A Study on Characteristic for Manufacturing Immobilization of Green Body for Moist Particulate and Sludge-Type Radioactive Waste

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1. Introduction

It is study of the process for manufacturing a green body for the moist particulate and sludge-type radioactive waste for disposal in domestic industry. The radioactive waste should be volume-reduced and satisfied with the requirements of radioactive waste delivery regulations for preventing the spread of contamination in radiation accident. In this study, it is aimed to derive the optimum molding pressure condition by observing the change of the height of green body and the apparent density by manufacturing a large size compression molding equipment.

2. Main Title

2.1 Process of manufacturing green body

As shown in Table 1, it is a comparison of composition between original radioactive waste samples and the simulated samples.

Table 1. Comparison of composition analysis between original samples and simulated samples(ppm)

	Si	Sb	Mo	Fe	Al	Cu	Zn	P	Ca	Mg	B	Ti
O.S*	22.3	2.58	332	27.04	35.21	-	1.33	2.27	698.7	21	61.85	0.38
S.S**	34.2	3.39	839.6	37.76	97.8	70.9	2.24	61.86	1704	52.9	123.7	1.69

*O.S : Original Sample **S.S : Simulated Sample

Fig. 1 shows the process of producing the dried powder sample. First of all, the simulated samples are dried in a large dryer for at least 6 hours to remove moisture in the molding process and put into a Super-Mixer to make a homogeneous powder. Then, the calculated amount of boron oxide and cerium(IV)oxide are injected into the powder.

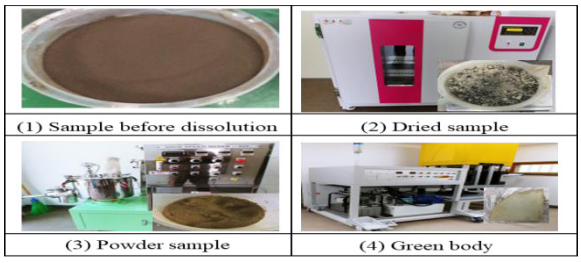

Fig. 1. Process for Manufacturing Powder Sample. The role of additives in the mixed sample is to maintain the state of glass ceramic compound and the shape of structure during the process of heat treatment.

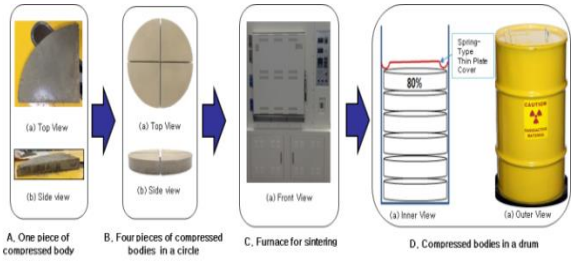

Fig. 2. The manufacturing process of green body.

2.2 Design and manufacturing the compression molding equipment

The shape of the mold is a fan shape which is 20 cm diameter with 200 ton maximum pressure.

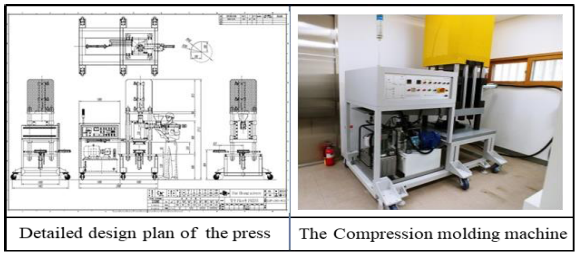

Fig. 3. Compression Molding Equipment.

2.3 Manufacturing Green Body

4kg dried powder sample was injected into the inside of the mold and flatting the surface of the sample before the compression. As shown in Table 2, the molding pressure was gradually set from 30 to 60 MPa, so sufficient molding pressure can be performed in consideration of the state of the green body.

