Composition Analysis of Dry Active Wastes after Heat Treatment

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1. Introduction

Large amount of dry active wastes (DAWs) has been generated during operation and maintenance of nuclear facilities. Management of the DAWs has become an important issue because of limited space for on-site storage and underground disposal. Heat treatment, such as combustion, of the DAWs is an attractive option for their management as significant volume reduction after the heat treatment is expected [1]. On the other hand, it is important to stabilize the heat treatment products of the DAWs for their underground disposal [2]. To design the stabilization process, the amount and the chemical properties of the heat treatment products should be characterized.

2. Methods and Results

Several representative organic DAW samples were chosen as listed in Table I. Their elemental analysis results (C, H, N) are also given in Table I. C and H dominantly exist in the DAW samples, showing that they are mainly composed of organic compounds, as expected.

Table I: Elemental analysis results of DAW samples

Sample	C (%)	H (%)	N (%)
Latex glove	67.81	8.89	0.43
Cotton glove	61.76	4.22	-
Shoe cover	84.91	14.39	0.56
Protection film	84.62	14.38	0.10
Plastic bag	85.41	14.55	-
Paper wiper	41.14	6.00	0.09
Filter fabric	85.12	14.57	-

Heat treatment of the DAW samples were carried out at 1000°C for 8 h using a box furnace in the air to remove the organic compounds and thus to leave inorganic compounds as the heat treatment products. Table II shows weight change of the DAW samples before and after the heat treatment. Except the latex glove, the DAW samples were almost lost after the heat treatment (weight loss ≥ 99%), indicating that the almost organic compounds were decomposed to form volatile species. It is thought that relative low weight loss of the latex glove is originated from inorganic fillers, such as $CaCO_3$, incorporated in the latex glove [3].

Despite the (very) small amount of the heat treatment products, it is important to identify their chemical composition because this information is used to build the stabilization process. In this respect, a qualitative energy dispersive X-ray spectroscopy (EDS) study was carried out to identify the elements existing in the heat treatment products as shown in Figs. 1-6. No heat treatment product of the filter fabric was left and thus its composition analysis could not be made.

Table II: Weight change of DAW samples before and after heat treatment

Sample	Before/After (g)	Loss (%)
Latex glove	26.2390 / 3.5779	86.36
Cotton glove	23.1673/ 0.1356	99.41
Shoe cover	21.2649 /0.0696	99.67
Protection film	24.9615 /0.0085	99.97
Plastic bag	23.2049 / 0.0204	99.91
Paper wiper	25.3212 / 0.2558	98.99
Filter fabric	21.6624/ 0	100

