Volume reduction of radioactive concrete waste generated from KRR-2 and UCP

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1. Introduction

As a part of a technical development for the volume reduction and stabilization of contaminated concrete wastes generated by dismantling a research reactor and uranium conversion plant, we have developed the volume reduction technology and immobilization of fine powder applicable to an activated heavy weight concrete generated by dismantling KRR-2 and a uranium contaminated light weight concrete produced from a UCP decommissioning. During a decommissioning of nuclear plants and facilities, large quantities of contaminated concrete wastes are generated. The decommissioning of the retired TRIGA MARK II and III research reactors and a uranium conversion plant has been under way. In Korea, two decommissioning projects such as the decommissioning of the retired research reactors (KRR-1 & 2) and a uranium conversion plant (UCP) at the Korea Atomic Energy Research Institute (KAERI) has been carried out. By dismantling KRR-2, more than 260 tons of radioactive concrete wastes are generated among the total 2,000 tons of concrete wastes and more than 60 tons of concrete wastes contaminated with uranium compounds are generated in UCP decommissioning up to now [1]. The volume reduction and recycling of the wastes is essential to reduce the waste management cost with expecting that an approximate disposal cost for low level radioactive waste will be more than 5,000 US dollars per 200 liter waste drum in Korea. It is well known that most of the radioactivity exist in cement mortar and paste composed of concrete [2, 3]. In this context, the volume reduction of concrete waste is based on the separation of radioactive concrete into a clean recyclable aggregates and a radioactive fine cement powder, which can be readily performed by heating to weaken the adherence force between the cement matrix and the aggregates followed by mechanical crushing and milling processes. In this study, we have investigated the characteristics of separation of aggregates and the distribution of radioactivity into the aggregates in the volume reduction point of view using an activated heavy weight concrete taken from KRR-2 and a uranium contaminated light weight concrete from a UCP using a lab scale pilot plant. To minimize the volume of the radioactive cement paste, the fine powder wastes were immobilized.

2. Method and Result

Activated heavy concrete and light concrete waste contaminated with uranium generated from UCP were used for the test. Figure 1 shows the separation procedure. At first, the dismantled concrete wastes are crushed for a size reduction. The crushed concrete was heated to about 450°C in an electric furnace for 40minutes. The separation was performed by a mechanical process in a ball mill for about 40minutes. Produced aggregates were sieved such as gravel (>5mm), sand (1-5mm), cement paste (< 1mm).

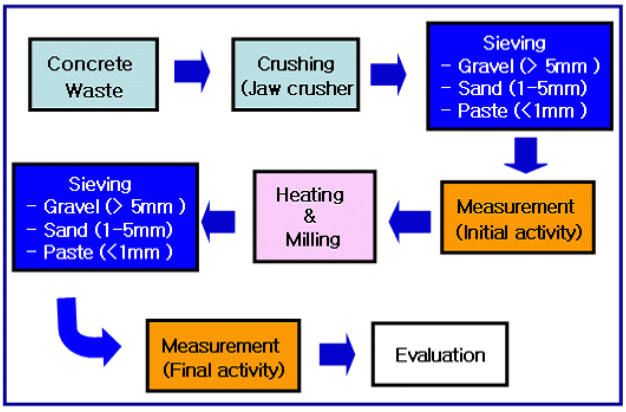

Fig.1. Experimental procedure

The classified each aggregate was taken by a standard cylindrical vial at 20ml and 80ml for an activity analysis. The aggregate samples were analyzed with a MCA (multi-channel-analysis) of a high-purity germanium detector to evaluate the radionuclides distribution. To establish the stabilization condition for the treatment of fine powder, a radioactive fine cement paste produced during the course of the mechanical treatment process was immobilized. Separation of the concrete into its components gravel, sand and paste is based on a reduction of the bond between the cement matrix and the aggregates.

Figure 2 shows the distribution of a self disposal aggregates for the activated heavy concrete after a heating and a milling. The activated concrete waste which is more than 70% can be reduced in volume by separating the aggregates and the fine powder after a heating and a grinding. The heating and milling process effectively plays an important role in the removal of the radionuclides from the activated concrete waste. The coarse and fine aggregates bearing a relatively low specific radioactivity could be obtained. Most of the radioactivity is concentrated in the fine aggregates (cement, sand) because cementitious materials are porous media, the penetration of radionuclides may occur up to several centimenters from the surface of a material[4], while the coarse aggregates (>1mm) are

practically unaffected because of their mineral composition and high density [5, 6].