Table 2. Pressure applied value per unit area

Diameter (cm)	Area ($A = \pi r^2$)	1/4 Area(cm^2)	Ton	MPa
40	1,256	314	96	30
			128	40
			160	50
			192	60

2.4 The Characteristic of Green Body according to Pressure

As shown in Fig. 3, it was measuring the height of the green body according to changing the pressure by

using the Vernier calipers.

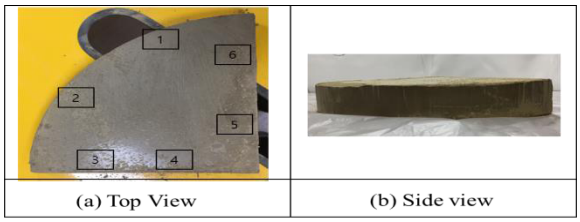

Fig. 4. Measurement of green body.

As a result, it was found that the height of the green body was lowered and the apparent density was increased according to the increased pressure as shown in the Table 3 & 4

Table 3. Variation of the height of the green body by pressure increase

Point Pressure	1	2	3	4	5	6	Avg. Height (cm)
30	5.201	5.188	5.205	5.214	5.245	5.170	5.203
40	5.132	5.130	5.133	5.144	5.158	5.250	5.158
50	5.097	5.045	5.066	5.032	5.057	5.05.3	5.059
60	5.045	4.987	5.018	5.050	4.944	4.938	4.997

Table 4. Variation of apparent density according to pressure increase

Weight (g)	Pressure [MPa]	r(cm)	H(cm)	V(cm^2)	Apparent Density (g/cm^3)	Relative Density
4,000	30	20	5.203	163.45	0.0244	0.960
	40		5.158	162.04	0.0247	0.969
	50		5.058	158.92	0.00252	0.988
	60		4.997	156.99	0.0255	1

As the representative value of the height for the green body by increasing the pressure from 30 to 60 MPa, it is obtained with the Lagrange third degree polynomial by using the simplest interpolation of Eq (1) and the result of third degree polynomial is Eq (2).

$$f(x) = \sum_k \left(\prod_{j\neq k} \frac{x-x_i}{x_k-x_j}\right) y_k \quad (1)$$

$$f(x) = p_1x^3 + p_2x^2 + p_3x^3 + p_4 \quad (2)$$

p_1 = 3.12E-07 $\quad p_2 = -8.89E-05$

$p_3 = -1.14E-03 \quad p_4 = 5.32E+00$

As using Eq (2), it could predict the height of the green body by more than designed pressure of the pilot-scale equipment. Fig. 4 is the estimated graph by using MATLAB program. As a result, it was confirmed that the optimum pressure value of the pilot-scale equipment is 60 MPa, which is the maximum value of the designed value.

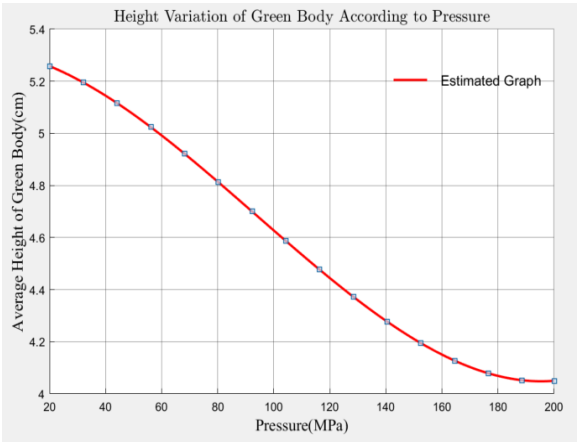

Fig. 5. Height Variation of Green Body by Using Lagrange Interpolation.

3. Conclusions

As a result of evaluating the characteristics of the compression green body of a large size, it was confirmed that the larger the pressure, the smaller the volume. In addition the apparent density was increased and the shape of green body had a smooth appearance. Based on the results of this study, it will be established with a suitable method of manufacturing a green body and study the appropriate to height of the green body. As the results of this study, it will be expected to be applied to the design basis of commercial compression molding equipment.

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