Research On Pb Adsorption Capacity Of Ash From Domestic Waste Incinerator

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***Abstract*—This study was conducted in a laboratory with the samples taken in Hich village, Phu Luong district, Thai Nguyen province, Vietnam. The research has identified: structure, composition and properties of ash in a waste incinerator, and determining the adsorption capacity of ash in a waste incinerator. To identify the adsorption capacity of ash, ash is mixed with the soil to with 4 different ratio (material/soil) which are 5%, 10%, 15%, 20% and were measured on adsorbing spectrophotometer AAS atom in different time interval of 1 hour, 2 hour, 4 hour and 8 hour. The modified materials have higher adsorption capacity than the control due to the change in grain structure, contact surface area. From the research, we conclude that the absorption capacity of mixing materials increases with time. In the intermediate periods conducted in the experiment, the optimal adsorption time of most materials is 8 hours. However, the best processing performance was recorded in most of the materials is at the processing time of 4 hour**

Keywords: **ash, heavy metal, Hich village, waste incinerator**

I. INTRODUCTION

Thai Nguyen is a province with many ore spots which generate negative impacts on the air, water and soil due to the production and exploitation activities. In recent years, the use of adsorbent for heavy metal adsorption in the soil is gaining much attention in the world. Ash is an inexpensive adsorbent for environmental treatment and improvement, the research was conducted to test the ability adsorption Pb in the soil of ash after burning domestic waste. Hich village zinc-lead factory is one of the member companies of Thai Nguyen Non-ferrous Metal, one-member State Company established in 1980 with six exploitation points covering over 280 ha in Dong Hy District, Thai Nguyen Province (Minh Long, 2008). The factory is located in Tan Long commune with a production site of 287 ha, mainly in mountainous areas and difficult roads. The factory a hot spot for lead pollution with the average lead content in soil is 13028 ppm, 186 times higher than the permitted standard. (Bui Thi Kim Anh et al., 2008).

The existing form of Pb in soil depends mainly on mechanical composition, the content of organic compounds, pH. Climate conditions that form soil greatly affect the form of lead. In dry soils, Pb exists in the form of adsorbed ions, organic carbonates, and sulfur. In the soils of the tropics, Pb in hydroxy form dominates. In the environment, Pb exists in soil from 150 to 5000 years and mainly exists in the form of ions of inorganic and organic compounds. (Charles D. Stone, p.E., 2002). Lead is a highly toxic element for human health. Ash is a solid waste generated from coal burning from thermal power plants. People often use air flow to classify ashes: ash is a small, fine type, flying up with flue gas; the type that does not fly up is called as ash (bottom ash). The ash used in the project is fly ash taken from Hich village.

The study was conducted to best assess the absorption capacity of ash in waste incinerator with lead to be able to apply to improve soil contaminated with heavy metals after mining.

2. OBJECTIVES AND METHODOLOGY

Objectives

Study on the composition and properties of household waste incineration ash and ash modified with 0.05N H_2SO_4 acid.

Test the Pb metal adsorption capacity of domestic waste incinerator ash, slag ash modified with H_2SO_4 acid.

Methodology

Laboratory:

The soil at the old landfill in Hich lead-zinc mine was taken with a large volume (5 kg) at a depth of up to 20cm and transported to the laboratory. After that, this mass of the soil is dried at laboratory temperature for 1 week to lose all water without changing properties. After drying, the soil is ground and sifted through a 1mm sieve. This soil was then used for the experiment with 9 experimental treatments and 3 replications, the experiment was arranged in a completely random design:

Table 1. Experimental treatment

Experimental treatment	Description
Control	100% soil
B5	5% ash denatured by acid H_2SO_4 + 95% soil
B10	10% ash denatured by acid H_2SO_4 + 90% soil
B15	15% ash denatured by acid H_2SO_4 + 85% soil
B20	20% ash denatured by acid H_2SO_4 + 80% soil
T5	5% ash + 95% soil
T10	10% ash + 90% soil
T15	15% ash + 85% soil
T20	20% ash + 80% soil

Experimental steps are as follow:

Step 1: Mix adsorbent with soil:

There are 2 adsorbent materials (1 denatured, 1 normal). Take each 40gram of contaminated Pb soil with 2 adsorbing materials at the rate of 0%, 5%, 10%, 15% and 20% (corresponding scales: 0g, 2g, 4g, 6g and 8g on the scale), with a repetition rate of 3 each, packed into a labeled plastic bag.

