Dechlorination effect of slow speed elution on municipal solid waste incineration bottom ash

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Abstract: The bottom ash, accounting for 20% to 30% of the original living garbage, has been a large content source of municipal solid waste in China and incineration treatment becomes the most important garbage disposal method. The water-soluble chloride ions will be released to the environment by the eluent produced from the bottom ash. It has a negative influence on bottom ash treatment and reuse. This study analyzed the changing of residue of chloride ion, ammonium nitrogen, pH value during the elution process by the column simulation experiment. The dechlorination investigation may improve the commercial application of bottom ash by revealed the regular of chloride ion migration under the condition of slow speed elution.

1. Introduction

Incineration fly ash and bottom ash is two final solid wastes that produced during municipal solid waste incineration procedure. Domestic waste incineration bottom ash also contains a large amount of soluble chlorine. The particle size of the incinerated bottom ash was mainly concentrated in 2 to 50mm particle size [1]. Linyiming et al. found that the contaminated material was mainly concentrated on particles less than 0.6 mm diameter [2]. Some people reported the content of chlorine in the bottom ash accounts for 1.46 % of the total mass ratio and mainly concentrated on the substrates of particle size less than 0.425 um [3].

Chlorine in the bottom ash has negative effect on cement solidification, which decreased the strength of the solidified body. The unconfined compressive strength of solidified body only 4.25MPa even the proportion of cement increases to 60% [4], if it has no dechlorination procedure before. When the liquid-solid ratio of water and fly ash upped to 6, the chloride ion dissolution rate reached to 97.7% [5]. The only disadvantage of this method was the large water consumption. In China, one dechlorination procedure studies have been conducted on effect of rapid infiltration by investigated N, P, TOC and other release factors in the elution process [6].

2. Materials and methods:

2.1 Experimental device

The experimental device is coupled with an organic glass column and a base. The column height is 500 mm, the diameter outside the simulated column is 200 mm and the wall thickness is 10 mm. A sprayer is installed on the top of the simulation column, one stainless steel water tank and a spray pump (humidifying pump) are connected with the PVC plastic pipe fittings. The cylinder and the base are connected by flanges. The bottom flange is equipped with a drain valve (an empty valve).
are gas sampling ports on the top and two solid sampling ports on the side of the column. A gauze cushion of about 30 mm thick was laid at the bottom of the column, and a layer of non-woven fabric was placed on the cushion to prevent fine-grained bottom slag particles flowing out of the column.

![Chart of simulated column structure](image)

**Figure 1 Chart of simulated column structure**

2.2 Pretreatment of the incineration bottom ash
The incineration bottom ash was sampled from one large municipal solid waste incineration plant of Beijing city in 2016. Fresh ash is air-dried for half a year in ventilated shelter. The colour of the bottom ash samples changes from grayish brown to grey-white after air-drying. Bottom ash was divided into two parts by screening method. The coarse particle size was larger than 4 mm, and the fine particle size was smaller than 4 mm. Moisture content of the bottom ash was measured by oven drying method. Element contents were determined by X-ray fluorescence analyzer (XRF) used the air-dried samples which removed impurities and through 100 mesh sieve.

2.3 Simulated column experiment
Rubber gaskets were installed at each interface of the simulated column in order to ensure good sealing of the device. Bolts of each interface were tightened before loading the column and water leakage test was carried out. Empty and dry the column after the test. Two different particle size bottom ashes (air-dried) were evenly loaded into two different columns respectively. The columns filling height of air-dried bottom ash was 105 mm and the filling volume was 2.67 L. The experiment lasted for 6 weeks (935 hours in total). Quantitative deionized water was measured and sprayed into the column every day. Soluble chloride ion content was determined by silver nitrate titration method GB 11896-89[7].

3. Results and analysis

3.1 Chemical constituents analyzing
Metals accounted for 28.2% of the original incineration bottom ash and other impurities (non-metallic) accounted for 6.4%. The residual material after removed impurities accounted for 65.5%. Element percentages of air-dried bottom ash were determined by X-ray fluorescence spectrometry (XRF) (Table 1).

| Chemical composition | SiO₂ | Al₂O₃ | Fe₂O₃ | CaO | TiO₂ | P₂O₅ | MgO | Na₂O | Cl | Other |
|----------------------|------|-------|-------|-----|------|------|-----|------|----|-------|
| Mass ratio %         | 21.42| 7.66  | 6.08  | 41.61| 1.50 | 2.70 | 3.64| 2.38 | 3.15| 9.86  |

3.2 The removal of soluble chlorine
The per day quality of chloride ion elution was calculated by the product of the amount of dehydration volume and chloride ion concentration. The change of the amount of chloride ion elution showed a similar trend. Except at 168 h, the single elution quantity of fine particle treatment has higher than that
of coarse particle treatment.

Figure 2 Single sample and cumulative quality of soluble chlorine in elution

From the experiment, the cumulative elution quality of soluble chlorine of fine particle treatment was nearly double times to that of coarse particle treatment by used the same volume of water (Figure 2, b). One reason is the fine particle bottom ash contains more soluble chlorine [8]. Another reason is the large specific surface area of fine particles that induced soluble chlorine to be eluted easily.

Large water consumption is the main problem of water-dechlorination method. It is necessary to use at least 3 to 4 times of treated water volume to achieve a nearly complete chlorine removal effect in other author study [8]. In our experiment, the volume of water consumption has nearly to the volume of bottom ash itself and removed most soluble chlorine in the same time. It is reveals that slow elution method can reduce water consumption and keep high dechlorination effectiveness in whole process.

4. Conclusions
Compared with the maximum value of chloride ion in the single eluent, the soluble chlorine concentration in the eluent decreased by 75.0% in fine particle treatment and decreased by 68.4% in coarse particle treatment.

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