# Basic Study on Development of Solidification Agent for Disposal Container Recycled From Paste Powder at Concrete in Decommissioning Nuclear Power Plant

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## 1. Introduction

For the first time, the nuclear power plant will be decommissioned as Kori unit 1 has been operated for over 40 years. In decommissioning nuclear power plant, various type of waste is generated and over 80 % is concrete in these wastes. There is volume reduction technology as method for reducing volume of concrete.

Generally, since portion of activation is only paste excluding the aggregate, it is need to separate paste and aggregate. The aggregates will be recycled and pastes will be disposed.

In this paper, study is conducted for hydration recovery by re-heating paste. The re-heat paste will be used to solidification agent for disposal container using separated paste. This study aims to obtain basic data necessary for the development of solidification agent for radioactive waste disposal container.

## 2. Experiments

### *2.1 Materials*

The paste was made W/B = 40% and cured for 28 days. For making the paste as the sample powder of solidification agent, crashed to a size of several millimeters using jaw-crasher. And they were dried at 100°C to remove un-acted water. To reflect 40 years old period, two type samples which are carbonation paste (CP) and non-carbonation paste (NP) were made according to KS K 2584. Also it was ground as same particle size to cement using ball mill.

### *2.2 Experiment methods and items*

After heat temperature conditions have been selected by 500, 600, 700°C for hydration recovery of the pastes, the pastes were heated in electric furnace during one and half hour. And then they were cooled in desiccators during the same time. To reflect carbonation environment in atmosphere over 40 years, carbonation paste (CP) and non-carbonation paste (NP) were mixed at 50:50%. Dehydrate gypsums were added by 4% to enhance compressive strength.

As experimental items, the specific gravity of each heat temperature was measured according to KS L 5110. Mortar compressive strength was measured according to KS L ISO 679 for evaluation of strength development.

### *2.3 Mortar mix design*

Rate of fine aggregate : cement : water is 3 : 1: 0.5 according to KS L ISO 679. Mix 1, 2 were designed to this method and table of mix proportion is shown to Table 1. But Mix 3 was designed to different amount of cement according to specific gravity.

Table 1. Mixing Design of Mix 1 and 2

| Type | | Temp | NP | CP | Gypsum | W/B | Sand |
|---|---|---|---|---|---|---|---|
| | | (°C) | (%) | | | | (g) |
| Mix 1 | 1 | 0 | 96 | 0 | 4 | 0.6 | 1350 |
| | 2 | 500 | 96 | 0 | 4 | 0.6 | |
| | 3 | 600 | 96 | 0 | 4 | 0.6 | |
| | 4 | 700 | 96 | 0 | 4 | 0.7 | |
| Mix 2 | 1 | 0 | 48 | 48 | 4 | 0.6 | |
| | 2 | 500 | 48 | 48 | 4 | 0.6 | |
| | 3 | 600 | 48 | 48 | 4 | 0.6 | |
| | 4 | 700 | 48 | 48 | 4 | 0.7 | |

Generally, specific gravity of cement is 3.15 g/cm$^3$. At this time, requested amount of cement is 450 g. If specific gravity of cement was decreased by 2.6 g/cm$^3$ after heating, cement volume of 450 g is same to that of 270 g. Like this, amount of cement is

varied depending on the change of specific gravity after heating. Mix proportion and specific gravity of each heating temperature were shown to Table 2. In case of 700°C, unit water content is increased to ensure the same flowability.

Table 2. Mixing Design and Density of Mix 3

| Type | | Density | Temp | NP | CP | Gypsum | W/B | Sand |
|---|---|---|---|---|---|---|---|---|
| | | ($g/cm^3$) | (°C) | | (%) | | | (g) |
| Mix 3 | 1 | 2.63 | 0 | 48 | 48 | 4 | 0.75 | 1350 |
| | | | | 376 g | | | | |
| | 2 | 2.67 | 500 | 48 | 48 | 4 | 0.75 | |
| | | | | 382 g | | | | |
| | 3 | 2.85 | 600 | 48 | 48 | 4 | 0.75 | |
| | | | | 407 g | | | | |
| | 4 | 3.01 | 700 | 48 | 48 | 4 | 0.8 | |
| | | | | 429 g | | | | |

*2.4 Result of compressive strength*

Compressive strength of Mix 1, 2 at 28 days is shown to Fig. 1. Compressive strength of Mix 1 and 2 increased with increasing heating temperature and compressive strength is highest at 600°C. But compressive strength at 700°C decreased due to the increase in mixing water for ensuring flowability. Mix 2 of mixing CP is lower compressive strength then Mix 1 because it is judged to limestone formed by carbonation.

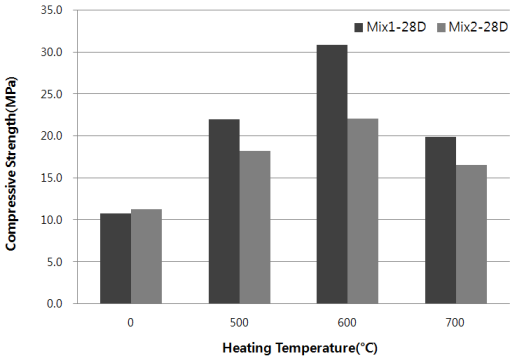


Fig. 1. Compressive strength of Mix 1, 2.

Compressive strength of Mix 3 at 7, 28 days is shown to Fig. 2. Compressive strength of Mix 3 is lower than Mix 1, 2 due to decreasing paste amount according to specific gravity. Also compressive strength increases with increasing heating temperature and the difference between 600°C and 700°C was not significant.

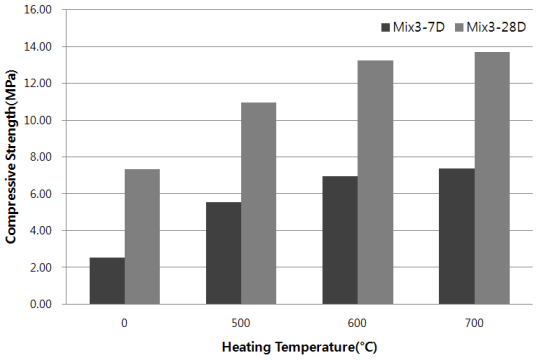


Fig. 2. Compressive strength of Mix 3.

## 3. Conclusion

Specific gravity of CP was as low as 2.63 $g/cm^3$. But Specific gravity was increased with increasing heating temperature due to water evaporation. Compressive strength at 600°C was highest and mixing water was needed at 700°C for ensuring flowability. Result of compressive strength experiment, it is judged that 600°C is more suitable than 700°C.

## Acknowledgement

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