Step 2: Incubate the adsorbent mixture with soil

Mix the freshly-mixed mixture with distilled water 2 times to return the experimental mixture to saturation moisture storage. Then incubated experiments for 1 hour, 2 hours, 4 hours, 8 hours.

Step 3: Treating the solution

Take 2g of soil into a beaker, then draw 50 ml of 1M NH_4OAc solution diluted at pH = 7 into the soil container and leave for 2 hours at room temperature. After 2 hours of filtration, the solution is taken for measurement of mobile Pb content.

These steps are conducted to monitor the ability to fix Pb in the soil of two adsorbent materials.

Indicators and tracking methods

Pb was analyzed by AAS adsorption spectrophotometer at Thai Nguyen University of Science, Vietnam.

Processing data

The analytical results of the samples were processed by SAS software to check the difference of the indicators of the parameters between different adsorbent materials at 1h, 2h, 4h and 8h adsorption time.

3. RESULTS AND DISCUSSION

Some properties of ash adsorption materials in a waste incinerator

Through research and analysis of some environmental factors of adsorbent materials such as pH, EC conductivity, percentage of N total and P_2O_5 total, and amount of Pb results are shown in the table 2.

Table 2. Properties of ash adsorption materials in a waste incinerator

No	Form name	Sample code	N (%)	P_2O_5 (%)	pH	EC (mS/cm)	Pb (mg/kg)	Pb (mg/kg)
1	Sample input - input land	T9-1	0.01	0.08	7.04	88.65	88.65	29.34
2	Denatured sample input - denatured ash	T9-2	0.07	0.56	8.25	1.36	1.36	-
3	Ash sample - ash	T9-3	0.06	0.49	8.38	1.68	1.68	-

The table shows that the N total of T9-1 is the lowest (0.1%), T9-2 is the highest (0.07%). Total P_2O_5 ranges from 0.08% to 0.56%. PH_{KCl} exceeds the permitted level from 7.04 to 8.38. EC conductivity of the material is quite high, ranging from 0.95-128.80 mS/cm), through the EC denaturation process of ash in a waste incinerator tends to increase sharply. The table shows that the highest amount of Pb and Pb move is in sample T9-1 (88.65 mg/kg - 29.34 mg/kg); the amount of Pb in T9-2 and T9-3 is lower (1.36 mg/kg - 1.68 mg/kg), and the amount of Pb move of these two samples is not available.

The adsorption capacity of materials in proportion to mixing ratio and time

The experiment conducted mixing soil + ash in a waste incinerator with 4 ratios (material/soil ratio) which are 5%, 10%, 15%, 20%, through the process of extracting solution, measuring on adsorbing spectrophotometer AAS atom and data processing have obtained the following results:

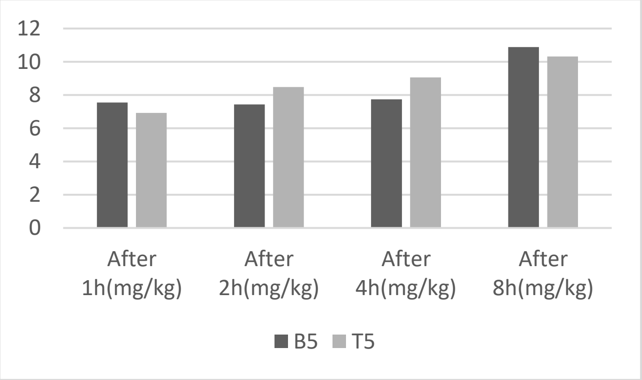

Figure 1. The adsorption capacity of materials with a mixing ratio of 5%

With a mixing ratio of 5%, it can be seen that mixing ratio after 8 hours is the highest, after 1 hours is the lowest. In general, there is not much change. It ranges from approximately 6 to approximately 11 mg/kg. Namely, B5 reached process performance 7.551 mg/kg (after 1h), 7.434 mg/kg (after 2h), 7.742 mg/kg (after 4h) and 10.892 mg/kg (after 8h). T5 reached process performance 6.732 mg/kg (after 1h), 8.483 mg/kg (after 2h), 9.059 mg/kg (after 4h) and 10.323 mg/kg (after 8h).

