

Study on Stabilization of Lead in Flue Dust

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Abstract. This paper mainly studied the stabilization effect of lead in flue dust on different stabilizers. The leaching concentration and fraction distribution of flue dust under different stabilizers were studied by TCLP and BCR continuous extraction. Experimental results showed that each stabilizer has a different effect on the leaching of heavy metals in flue dust. After phosphate stabilization or phosphate plus calcium source stabilization, the leaching concentration of Pb decreased considerably, and Pb was mainly transformed to residual state. Therefore, it achieved the stable effect for heavy metals.

1. Introduction

With the industrial development, the amount of heavy metal wastes generated in the fields of chemical industry, metal work industry and others continue to increase. Heavy metal pollution has become a serious environmental problem [1,2]. In the treatment process of heavy metal wastes, the leaching of heavy metals will affect the utilization of the wastes and pose potential impact on environment.

Flue dust is a kind of waste containing heavy metals, such as Zn, Pb and Cu, which needs further treatment before it can be recycled [3-5]. The process of stabilization of heavy metals is mainly through the addition of chemical stabilizer to change the fractions of heavy metals and reduce the leaching concentration in the environment [6].

In this study, the flue dust was used as the research object, which has relatively simple composition and high content of heavy metal. The stability effect of the flue dust under the action of different stabilizers was studied as well. The TCLP and BCR continuous extraction methods were used to study the control effects of different chemical stabilizers on heavy metals.

2. Methods

2.1. Experimental materials

The flue dust used in the experiment was taken from an iron and steel smelter in Zhejiang Province. The main elements of the flue dust were Pb, Zn, Cu, Cl and Sn, of which element Pb accounts for about 15%. The flue dust mainly consists of carbonates, sulphates, sulphides and other complex substances.

2.2. The sample XRD analysis

X-ray diffraction can be used to determine the phase composition and crystallinity of the sample. The XRD model adopted in this experiment was D/max-2200, the instrument test parameters were Cu K α



rays and tube voltage was 40kV. Sampling was performed by continuous scanning, with the scanning range 2θ of 10° - 80° and the scanning speed $8^\circ/\text{min}$. The obtained test data was analyzed using the matching Jade 6.0 software.

2.3. Stabilization test of heavy metal in flue dust

The samples were stabilized by different stabilizers to carry out heavy metal stabilization experiments. The leaching concentration of heavy metals and the fractions of heavy metals in the samples were measured.

2.4. TCLP test

The heavy metal leaching characteristics of each curing system were measured using the EPA Toxicity Characteristic Leaching Procedure (TCLP). The leaching medium and the solid were put in a PTFE bottle at a dosage of 1:20 and then placed in a TCLP preparation apparatus. The turning time was (18 ± 2) hours and the temperature was $(22 \pm 3)^\circ\text{C}$. Then $0.45\ \mu\text{m}$ acetate microfiltration membrane was used for filtration, and the filtrate was placed in a refrigerator at 4°C to be tested.

2.5. Analysis method of heavy metal fractions

The fraction analysis method used in this paper is an improved BCR fraction analysis method. The BCR fraction analysis method divides the heavy metal fractions into four parts, acid-soluble state, reducible state, oxidizable state and residual state.

2.6. Determination of heavy metal concentration

The concentration of heavy metal in the solution was measured using Inductively Coupled Plasma Emission Spectrometer, produced by American Liman Instrument Manufacturing Co. Ltd.

3. Results and discussion

3.1. Flue dust composition analysis

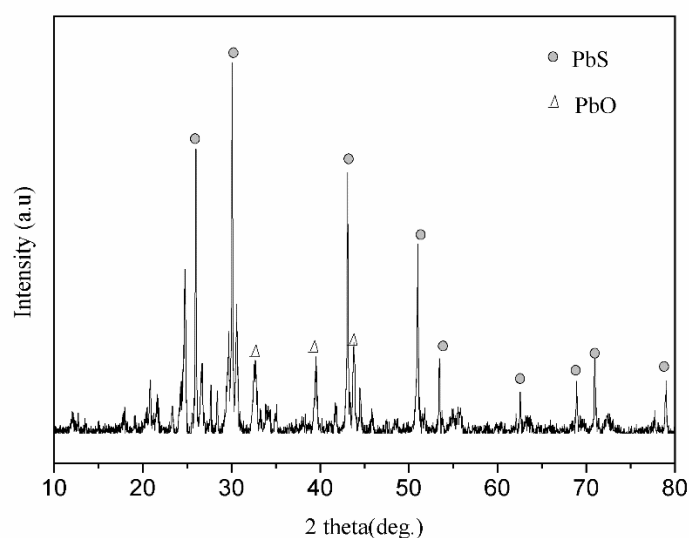


Figure 1. XRD spectra of flue dust.

