UTILIZATION OF FISHBONE FOR THE STABILIZATION OF HEAVY METALS IN MUNICIPAL SOLID WASTE INCINERATION (MSWI) FLY ASH

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論 文 名：　UTILIZATION OF FISHBONE FOR THE STABILIZATION OF HEAVY METALS IN MUNICIPAL SOLID WASTE INCINERATION (MSWI) FLY ASH
（魚骨による焼却飛灰の重金属安定化に関する研究）

区　　分：　甲

論　文　内　容　の　要　旨

As one of the most effective means for the disposal of municipal solid waste that daily generated in a huge amount, incineration is adopted increasingly as it can reduce the mass and volume of the waste dramatically and recovery energy. Municipal solid waste incineration (MSWI) fly ash is one of the main solid residues derived from the incineration process, which is classified as hazardous waste worldwide owing to the relatively high concentration of heavy metals. Thus MSWI fly ash requires further treatment before the reuse or recycle, and the final disposal in landfill sites. There have been many technologies for the stabilization of heavy metals in MSWI fly ash, whereas most of them are too complicated or expensive to be practically accepted. Therefore, simple and low-cost new technologies are in demand.

Fishbone is a common type of waste generated from the food and especially fish processing industries. As a bio-waste, fishbone or fish waste are usually treated as the source of organic matters for the by-production. In addition, fishbone is an enriched natural source of hydroxyapatite (HAP) which is reported to possess the ability on the stabilization of heavy metals by producing metal-HAP bonding. Ample efforts have been conducted for the utilization of HAP or fishbone on the heavy metal stabilization in the contaminated environments, while there is no practical investigation on the stabilization of heavy metals in MSWI fly ash. Therefore, this research was conducted with the aim of stabilizing the heavy metals by waste fishbone as an environmental-friendly technique for the utilization or final disposal of MSWI fly ash.

In the present research, the MSWI fly ashes from three plants in Japan were used for heavy metal stabilization with HAP from waste fishbone. The collected fly ash materials were firstly subjected to different tests for characterization. The feasibility of HAP on heavy metal stabilization was verified by adding fishbone during the leaching process of MSWI fly ash. Then two approaches were taken into account for improving the effectivity of fishbone HAP on the stabilization of heavy metals in MSWI fly ash.

The contents of the thesis are organized as follows:

Chapter 1 introduces the background and objectives of this thesis. The current states of municipal solid waste generation and treatments were reviewed, with the emphasis on the strategies of MSWI fly ash disposal and the utilization of waste fishbone. Then the motivation and purpose of this research was presented.

Chapter 2 presents the characterization of MSWI fly ash. Various properties of MSWI fly ash were tested, including pH, particle size distribution, thermogravimetric and loss-on-ignition features, elemental composition and leaching property, as well as the mineral composition and transformation. Accordingly, Pb was identified as the main target of the heavy metal stabilization in MSWI fly ash.

Chapter 3 verifies the feasibility of fishbone on the stabilization of heavy metal in MSWI fly ash. Natural fishbone was added during the leaching process of MSWI fly ash. The effectivity of fishbone on Pb stabilization in MSWI fly ash was represented as Pb removal efficiency in the leachate at the presence of fishbone. The results indicated that either longer contact time or higher fishbone dosage benefited Pb stabilization. However, Zn and particularly Cu were encouraged to leach out rather than to stabilize. Besides, higher capacity of fishbone on Pb stabilization was obtained at lower dosage of fishbone, which implied that the relatively abundant supply of heavy metal ions might facilitate the stabilization reactions.

Chapter 4 focuses on the approaches to improve the effectivity of fishbone on the stabilization of heavy metals in MSWI fly ash. According to the observation to the experiments of Chapter 3, providing various L/S conditions and taking ignition as the further pre-treatment on natural fishbone were taken into account. The results from the experiments under various L/S indicated that the preferred effectivity on Pb stabilization could be obtained at lower L/S conditions, and Zn turned to be stabilized concurrently. However, the leaching of Cu still existed at all L/S conditions. In the second approach, candidate ignition temperatures were selected based on the potential phase transformation of fishbone. These ignited fishbone from different ignition temperatures was involved into the stabilization processes as natural fishbone subjected previously. Accordingly, 430 °C was chosen as the optimal ignition temperature for the pre-treatment of fishbone, because the product showed better performance on Pb stabilization, and prevented the leaching out of Cu and P into the leachate of MSWI fly ash. The fishbone ignited at 430 °C brought higher Pb removal efficiency than the natural one under various scenarios, while it was not proportionate to the mass loss during the ignition. The ignition process not only removed the non-HAP fraction of fishbone but also promoted the crystallinity of HAP. However, the latter was not beneficial to the stabilization of heavy metals in MSWI fly ash.

Chapter 5 summarizes the conclusions of the study, and makes recommendations for the future researches.