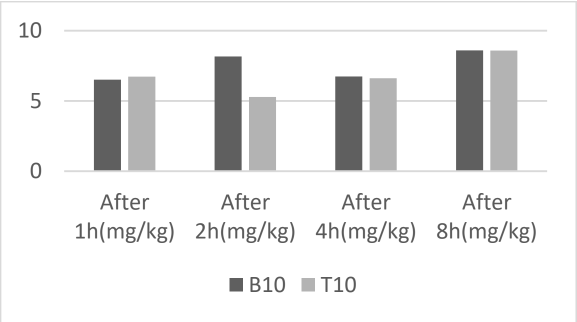

Figure 2. The adsorption capacity of materials with mixing ratio of 10%

With a mixing ratio of 10%, after 4 periods of adsorption which was conducted in the experiment we see: after 8 hours were the highest with B10 which was 8.598 mg/kg, T10 was 8.586 mg/kg. And, after 1 hour and 4 hours almost equal from about 6 to 7 mg/kg. Besides, after 2 hours reached process performance 8.166 mg/kg (in B10) and T10 was the lowest at 5.284 mg/kg. Namely, B10 reached process performance 6.515 mg/kg (after 1h), 8.166 mg/kg (after 2h), 6.740 mg/kg (after 4h) and after 8 hours reached 8.598 mg/kg. For T10, after 1 hour reached process performance 6.732 mg/kg, 5.284 mg/kg (after 2h), 6.613 mg/kg (after 4h) and 8.586 mg/kg (after 8h).

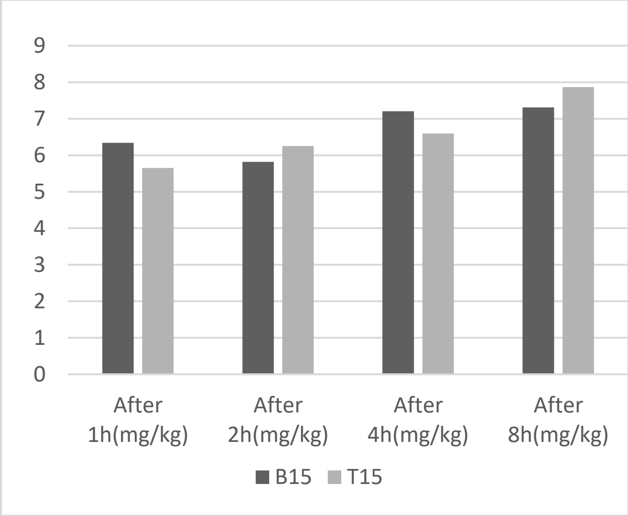

Figure 3. The adsorption capacity of materials with a mixing ratio of 15%

With a mixing ratio of 15%, after 4 adsorption intervals conducted in experiments, most of the materials have reached the optimal value after the adsorption period of 8 hours. With denaturation ash, the optimal time is 4 hours reached 7.205 mg/kg. With ash, the optimal time is 8 hours and the material has the highest absorption rate (7.866 mg/kg). Namely, B15 reached process performance 6.343 mg/kg (after 1h), 5.818 mg/kg (after 2h), 7.205 mg/kg (after 4h) and 7.310 mg/kg (after 8h). T10 reached process performance 5.651 mg/kg (after 1h), 6.251 mg/kg (after 2h), 6.597 mg/kg (after 4h) and after 8 hours was 7.866 mg/kg.