The XRD spectra of the flue dust is presented in Figure 1. The results in the XRD spectra showed that lead mainly existed in the forms of PbS and PbO. However, peaks of other materials can also be seen in Figure 1.

3.2. Stabilization effect of different stabilizers on flue dust

Experiments were conducted at room temperature to study the stabilizing effect of different stabilizers on the heavy metal in flue dust. The stabilization experiment of the flue dust was performed after the pretreatment. NaOH was used as a stabilizer in the hydroxide stabilization process, NaCO_3 in the carbonate stabilization process, $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$ in the phosphate stabilization process, while phosphate plus calcium sources stabilizing process used $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}$ and Ca(OH)_2 as stabilizer.

3.2.1. The leaching concentration of heavy metals in flue dust after stabilization

The leaching concentration of Pb in flue dust was 51.10 mg/l. After addition of different stabilizers, the toxic leaching concentration of heavy metals in flue dust decreased to various degrees. The results of TCLP experiments showed that with the addition of different stabilizers, the heavy metals in the flue dust were transformed from an unstable form to a form which is not easy to leach. By comparison with the stability of heavy metals after hydroxides and carbonates stabilization, it was found that the TCLP leaching concentration of Pb decreased slightly. After phosphate stabilization, the TCLP leaching concentration of Pb decreased to 4.32 mg/l, while after stabilization by the phosphate plus calcium source, the TCLP leaching concentration of Pb was reduced to 0.70 mg/l. Different stabilization processes have different effect on heavy metals in solid waste, which is mainly related to the fractions of the heavy metals after stabilization.

3.2.2. Fraction distribution of heavy metals in flue dust after stabilization

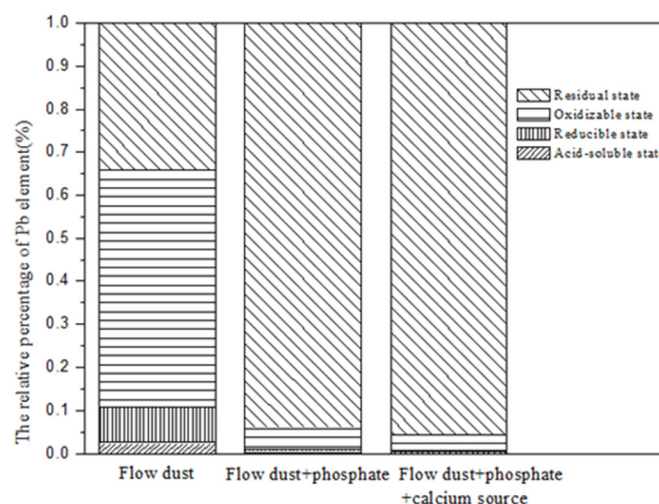


Figure 2. Fraction distribution of Pb in the raw flue dust and the stabilized flue dust.

As can be seen from Figure 2, the unstable form (acid-soluble, reducible and oxidizable states) of Pb in the flue dust accounted for major proportion. Studies have shown that the first three parts usually have poor stability. So, it needs to be stabilized or treated in other ways to reduce the damage to the ecological environment.

Flue dust was stabilized by hydroxides and carbonates, and its leaching concentration was reduced. However, under the two conditions, the stability of heavy metals was still relatively poor, while the leaching of heavy metals was still relatively high. Since the leaching of heavy metals after stabilization by phosphates was greatly reduced, further analysis of the fractions of heavy metals stabilized by both phosphate and phosphate plus calcium source was performed. It can be seen from Figure 2 that after the flue dust was stabilized by phosphate, Pb was mainly in the residual state. The main reason for this change is due to the formation of stable compounds such as lead-containing minerals, which can make the unstable Pb transform to the residual state. By comparison with before and after addition of

calcium sources in Figure 2, the acid-soluble, reducible and oxidizable states of Pb did not change significantly. Therefore, the usage of phosphates to stabilize heavy metals in waste can minimize the leaching potential of heavy metals in the environment.

4. Conclusions

The stabilizing effect and fractions distribution of flue dust under different stabilizers at room temperature were studied. By comparing the experiment adding different stabilizers, it can be found that each stabilizer has a different effect on the fractions of heavy metals in flue dust.

- The leaching concentration of heavy metals using hydroxides, carbonates, phosphates and phosphate plus calcium source as a stabilizer were reduced. After phosphate stabilization or phosphate plus calcium source stabilization, the leaching concentration of Pb decreased considerably.
- After the flue dust was stabilized by phosphate or phosphate plus calcium source, the fractions of Pb were mainly transformed to residual state. Therefore, it achieved the stable effect for heavy metals.

Acknowledgments

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