Study on Heavy Metal Stabilization in Sludge with Bentonite and Sulfide

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Abstract: The stabilization of heavy metals in sludge was studied by using bentonite and Sulfide separately. With chemical speciation analysis of heavy metals and with heavy metal toxic characteristic leaching experiment, the application probability of two kinds of materials in adsorption and stabilization of heavy metals were studied to offer a new way to treat heavy metals effectively in the agriculture utilization of sludge. Results show that leaching concentration of heavy metals is decreased to meet the standard of sludge utilization in agriculture. And, the species of heavy metals are changed too with the ratio of the unsteady species of heavy metals in sludge reduced greatly. Among these, Bentonite has effective adsorptive properties on heavy metals like Cd and Ni, while pH value is main influencing factor on adsorption and sodium sulfide has good stabilization properties on heavy metals like Zn, Cu and Cd. When 10% scales medicament was used, leaching concentration of Zn was 4.96 mg/L only and the ratio of the unsteady species of heavy metals in sludge was reduced by 50% ~60%.

Key words: sludge; heavy metals; bentonite; sulfide
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1 Introduction

Sewage sludge contains heavy metals, such as Zn, Cu and Cd, which can lead to series health problem when entering into food chain. Stabilization is a process of transforming heavy metals from poisonous and deleterious matters to low dissolvable, low transferable and low poisonous ones. Bentonite and Sulfide were mixed with sludge at different scale separately in following experiment. By comparing corresponding effect, the high-effective chemical stabilization materials were found out[1-2].

2 Experiments

2.1 Materials and Sequential Extraction of Heavy Metals

A kind of industry sludge, sampled from Tao Pu Wastewater Treatment Plant of Shanghai was adopted as experiment sample. Other main material include $Na_2S \cdot 9H_2O$, and Ca-bentonite. The toxicity of the sludge samples were determined at different pH values with Toxic Characteristic Leaching Procedure prescribed by USEPA. The leachate components were tested using ICP Emission Spectrometry[3], and the sequential chemical extraction of heavy metals was performed[4-6].

2.2 Heavy Metal Stabilization Experiment with Bentonite and Sulfide

Four different scales (1, 2, 3 and 5 gram) of bentonite and four different scales (2, 5, 10 and 15 gram) of $Na_2S \cdot 9H_2O$ were adopted separately, into which 100 gram of sludge sample was joined. Each sample was fully mixed and leached with TCLP to evaluate the effectiveness of bentonite or sulfide in stabilization of heavy metals.

3 Results and Discussion

3.1 Leaching Concentration of Heavy Metals in Sludge

Tab.1 leaching concentration of heavy metal with TCLP (mg/L)

pH	Zn	Cu	Ni	Cd	Cr
2.88	42.2	26.9	41.8	0.32	6.22
5.0	19.5	12.6	18.7	0.09	2.75

In this study, Zn, Cu, Ni, Cr and Cd were selected as targeted heavy metals according to their relative concentration in raw sludge showed in Tab. 1 and

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the allowed leaching out from agricultural used materials.

3.2 Heavy Metal Adsorption with Bentonite

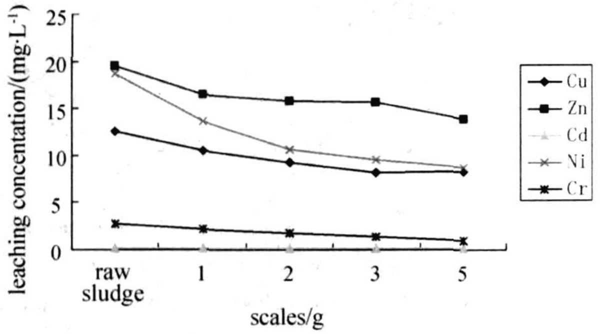

Fig.1 Leaching concentration of heavy metals with bentonite

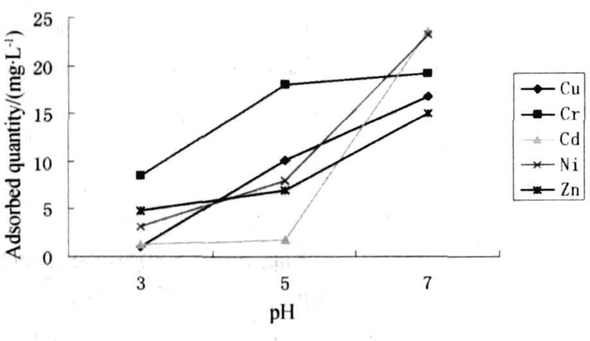

Fig.2 Adsorbed quantity changed with PH

Fig.1 shows that leaching concentration of heavy metals were decreased at PH5.0. The adsorption of Cd and Ni with bentonite was decreased obviously when 5 gram of bentonite was added in sludge, while that of Cd and Ni was decreased to 0.07 mg/L and 8.76 mg/L respectively. Whereas, the adsorption of Zn and Cu were not obvious at PH5.0. The adsorption of heavy metals with bentonite was not obvious at PH 2.88 too.

Effect of PH value ranged from 3.0 to 7.0 on the adsorption of the heavy metals added with bentonite was investigated in the experiment. Fig.2 shows that increases in PH in the leaching solution will lead to an increase of adsorbed quantity of the Cu ion. Adsorbed quantity of Cd, Ni and Zn changed obviously at PH value ranged from 5.0 to 7.0. The adsorption of Cr was similar with Cu. In general, the range of PH value from 5.0 to 7.0 was preferable for adsorption of heavy metals added with bentonite. The adsorption characteristic was not reflected by the curve in Fig.2 because insoluble hydroxides will be formed at higher PH. Because H^+ has strong competition at lower PH, the adsorption of heavy metals added with bentonite was not obvious at PH 2.88.

