Influence of bottom ash solidification on leaching behavior of heavy metals

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1. Background and Objective
The proportion of bottom ash in the amount of final disposal in Japan is increasing. It reached about 71% in 2008. However, it was identified that bottom ash tends to solidify in landfill at where incineration residue was mainly disposed of. And currently, its influence on stabilization is concerned. According to previous study (Ishii, 2012), hydraulic conductivity of bottom ash is decreased and wash-off of salts is blocked by the solidification. Furthermore, it is confirmed that one of the solidification mechanism is carbonation. Meanwhile, heavy metal content of bottom ash is two order of magnitude higher than that of soil. Although leaching characteristics of heavy metals is important, influence of bottom ash solidification on the emission of heavy metals has not investigated yet. It is important to clarify how leaching characteristics of heavy metals is changed by solidification. In this study, we discuss influence of bottom ash solidification on the emission of heavy metals. In concrete terms, we made “solidified condition” and “un-solidified condition” by using same bottom ash, and revealed their difference on leaching characteristics of heavy metals.

2. Materials and Methods

(1) Sample
According to previous study (Ishii, 2012), there are bottom ash that can solidify (Ash-A) and one that can’t solidify (Ash-B). In this study, these two kinds of ash are used.

(2) Preliminary experiment on achieving "solidification" and "un-solidification"
To verify influence of solidification, to achieve "solidified condition" and "un-solidified condition" on same ash is necessary. Differences of ash-A and ash-B are content of calcium, contact history with water (quenched/un-quenched), and content of Portlandite. So, these conditions were changed to confirm whether solidification took place or not. Ash-A which tends to solidify became to not solidify by repeating procedure of wetting and drying. Ash-B which doesn’t solidify became to solidify by adding Portlandite.

(3) Verification of solidification by tracing hydraulic conductivity and hardness
In order to quantitatively confirm the occurrence of solidification as the result of changing characteristics of each ash, hydraulic conductivity was tracked and hardness was also measured. Samples in wet condition were filled up to columns (83mm of diameter) and were kept as they were. After several days passed, hydraulic conductivity and hardness were measured.

(4) Column leaching test
Each ash in wet state is filled to each column (50mm of inner diameter and 50mm of height). Experimental series are indicated in Table 1. As indicated in Table 1, both conditions (solidifying and un-solidifying condition) were prepared for each ash. Since carbonation is important process for solidification and also stabilization of ash, condition to expose carbon dioxide was set up. Except for the series of carbon dioxide exposure, column was placed under atmospheric conditions.

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condition. Distilled water was supplied every day from upper part of the column. Leachate was collected by flask placed at the bottom of the column and it was sampled every week for analyzing heavy metal. Elements analyzed were Ca, Na, Pb, Cu, and Zn. Each test series was duplicated. After eight weeks passed, column was dismantled and sample in the column was taken out. To find out change of chemical form, sequential batch extraction was conducted to these ashes.

3. Result and discussion

(1) Quantitative evaluation on solidification/un-solidification
Ash-A that originally tends to solidify became to not solidify as a result of repeating of wetting and drying. Its hardness decreased significantly from 200 kg/cm² to approximately 50 kg/cm² after 3 times repetition of wetting and drying. And Ash-B, to which Portlandite was added at 10% of mass ratio, was verified to be having higher hardness (by soil hardness tester) than original state. Furthermore, decrease of hydraulic conductivity was confirmed.

(2) Leaching characteristics of each metal by column test
The amount of cumulative leaching of Pb and Zn is indicated in Figure 1. While the cumulative leaching amount of Pb increased in both solidified conditions (A-S-Air and B-S-Air), leaching of Pb was hardly confirmed in un-solidified condition. Higher leaching of Pb occurred because pH (above 12.5) was kept higher under solidified-condition during experimental period. On the other hand, pH dropped to 11 or 10 under un-solidified condition. Regarding Zn, although remarkable leaching occurred initially under solidified-condition (A-S-Air), it ceased after that. Leaching amount of Zn under carbon dioxide exposure (A-U-CO₂ and B-U-CO₂) kept rising along with L/S increase. pH of un-solidified condition.