Study on the Stabilization of Chemical Stabilizers for the Treatment of Lead and Zinc Smelting Sludge from Sulfuric Acid Sewage

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Abstract. Using the adsorption and precipitation effects of the stabilizers on arsenic and selenium, the experimental study on the stabilization of lead and zinc smelting sludge was carried out, and the influencing factors of the stabilizers were discussed to determine the feasibility and optimal test parameters of the experiment. The results show that the stabilizers can effectively reduce the leaching concentration of arsenic and selenium in lead and zinc sludge, and the stabilization effect is significantly improved compared with the control. When the amount of the stabilizer K is 5%, the stabilizing effect of arsenic and selenium is increased to 90% and 55%, and the leaching concentration of arsenic and selenium is lower than the national standard (GB5085.3-2007). It shows that the material is very effective in stabilizing lead and zinc mixed sludge.

1. Introduction
Arsenic pollution is mainly concentrated in the non-ferrous metal mining and smelting industry. The toxic components in the raw materials generally exist as compounds, and the acid wastewater exists in the form of ions. During the roasting, smelting and refining processes, As, Hg, Pb, and S in the raw materials are oxidized into the flue gas (smoke) or the waste acid wastewater and waste residue [1-2]. The treatment of sewage acid wastewater is usually used the lime iron salt method, the polymerized ferric sulfate method, etc., and the heavy metal ions in it are precipitated and dehydrated to form a semi-solid sewage acid sewage treatment sludge. At present, the acid sewage treatment sludge has a large stockpile and is classified as a hazardous waste, which bringing harm to the environment and human health [3]. Therefore, how to solidify and stabilize this kind of sludge and make comprehensive use of resources would become nonferrous urgent issues for the metal industry.

The stability and stability of lead and zinc sludge were studied using the adsorption and precipitation properties of stabilizers for arsenic and selenium. At the same time, the factors affecting the stabilization effect of lead and zinc sludge were discussed, and the optimal stabilization effect of the test was obtained, which providing a theoretical basis for the stabilization of sludge in the lead and zinc smelting industry of nonferrous metals.
2. Test materials and methods

2.1. Test materials
(1) Sludge from sewage treatment of lead acid smelting acid: brownish-yellow to light gray, with a water content of 35% -40%, and a pH value of 7.76. The particle size is less than 200 mesh, and it is naturally dried for using.

(2) Chemical stabilizers: K and KY.

2.2. Test method

The leaching toxicity test was carried out in accordance with the “Solid waste-Extraction procedure for leaching toxicity-Sulphuric acid & nitric acid method " (HJ/T 299-2007), and the solidified body samples were ground to a size of less than 9.5 mm. According to the solid-liquid ratio (mass-volume ratio, g: mL) of 1:10, it added an extraction solution with a pH of 3.20 ± 0.05 prepared by mixing sulfuric acid and nitric acid, and adjusting the rotation speed to (30 ± 2) r/min. After the test is inverted and shaked (18 ± 2)h at (23 ± 2)℃, the concentration of arsenic and selenium in the supernatant was measured by centrifugation.

The experimental analysis was performed in accordance with “Identification standards for hazardous wastes-Identification for extraction toxicity "(GB 5085.3-2007).

2.3. Experimental design

After the lead and zinc sludge was naturally dried, the leaching concentration, corrosiveness and chemical composition were measured.

Weigh 300g of lead sludge and zinc sludge, choosing two kinds of the K and KY Stabilizers, the dosage ratio is 1%, 3%, 5%, and the specific dosage is shown in Table 1:

| Numbers | K  |   |   | KY |   |   |
|---------|----|---|---|----|---|---|
| 1%      | 2.5| 0.7| 2.5| 0.5|   |   |
| 3%      | 5.0| 2.1| 7.5| 1.5|   |   |
| 5%      | 10 | 3.0| 12.5| 2.5|   |   |

The main chemical components of the sludge were treated with lead sludge by ICP detector in Table 2 and Table 3.

2.4. Test results of the leaching toxicity

The leaching toxicity and corrosiveness experiments on lead and zinc sludge were conducted. The results were: (1) The leaching concentrations of arsenic and selenium in lead sludge were 6.92 mg/L, 1.34mg/L, and the pH value was 7.87; (2) The leaching concentrations of arsenic and selenium in zinc sludge were 0.13 mg /L, 0.22 mg /L, and pH value was 8.97.
3. Experimental results and analysis

3.1. Effect of the stabilizer dosage on leaching concentrations of arsenic and selenium

![Image 1](https://example.com/image1)

Figure 1. Effects of two stabilizers on leaching concentrations of arsenic and selenium

It is concluded from Figure 1 that both stabilizers had a significant effect on the leaching concentrations of arsenic and selenium. Among them, with the increase of the amount of K stabilizer, the stabilization rates of arsenic and selenium were increased by 59.5%, 88.6%, 96.2%, and 67.1%, 67.7%, and 70.3% respectively. With the increase of the amount of KY stabilizer, the stabilization rate of arsenic and selenium were increased by 58.2%, 85.4%, 93.7% and 66.5%, 67.1%, 69.6% respectively. It can be concluded that the K stabilizer (5%) had the best stabilization effect, followed by the KY stabilizer (5%).

3.2. Effect of K stabilizer on leaching concentrations of arsenic and selenium in lead and zinc sludge with different proportions

![Image 2](https://example.com/image2)

Figure 2. Changes in leaching concentrations of arsenic and selenium in lead and zinc sludge of 1.5:1 and 2:1

It can be seen from Figure 2 that after the K stabilizer (5%) was preferred, the stabilizing effect on arsenic and selenium in mixed sludge with different proportions was relatively significant. As the increases content of the lead sludge, the stabilizing effect was reduced slightly. Among them, the mixed sludge under the condition of 1.5:1 has increased the stabilization rate of arsenic and selenium by 93.0%
and 61.9%. The mixed sludge under the condition of 2:1 has improved the stabilization rate of arsenic and selenium 92.5% and 57.1% respectively.

4. Conclusions and recommendations
1) The addition of stabilizers can promote the stabilization of arsenic and selenium and reduce the leaching properties of arsenic and selenium in the sludge. Compared with the absence of stabilizers, the stabilization efficiency is significantly improved. The stable effect will be better with the higher amount.
2) After the K stabilizer (5%) is preferred, the stabilization effect is slightly reduced. With the increase of lead sludge content and the higher value of pH, the stabilizing effect of stabilizers on arsenic and selenium is decreased.
3) The optimal amount of the K stabilizer is 5%. The actual lead and zinc sludge sample can be successfully stabilized with the optimized conditions. Therefore, the K stabilizer can be used as stabilizing lead and zinc sludge for the effective method.

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