3.3 Heavy Metal Stabilization with Sulfide

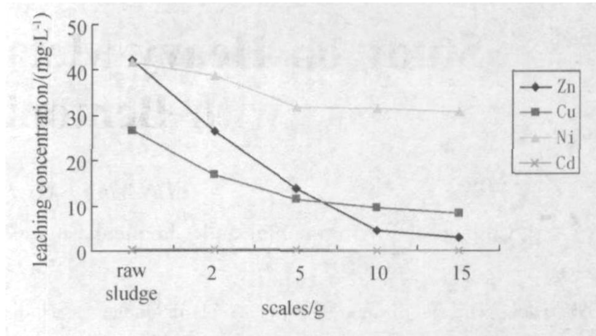

Fig.3 leaching concentration of Heavy metal with sulfide

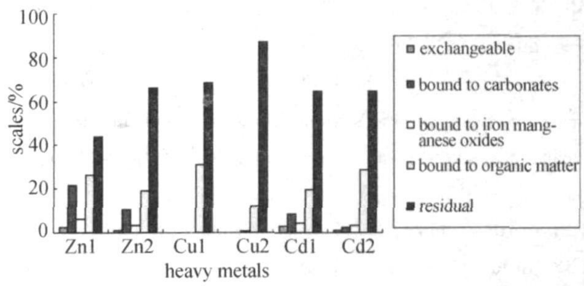

Fig.4 Changes of Fractionation of heavy metals

In this experiment, $Na_2S\cdot 9H_2O$ was used to stabilize heavy metal ions in sludge. Fig.3 shows that leaching concentration of Heavy metal was decreased obviously at PH 2.88. When 10 gram of $Na_2S\cdot 9H_2O$ was added in sludge, leaching concentration of Zn, Cu and Cd were 4.96 mg/L, 9.65 mg/ and 0.11 mg/L respectively. The leaching concentation of Ni did not decrease obviously. When 15 gram of $Na_2S\cdot 9H_2O$ was added, leaching concentration of Ni remained at 30.86 mg/L.

Fractionation analysis of three kinds of heavy metals in sludge after and before stabilization was reflected in Fig.4. Content of Zn in exchangeable fraction, bound to carbonates fraction, and bound to iron-manganese oxides fraction accounted for 2.31%, 21.3% and 6.15% respectively before stabilization, while the proportion was changed to 0.91%, 10.4% and 3.21% after stabilization. The former three kinds of fractions were unstable fractions and the others were stable fractions. Content of Zn in unstable fraction is decreased by 50% ~60% after stabilization.

In conclusion, Fractionation of heavy metals in sludge after and before stabilization is basically consistent with results of leaching concentration, while content of heavy metals decreases in unstable fraction and increases in stable fraction.

4 Conclusions

(1) Two different mechanisms for heavy metal

stabilization were discussed in the paper. Heavy metal absorption added with bentonite is influenced by the surface properties of this adsorptive material, while sulfide has chemical reactions with heavy metal ions to form insoluble substances.

(2) Bentonite has excellent adsorptive properties on heavy metals like Cd and Ni in neutral circumstance. This method is restricted in lower pH circumstance.

(3) Heavy metal stabilization with sulfide is a kind of effective method by decreasing the leaching concentration of heavy metals to meet the standard of sludge utilization in agriculture. When 10 ~ 15 gram of reagent was used, leaching concentration of Zn was 3 ~ 4 mg/L only, the ratio of the unsteady speciation of heavy metals in sludge reduces greatly while that of stable speciation increases after stabilization.

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利用膨润土及硫化物对污泥中重金属的稳定化研究

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摘 要：分别采用膨润土及硫化物对污泥中重金属进行了稳定化研究，通过重金属形态分析及浸出毒性实验，研究了两种物质吸附及稳定化污泥中重金属的作用，从而为污泥农用中重金属的处理提供一个有效的方法。结果表明，经过处理后，污泥中重金属的浸出毒性减少，可以满足污泥农用标准，重金属不稳定形态含量显著减少。其中，膨润土对重金属Cd、Ni具有较好的吸附效果，pH值是影响吸附的重要因素；而硫化物对重金属Zn、Cu和Cd具有较好的稳定化效果，当加入10%的药剂时，Zn的浸出浓度仅为4.96mg/L，同时污泥中重金属不稳定形态的比例减少了约50%~60%。

关键词：污泥，重金属，膨润土，硫化物

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(上接第38页)

来自自然界的可再生能源 — 生物质乙醇重整制氢

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摘 要：在镧系金属氧化物载镍催化剂上通过催化重整乙醇和乙醇水溶液可以直接转化为H_2，H_2的选择性达到60%，乙醇的转化率达到100%。优化催化剂及降低重整反应的温度以使水汽转化反应同时发生来降低产物气中CO的含量。该过程对于生产小型燃料电池的低成本燃料H_2，以及便携燃料电池系统需要液态燃料存储的应用具有巨大的潜在价值。

关键词：制氢；生物质乙醇；水蒸汽重整；催化剂；系统

中图分类号：O646