A Study on the Volume Reduction of Concrete Waste by Sintering Method

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1. Introduction

A large amount of radioactive waste is generated when nuclear power plants are dismantled. Most radioactive wastes, except for the clearance level waste are deemed to be treated and disposed in various ways according to the waste acceptance criteria. Many of them need to be solidified for that. Methods for solidifying waste include cement solidification, geopolymer, bitmen, ceramic, glass, glass-ceramic solidification method. Among these solidification methods, the glass and ceramic manufacturing method by sintering have the following advantages as shown in Table 1.

Table 1. Characteristics of the manufacturing method by glass and ceramic [1]

	Ceramics	Glass
Waste loading	Up to 50% dry weight	Up to 25% dry weight
Volume	Increase	Reduction
Leach resistance	High for most radionuclides	Very high

Therefore, in this work, the solidification experiment was performed by the sintering method using the glass-ceramic solidification method.

2. Methods and Results

The materials used in the experiment were fine concrete waste powder which was sieved under 1 mm after the aggregate was separated from the concrete waste. The remaining wastes were pulverized after heat treatment at over 500℃. According to the waste acceptance criteria, wastes containing particulate dispersive matter should be treated and packaged to be non- dispersible. To evaluate glass-ceramic waste form, pellets with height of 8 mm were manufactured at a pressure of 30, 60, 120, 150 MPa using a mold in diameter of 13 mm. The sintering temperature was maintained at 1,000℃, 1,050℃ and 1,100℃.

B_2O_3, which is an additive to form glass-ceramic matrix from the concrete waste, was added at certain ratio according to the content of SiO_2 in the waste and solidified. The compositional analysis of the concrete waste by SEM-EDS showed 26.93wt.% of CaO, 26.82wt.% of SiO_2 and others are Al_2O_3, Fe_2O_3 etc. The experiment of sintering with a change of temperature showed that the pellet melted over 1,050℃ and there was no significant large volume reduction below 1,000℃.

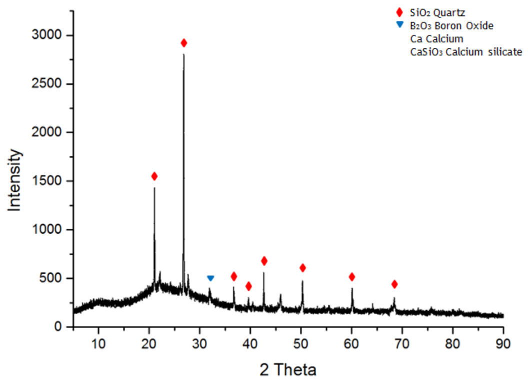

Fig. 1. XRD pattern of material remained after sintering.

The XRD results of the sintered body at 1,050℃ are shown in Fig. 1. It shows generally amorphous phase due to formation of glass phase with partially crystal phase. Such a matrix means that glass-ceramic wasteform can be formed from the concrete waste.

Fig. 2 shows the photos of the sintered body and SEM photo of fractured surface. Fig. 2(a) shows the sintered pellet which is the volume reduced and Fig. 2(b) shows the fractured pellet has non porosity.

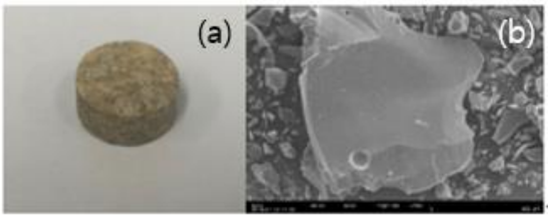

Fig. 2. (a) Sintered pellet, (b) Surface of the fractured pellet after sintering.

3. Conclusion

The concrete waste was confirmed to form the glass-ceramic wasteform with volume reduction. And the shrinkage ratio of sintered body was approximately 40% from the initial concrete waste fine powder.

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