INFLUENCE OF QUENCHING PROCESS ON MUNICIPAL SOLID WASTE INCINERATION BOTTOM ASH CHARACTERIZATION

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https://doi.org/10.15017/1654856

出版情報：九州大学, 2015, 博士（工学）, 課程博士
バージョン：

（様式２）

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論 文 名 ： INFLUENCE OF QUENCHING PROCESS ON MUNICIPAL SOLID WASTE INCINERATION BOTTOM ASH CHARACTERIZATION
（一般廃棄物焼却における水冷プロセスが焼却灰の性状に及ぼす影響）

区　　分 ： 甲

論 文 内 容 の 要 旨

Many efforts have been undertaken in past decades to characterize municipal solid waste incineration (MSWI) bottom ash, however, the investigation in this field still challenges due to the MSWI bottom ash from place to place is different, particularly in terms of both composition quantity and quality. In this study, the main focus is paid to the influence of quenching process, and the formation of the quench product on the MSWI bottom ash which details are existed in less information. Quenching process could influence the characteristic of the ash directly and this could affect to its management due to the proper ash management should be practiced based on its characterization. Therefore, quenching process is important in the sense of waste management and material recycles.

With the goal to obtain a better understanding on quenching process (which regard as the initial stage of weathering) and the formation of the quench product on the MSWI bottom ash, two approaches have been used in this study; i(the intensive investigation on the representative sample obtained from the incineration plants and ii(the simulative investigation on lab-scale quenching experiment. Details of research are divided into six chapters.

In Chapter 1, the background of this research as well as objectives and research flow were introduced with the review of literature regarding to municipal solid waste generation and treatment strategy in Japan, incineration technology, ash discharge technology/ quenching system, MSWI residue generations, MSWI bottom ash characterization, and its disposal strategy.

In Chapter 2, the details of the investigation on physical, chemical and mineralogical characterization of materials involved in quenching system namely grate sifting, unquenched bottom ash and freshly quenched bottom ash were presented. The investigations were performed utilizing various methods to determine the characteristics of specimen, namely visual observation, analysis of particle size distribution, particle thin section analysis, and measurement of pH, moisture content, and loss on ignition, bulk chemical analysis, and mineral composition analysis. Results showed that the pH of all samples was in the range of 11. 7–12. 7. Approximately 70–80 % of samples consisted of CaO, SiO_2, Al_2O_3, and Fe_2O_3. Grate sifting was slightly similar to the unquenched bottom ash in terms of physical appearance that did not contain the quench product, however it was dominant with the characteristic of high concentration of Al and heavy metals. The unquenched bottom ash was dominated by the melt product which contains amorphous glass, minerals and refractory materials. The mineral that could be found only in the grate sifting and the unquenched bottom ash was lime. In the opposition, the freshly quenched bottom ash was dominant by the existence of the quench product on its surface and the presence of Friedel's salt.

In Chapter 3, the influence of water quenching on the characterization of the MSWI bottom ash from two incineration plants with the different quenching system; drag chain conveyor tank and hydraulic ram discharger were investigated. The observation was based on the comparative study between the unquenched samples and freshly quenched samples. The particle size distribution analysis, thin section analysis, intact particle analysis, specific surface area analysis, pH and bulk chemical composition analysis, and mineralogical analysis were conducted to evaluate the impacts of water quenching on the characterization of bottom ash products. The result showed that water quenching was considerable influence on the bottom ash characterization by changing particle size, increasing specific surface area, changing its morphology by forming the quench product, reducing pH, altering the chemical composition, and enhancing portlandite, hydrocalumite and Friedel's salt formation.

In Chapter 4, the characterization of the quench product on MSWI bottom ash was performed with the aim of describing this material in terms of microstructure and mineralogy. A variety of microscopic and spectroscopic analyses were carried out in both intact particles, thin section, and bulk particles. In addition, the relationship between the existence of Friedel' s salt and the quench product was evaluated. Microstructure characterization revealed that the quench product commonly distributes on the surface of the melt products. The thickness is variable from 10 μm to 1 mm. The quench product mainly exhibits by amorphous and microcrystalline of hydrate phases. Mineral such as quartz and iron-oxide was embedding in the matrix of amorphous hydrate as well as refractory glass, relics, metal and organic matter. The experimental data shows that the characteristic of the quench product from the quenching experiment is similar to the reference samples that obtain from the large scale quenching.

In Chapter 5, the quenching experiments were performed with the different scenarios to observe the formation mechanisms of the quench product on the surface of MSWI bottom ash. In the experiments, the unquenched bottom ash was heated to 300°C, immediately quenched by warm water, filtered, and dried. Particle size distribution analysis, intact particle and thin-section observation, X-ray diffractometry, and scanning electron microscope/energy dispersive X-ray spectroscopy were conducted on the freshly quenched bottom ash samples. The results indicated that the freshly quenched bottom ash was dominated by a quench product as the same as the reference sample. The dominant mineral phases produced by quenching process and detected by XRD were calcite, Friedel' s salt, hydrocalumite and portlandite. The formation of quench product on the surface of the bottom ash is controlled by moisture/quenching water, fine fraction of the ash with a diameter less than 0.425 mm, and physical and chemical changes during discharging. It is also found that the formation of the quench product may be defined into two steps; i(chemical alteration of the particles with diameter less than 0.425 mm to be the quench product during quenching and ii(the attachment of the quench product on to the surface of the melt product which perceived as the core particle.

In Chapter 6, the key finding of the research was summarized. The main conclusion is that water quenching influenced the characteristics of the MSWI bottom ash drastically, by enhancing the formation of the quench product on the surface of the MSWI bottom ash. Since the formation of the quench product is controlled by the ash particle smaller than 0.425 mm, the results suggest that separation of this fraction prior to quenching would help to prevent the formation of the quench product and Friedel' salt in the MSWI bottom ash.