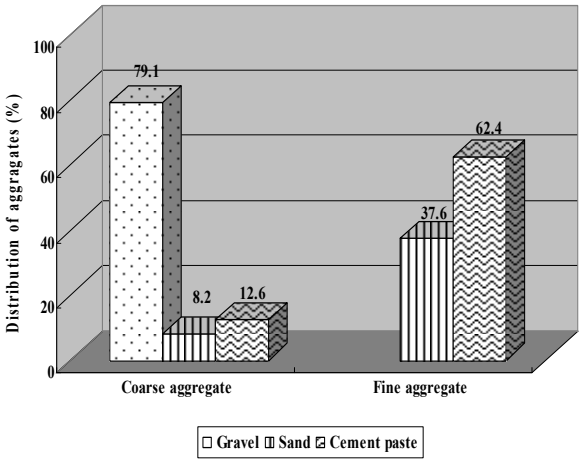

Fig. 2. Volume reduction of activated heavy concrete

Two types of concrete wastes are produced from uranium conversion plant such as mortar cement concrete and general light weight concrete. Figure 4 shows the distribution of the aggregate of the contaminated uranium concrete waste. The general light weight concrete could be separated into coarse and fine aggregates of more than 70% with a low specific radioactivity. Uranium radioniclides were removed easily from the concrete wastes by removing the cement matrix to weaken the adherence force between the cement matrix and the aggregates by a heating and a crushing

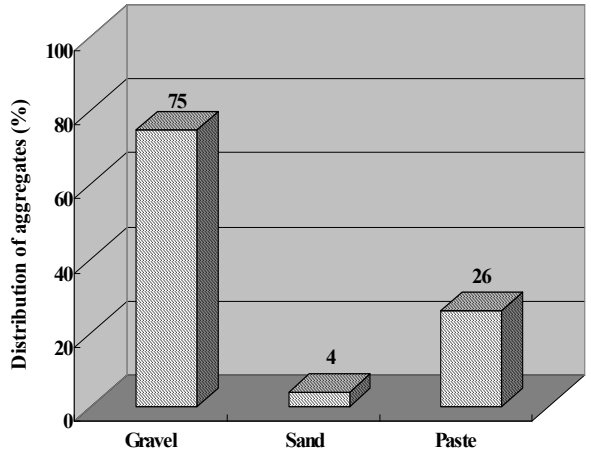

Fig. 3. Volume reduction uranium concrete waste

Figure 4 shows the distribution of aggregates for the non radioactive light concrete after a heating and a mechanical pilot plant of lab scale. The dismantled concrete waste which is more than 65% can be reduced in volume by separating the aggregates and the fine powder after a heating and a mechanical grinding.

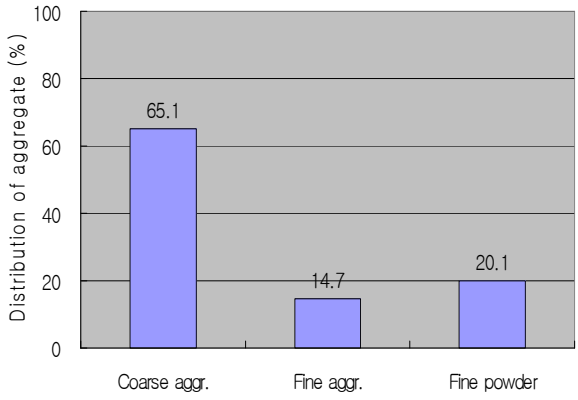

Fig. 4. Distribution of aggregates by lab scale pilot plant

3. Conclusions

We have investigated the characteristics of a separation of aggregates and the distribution of the radioactivity into the aggregates for the volume reduction point of view using an activated heavy weight concrete taken from KRR-2 and uranium contaminated light weight concrete from the UCP. Through these experiments, the following conclusions can be drawn:

- Radioactivity is mainly concentrated in the porous fine cement powder below a size of 1mm
- A volume reduction rate above 75% could be achieved by a heating followed by mechanical separation process.
- Recovery of aggregate by a lab scale pilot plant above 65% could be possible

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