Preliminary Study on the Heating and Grinding Method for Volume Reduction of Radioactive Concrete Waste From Decommissioning Process

Maeng-Kyo Oh[1),2)], Keun-Young Lee[2),*], Richard I. Foster[2)], and Chang-Ha Lee[1),*]

[1)] Yonsei University, 50, Yonsei-ro, Seodaemun-gu, Seoul, Republic of Korea

[2)] Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea

* lky@kaeri.re.kr, leech@yonei.ac.kr

1. Introduction

Nuclear facilities, which lost utility value, will be safely returned to society after a period of about 10~20 years of decommissioning processes including preparation, characterization, decontamination, dismantling, waste treatment and environmental remediation.

Various types of decommissioning wastes are generated during the decommissioning of nuclear facilities. Concrete, which is the main building material of a nuclear facility, is contaminated and activated during its operation, resulting in a large amount of radioactive waste. The amount of radioactive concrete waste generated varies significantly depending on the type of facility, method of decommissioning and volume reduction treatment that has a huge impact on the cost of decommissioning. In Korea, the volume of radioactive concrete must be reduced. Because strict and high standards are applied to classification, treatment and disposal of radioactive wastes, also the disposal cost for radioactive waste is very high.

Most radionuclides found in radioactive concrete waste are present in cement component [1]. Heating and grinding technology is a typical radioactive concrete waste treatment technology using to separate the cement and aggregate components, thus separating radioactive and non-radioactive waste[2,3]. It has been confirmed through previous researches that must of cement paste is separated from the aggregate, thus achieving an effective volume reduction of concrete waste. However, it is unclear that separated aggregate could be released after heating and grinding treatment, and further studies are required to meet regulation criteria for free-release.

In this study, basic studies were conducted to improve the separation efficiency of aggregates and cement by using heating and grinding technology for the volume reduction of radioactive concrete waste.

2. Materials and Methods

The concrete simply crushed to 10~40mm diameter was obtained from a construction waste disposal company.

During the heating and grinding experiment, 150~200 g of concrete was heated at 400~700℃ for 10~120 minutes using muffle furnace(MF-12GH, JEIO-TECH). The concrete was then cooled naturally before the grinding. Concrete grinding was completed using a ball mill (LM-BD4530, LK LAB KOREA) that was most commonly used in the industry. The pre-heated concrete along with grinding balls (Alumina ball, D: 0.5~40 mm) were placed in the mill pot (Porcelain, 500 ml) and ground for a certain time at 300 rpm/mill roller speed. The ground concrete was separated into aggregate and cement paste by using a 1mm test sieve and the weight of each parts were measured to confirm the classification rate.

The difference in weight before and after grinded concrete using acid dissolution were confirmed the separation rate of cement and amount of residual cement in aggregate. This method is an analytical method using difference of solubility of aggregate and cement in acid solution. Each component was dissolved using 4 M hydrochloric acid (HCl, Merck) as shown in Fig.1. Since aggregate was almost

insoluble and cement has a high solubility, which was easy to analyze the residual amount of cement.

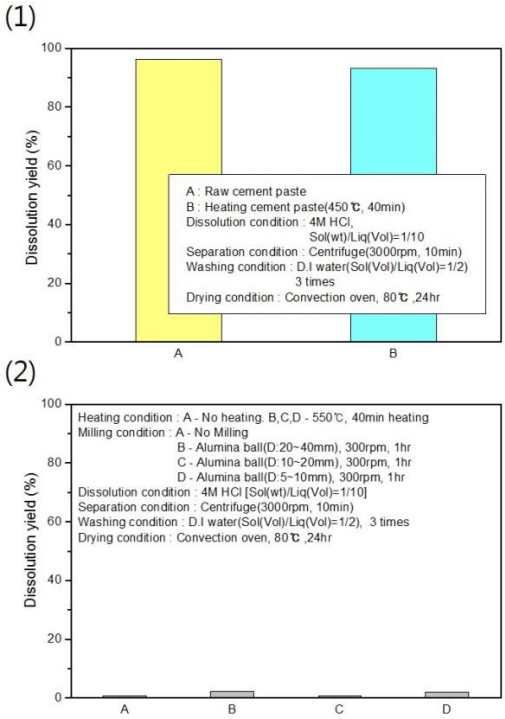

Fig. 1. Dissolution yield of (1) Cement, (2) Sand.

3. Result and discussion

Fig. 2 shows the results of 5 min ~ 24 hrs for grinding condition using ball mill after heat treatment at 450℃ in 40 minutes.

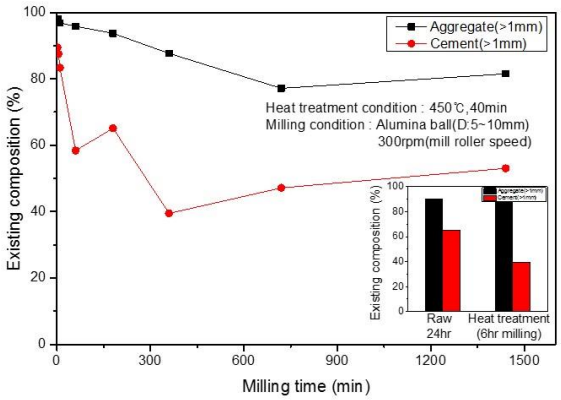

Fig. 2. Result of heating and grinding experiment.

In the case of raw concrete, that 65% cement component was remains in the aggregate of 1mm or more after 24hours grinding. However, heat-treated concrete was about 45% cement component remains in the aggregate at the 6hours grinding. Because of the bonding strength between the cement and aggregate was reduced by heating above 450℃.

Aggregate and cement will be separated more effectively by optimizing the heating temperature with time and grinding condition like a ball size, combined grinding medium and filling method.

4. Conclusion

This study was to improve the separation efficiency of the heating and grinding technology for radioactive concrete waste. In the case of concrete, it was found that the separation rate was increased by first weakening the bond between the cement and aggregate by heat treatment. If the heat treatment conditions, temperature, time and grinding condition, are optimized, it could be expected that a lot of volume reduction can be achieved.

ACKNOWLEDGEMENT

This work was supported by the National Research Foundation of Korea grant (No. NRF-2017M2A8A5015147) funded by Ministry of Science and ICT.

REFERENCES

[1] K.Y. Lee, M.K. Oh, J.M. Kim, E.H Lee, I.S Kim, K.W. Kim, D.Y Chung, B.K Seo, “Trends in technology development for the treatment of radioactive concrete waste”, Journal of Nuclear Fuel Cycle and Waste Technology, 16(1), 93-105 (2018).

[2] B.Y Min, W.K. Choi, K.W Lee, “Separation of clean aggregates from contaminated concrete waste by thermal and mechanical treatment”, Annals of Nuclear Energy, 37, 16-21 (2010).

[3] I.P. Binkhorst, H.A.W. Cornelissen, “Technology for reuse of contaminated concrete constituents”, IAEA-TECDOC-1022 (1998).