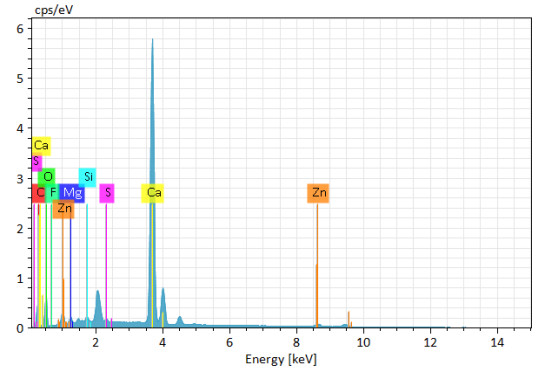

Fig. 1. EDS analysis of heat treatment product of latex glove

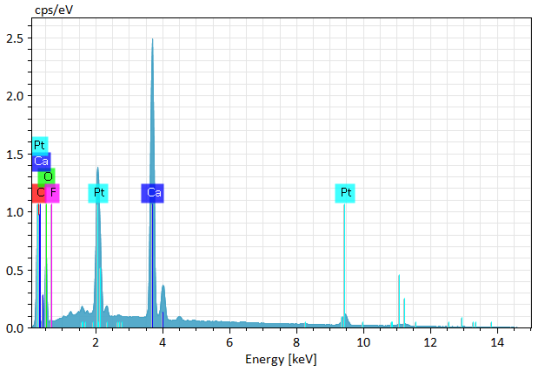

Fig. 2. EDS analysis of heat treatment product of cotton glove

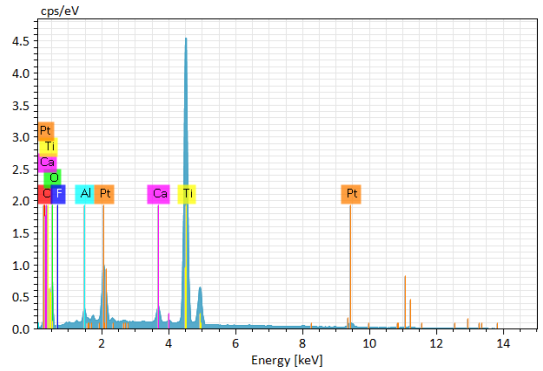

Fig. 3. EDS analysis of heat treatment product of shoe cover

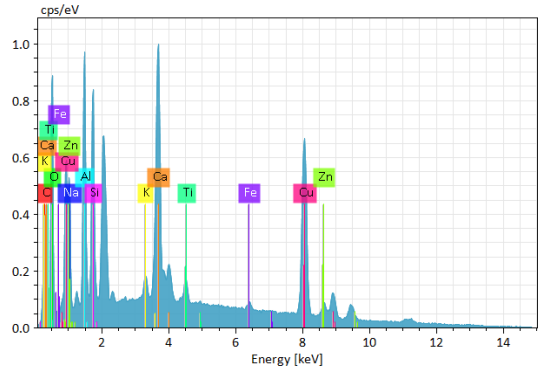

Fig. 4. EDS analysis of heat treatment product of protection film

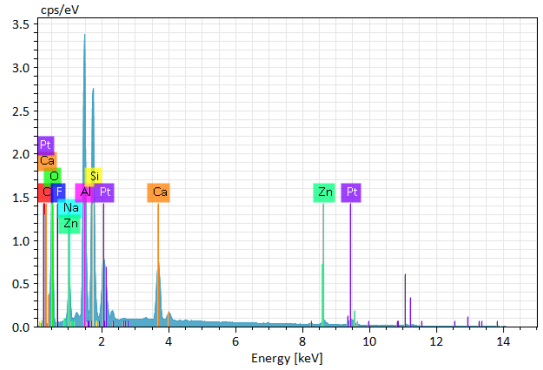

Fig. 5. EDS analysis of heat treatment product of plastic bag

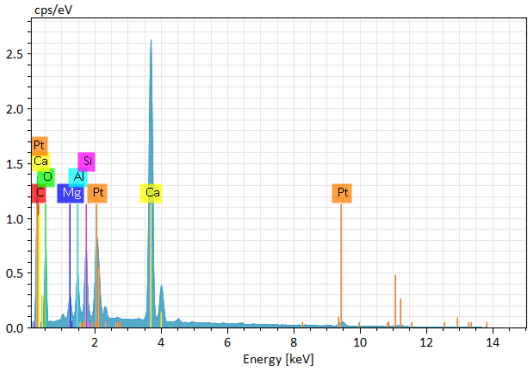

Fig. 6. EDS analysis of heat treatment product of paper wiper

Table III summarizes the EDS analysis results (meatllic elements only). The inorganic elements in Table III are listed from most to least. The DAW samples were composed of various metllic elements and Ca was identified for all cases. Ti and Cu were found to be major inorganic elements in the shoe cover and the protection film, respectively. Si and Al also seem to be signficant for most casese. Since the EDS study cannot provide precise quantitative result, more detailed composition analysis will be carried out by inductively-coupled plasma (ICP) method.

Table III: Identified elements on heat treatment products of DAW samples

Sample	Elements
Latex glove	Ca >> Zn, Mg, Si
Cotton glove	Ca
Shoe cover	Ti >> Ca, Al
Protection film	Cu > Ca, Al, Si, Na > etc.
Plastic bag	Al, Si > Ca > etc.
Paper wiper	Ca >> Si, Al, Mg

3. Conclusions

The ambient air heat treatment of several DAW samples were carried out to figure out their weight loss and to identity their inorganic components. It was found that, except the latex glove, most of the DAW samples could be eliminated by the heat treatment to leave very small amount of the heat treatment product (≤1%). Meanwhile, relatively large amount (~14%) of the heat treatment product remained in the latex glove, which should be originated from its intrinsic property (e.g., $CaCO_3$ filler). EDS analysis revealed that there are various metallic elements in the DAWs such as Ca. Subsequent ICP analysis will be made for the quantification, which will be used to design the stabilization process.

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