Chemical Pretreatment of Dry Active Waste for Determination of Radionuclides

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1. Introduction

Dry active waste (DAW) is the most common type of radioactive waste in nuclear power plants. To permanently dispose of these wastes in a repository, the threshold for the activity concentration of ^{241}Am, ^{242}Cm, $^{58,\ 60}$Co, ^{137}Cs, ^{55}Fe, ^{94}Nb, $^{59,\ 63}$Ni, $^{238,\ 239,\ 240,\ 241}$Pu, ^{90}Sr, and ^{99}Tc as well as the total alpha, based on the radioactive waste acceptance criteria specified by nuclear safety and security commission (NSSC) notice No. 2015–4 should be met. A chemical analysis of DAW for the determination of radionuclides has technical difficulties owing to its high volume, representative samples, and various decomposition characteristics [1]. Fig. 1 shows composition of low level radioactive wastes from nuclear power plant in 2014 years and picture of dry active wastes.

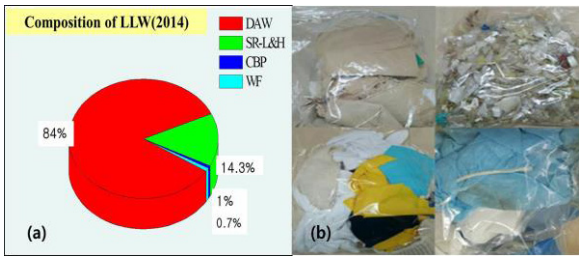

Fig. 1. Composition of low level radioactive waste from nuclear power plants in 2014 (a), and picture of dry active wastes (b).

The volume is therefore minimized through ashing, and the waste is then dissolved using various acids. However, because of the various chemical compositions, the ashing characteristics of DAW are different in terms of the ashing time and temperature. The dissolution of the produced ash is difficult due to the formation of certain oxides while dry ashing at high temperature. Using closed microwave digestion for sample dissolution has advantages, such as a high heating efficiency, a rapid reaction time, avoiding the loss of volatile elements, a low blank level, the prevention of sample contamination, and low reagent consumption, compared to hot plate heating [2].

2. Experimental

We investigated the dissolution properties of dry active wastes for analytical samples arising from nuclear power plants. The analytical samples are prepared using three types of decontamination papers, vinyl gloves, cotton gloves, plastics and linoleums. The weight of each sample is 50 g, and the samples were cut into dimensions of 10 mm x 10 mm. An electric muffle furnace was used to ignite the dry active waste samples. To prevent the formation of soot or a flame during ashing, the temperature was increased step by step from room temperature to 100, 200, 250, 300 ℃, and maintained for 4 or 5 hrs at every step. The Table 1 shows the analytical samples for ashing.

Table 1. Sample by each type for ashing

	Group	Content
1	Paper	Decontamination paper
2	Vinyl	Doggie bag, Latex gloves
3	Cotten	Polyurethane coated gloves, Cotten gloves, Shoes cover
4	Plastic	High-density polyethylene, Low-density polyethylene, Polypropylene
5	Pad	Linoleum

For evaluating the chemical pretreatment, chemicals including HCl, HF, and HNO_3 (Merck, Germany) were used of analytical grade. After dry ashing, the produced ash was dissolved with a mixed acid of HNO_3-HCl-HF by a closed vessel microwave digestion system. The operation conditions of the closed vessel microwave digestion system are shown in Table 2.

Table 2. Operation condition of closed vessel microwave digestion system

Step	Condition	
	Power (W)	Time (min)
1	290	4
2	400	10
3	300	1
4	250	10

3. Result

After completely ashing, the ashing ratio of the analytical samples were 1.04%, 0.61%, 0.45%, 0.54%, 11.83%, respectively. Most samples were completely dissolved with 10 mL of HNO_3, 4 mL of HCl, and 0.25 mL of HF using closed vessel microwave digestion system. However, linoleum were not dissolved with the same condition because of containing titanium and silicon as major compositions.

4. Conclusion

For the ashing results, the ashing ratio of linoleum were comparably much higher than the other samples.In addition, the dissolution of ash of linoleum were not dissolved. The dissolution of ash was affected by the sample weight of ash. For this reason, ashing using linoleum in the radiochemical analysis should be considered deeply because of the representatives in the samples.

REFERENCES

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