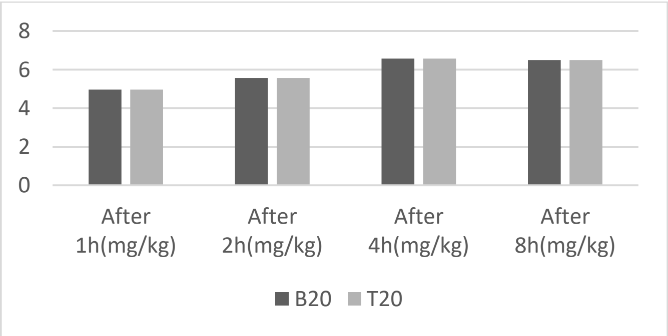

Figure 4. The adsorption capacity of materials with a mixing ratio of 20%

The 20% mixing ratio has the highest adsorption rate of all materials. After 4 absorption intervals conducted in experiments, most of the materials have reached the optimal value after the adsorption period of 4 hours. B20 was the highest at after 4 hours (6.569 mg/kg) and it was the lowest at after 1 hour (4.965 mg/kg). Besides, after 2 hours reached 5.566 mg/kg and 6.498 mg/kg (after 8h). T20 was the highest at after 8 hours (7.513 mg/kg) and it was the lowest at after 2 hours (5.383 mg/kg). It can be seen that after 1 hour reached process performance 5.506 mg/kg and 6.351 mg/kg (after 4h).

Table 3. Processing performance

Treatments	After 1h (%)	After 2h (%)	After 4h (%)	After 8h (%)
Control	41.96	47.54	45.10	46.22
B5	74.26	74.66	73.61	62.88
B10	77.79	72.17	77.03	70.70
B15	78.38	80.17	75.44	75.09
B20	83.08	81.03	77.61	77.85
T5	76.39	71.09	69.12	64.82
T10	77.06	81.99	77.46	70.74
T15	80.74	78.69	77.52	73.19
T20	81.23	81.65	78.35	74.39

With a mixing ratio of 5%, after 4 periods of adsorption were conducted in the experiment: in denaturation, processing performance was the highest after 2h at 74.66%, the lowest after 8h at 62.88%, after 1h at 74.26% and after 4h at 73.61%. In ash, process performance was 76.39% (after 1h), 71.09% (after 2h), 69.12% (after 4h) and 64.82% (after8h).

With a mixing ratio of 10%, B10 reached process performance at 77.79% (after 1h), 72.17% (after 2h), 77.03% (after 4h) and 70.70% (after 8h). T10 reached process performance at 77.06% (after 1h), 81.99% (after 2h), 77.46% (after 4h) and70.74% (after 8h).

With a mixing ratio of 15%, B15 reached process performance at 78.38% (after 1h), 80.17% (after 2h), 75.44% (after 4h) and 75.09% (after 8h). T15 have processing performance at 80.74% (after 1h), 78.69% (after 2h), 77.52% (after 4h) and 73.19% (after 8h).

With a mixing ratio of 20%, B20 reached process performance at 83.08% (after 1h), 80.03% (after 2h), 77.61% (after 4h) and 77.85% (after 8h). T20 reached process performance 81.23% (after 1h), 81.65% (after 2h), 78.35% (after 4h) and 74.39% (after 8h).

Geological structure and environmental factors of soil such as Eh, EC, CEC are some of the important causes affecting the adsorption time of materials. This change in environmental factors is responsible for the change in the optimum adsorption time of materials. Combined with previously published studies, it can be concluded that waste incinerator has very good adsorption of heavy metal ions.

4. Conclusion

The research initially identifies the factors affecting the adsorption process such as the type of adsorbent, the rate of adsorbent material, adsorption time. However, according to the results of a number of domestic and international researches, the adsorption process is also affected by many other factors of the surrounding environment. Due to the limited time and funding, the author has not been able to fully evaluate the factors affecting the adsorption capacity of the material, so it is recommended by the authors to have more researches on this issue in order to fully assess the influence of factors on the adsorption of the waste incinerator. In order for the topic to be effective and can be widely applied, it is necessary to create conditions and have higher-level studies on this issue.

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