Dissolution of Large Amount of Ash Produced From Radioactive Waste Using High-Performance Microwave Digestion Systems

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1. Introduction

Drums of low and intermediate levels of dry radioactive waste (DAW) containing paper, cotton, vinyl, and plastic have been managed temporarily in Korea atomic energy research institutes (KAERI) site. For permanently disposal of these wastes in a repository, the activity of ^{60}Co, ^{137}Cs, ^{55}Fe, ^{94}Nb, ^{59}Ni, ^{90}Sr, and ^{99}Tc in DAW based on the radioactive waste acceptance criteria specified by nuclear safety and security commission (NSSC) should be determined. A dry ashing method [1,2] has been used for sample pretreatment owing to advantages such as allowing the decomposition of a large sample size, no requirement of reagents, relatively safe techniques, and capability of mass production.

2. Dissolution of ash

2.1 Amount of ash produced

To treat 80 to 100 g of sample, a dry ashing method was selected due to the decomposition of a large sample size and the concentration effects of the sample. The weight difference of DAW between before and after ashing was usually big from 80 g to 2-3 g. However, the amount of ash produced from DAW including cotton gloves coated with rubber and surgical gloves was significantly large about 20 g.

2.2 Dissolution of large amount of ash produced

We have established a sample pretreatment procedure of ash produced from DAW. However, the established procedure couldn't be applied to the large amount of ash produced. Therefore studies on the dissolution of the large amount of ash produced with a high-performance microwave digestion system (HP-MDS) containing HNO_3-HCl-HF were performed owing to the difficulty in dissolving certain oxides after heating.

3. Results & discussion

The large amount of ash produced was not completely dissolved by the established sample pretreatment procedure [3]. The sample was not absolutely dissolved with 12 mL of aqua regia and 0.25mL of HF using an HP-MDS. In addition, the ash sample was also not dissolved with fusion method using lithium metaborate and lithium tetraborate (50:50, wt%) as a flux. Although the sample was not completely dissolved, a qualitative analysis using inductively coupled plasma atomic emission spectrometry (ICP-AES) showed the highest concentration of silicon.

Owing to the highest contents of silicon, the volume of HF increased from 0.25 mL to 0.5 mL. Finally the 0.1 g of sample was absolutely dissolved with 12 mL of aqua regia and 0.5 mL of HF using the HP-MDS. A qualitative analysis using the ICP-AES showed the presence of Si, Al, Fe, Ti, Ca, and K in order of high concentration. Analytical results of the ash samples are shown in Table 1.

Table 1. Analytical results of the ash sample

Item	Results (%)	
	Measured	Calculated
Al	0.24	0.44 (as Al2O3)
Ca	0.16	0.23 (as CaO)
Fe	0.24	0.34 (as Fe2O3)
K	0.09	0.11 (as K2O)
Si	43.4	92.97 (as SiO2)
Ti	0.20	0.34 (as TiO2)
Total	44.33	94.44

4. CONCLUSIONS

A sample treatment procedure for the dissolution of a large amount of ash produced by heating the dry radioactive waste including cotton gloves coated with rubber and surgical gloves was established. We found over 90 percent of the ash was SiO_2. This procedure will be applied to the dissolution of the large amount of ash produced.

REFERENCES

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