. The incineration technology has been selected for the treatment of combustible wastes. About 34 tons of decommissioning combustible waste has been treated using Oxygen Enriched incineration. Temperature, pressure of major components, stack gas concentration, i.e., SOx, NOx, CO, CO_2 and HCl, and the residual oxygen were measured. Measured major parameters during normal operation were sustained on a stable status within a criteria operation condition. Oxygen enriched air, 22vol. % (dry basis) was used for stable incineration. The volume reduction ratio has achieved about 1/117.

2. Facility Operation

]. Incineration technology is an effective treatment method that contains hazardous chemicals as well as radioactive contamination [2]. 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. Table 2 shows a measured parameter during a normal operation of incineration system. 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). The O_2 monitor uses a zirconia sensor to determine the absolute oxygen content of the off-gas sample. The MIR 9000 sampling system continuously draws a small quantity of air from the stack.

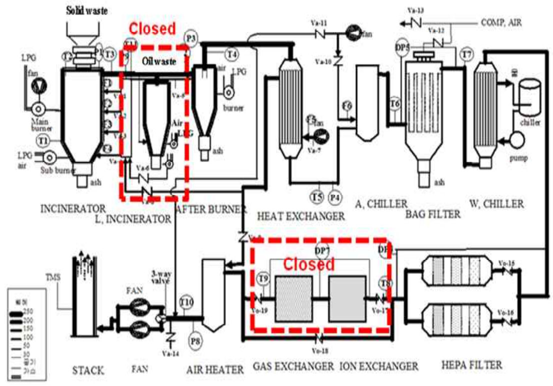

Fig. 1. Schematic diagram of the incineration facility

Table 2. Normal operation condition

	Incinerator	Afterburner	Bag-filter	Filter-bank
Temp. (℃)	800~1000	900~1100	150~200	60~85
Pressure (mmH_2O)	-30 ~ -50	-80 ~ -100	-250 ~ -350	-350 ~-400

3. Results and Discussion

3.1 Major Parameter

Table 3 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.

Table 3. 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
		Criteria		Measured	
Differential pressure (mmH_2O)	Bagfilter	< 100		< 85	
	Medium	< 30		< 16	
	HEPA	< 50		< 16	
	Chalcoal	< 50		< 15	

3.2 Off-gas

Fig. 2 shows the sulfur oxide (SOx) concentration. SOx concentration remained below about 5 ppm range during facility operation. Regulatory limit in Korea of SOx is 300 ppm (corrected to 12% oxygen). The NOx concentration remained below 20 ppm with occasional spikes to approximately 30 ppm (Fig. 3). The measured values are well within the emission limit. The achievement of low NOx is a function of what happen to the air as it passes through both the incinerator and afterburner. The Carbon monoxide (CO) concentration remained 10-50 ppm range for the majority of the normal operation (Fig. 4). The CO is the most significant of combustible gases. The allowable amount of carbon monoxide is normally limited by regulatory agencies which is Korea Institutes of Nuclear Safety (KINS), usually to less than 600 ppm (corrected to 12% oxygen). The US EPA emission limit is 150 ppmdv and KINS limit is 600 ppm. Both the US EPA and the US proposed MACT limit is 100 ppm [2].

3.2 Volume Reduction

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 34 tons using incineration technology in 2013. The achieved volume reduction ratio is about 1/117 through incineration in nine month (Table 4).

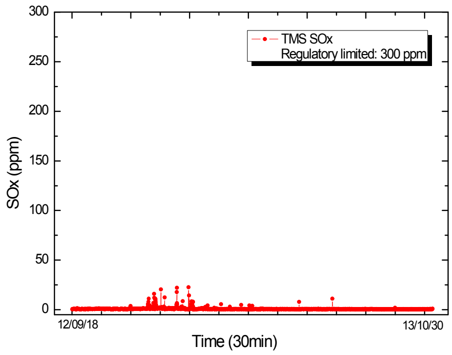

Fig. 2. Sulfur oxides concentration

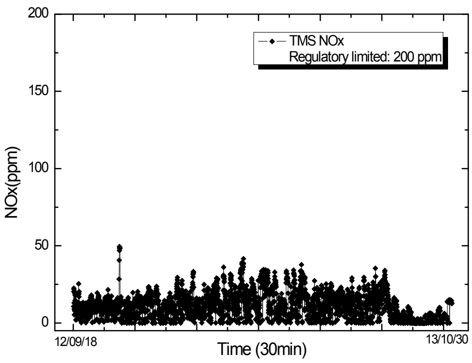

Fig. 3. Nitrogen oxides concentration

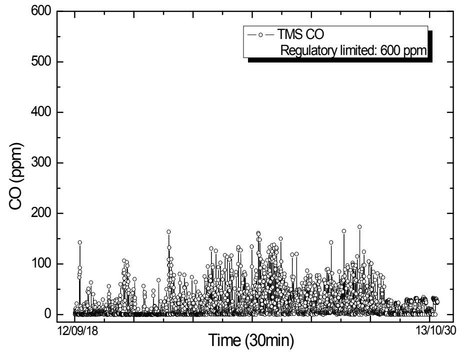

Fig. 4. Carbon monoxide concentration

Table. 4 Results of volume reduction

Month	Decommissioning Waste(L)	Total Ash (L)	V.R. (-)
Jan.	1,641	35	47
Feb.	2,359	23	101
Mar.	5,068	48	105
Apr	5,418	73	74
May.	5,451	39	141
Jun.	3,470	17	210
Jul.	4,785	27	180
Aug.	2,746	10	263
Sep.	3,534	22	159
Total	34,471	294	117

4. Conclusions

The incineration with decommissioning radioactive combustible waste is possible with moderate oxygen enrichment of 22 vol.% (dry basis) into the supply air. 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 is about 1/117.

REFERENCES

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

[2] 40 CFR 266, Appendix IX: Methodology for the Determination of Metals Emissions in Exhaust Gases from Hazardous Waste Incineration and Similar Combustion Source , 2004.