Proceedings of The 9th Joint Conference on Chemistry

Diponegoro University (UNDIP), Semarang State University (UNNES), Sebelas Maret University (UNS) and Jenderal Soedirman University (UNSOED)

Grand Candi Hotel, Semarang, 12-13 November, 2014

Green Chemistry

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Preface to The Conference Proceedings

We are very pleased to introduce The 9th Joint Conference on Chemistry (9th JCC) held by Diponegoro University (UNDIP) on behalf of the Chemistry Consortium in Central Java, Indonesia. The JCC is an annual conference organized by the consortium of Chemistry Department of four universities in Central Java: Diponegoro University (UNDIP), Semarang State University (UNNES), Sebelas Maret University (UNS) and Jenderal Soedirman University (UNSOED); since 2006. The growing of environmental problems that persist to escalate worldwide has compelled us to select “Green Chemistry” as the leading theme of the 9th JCC.

We had 10 plenary speakers, 10 invited speakers and over 120 suitable papers from 11 countries were submitted for presentation at the conference. This required the program to be organized in five parallel sessions, each on a specific theme, to provide each paper with sufficient time for presentation and to accommodate all of them within the overall time allocated. One of the five sessions contained analytical chemistry. A second session was devoted to the theme of biochemistry. The third and fourth session were dedicated to physical and material chemistry. The fifth session was concerned with chemical education. These were well represented in the program of the conference and were clearly topics which continue to stimulate a global interest. The programs were chaired in a professional and efficient way by the session chairmen who were selected for their international standing in the subject.

All the papers went through a peer-review procedure prior to being accepted for publication in this book. These Proceedings present the permanent documentation of what was presented. They indicated the state of advancement at the time of writing of all aspects of this theme and will be very useful to all people in the field.

As a final point, it is appropriate that we record our thanks to our fellow members of the steering committee, organizing committee, and scientific committee. We are also indebted to those who served as chairmen. Without their support, the conference could not have been the success that it was. We also would like to express our sincere gratitude to all authors for their valuable contributions. We are thankful to the students of Chemistry Department Faculty of Science and Mathematics Diponegoro University especially to Maya and Fuad for their support during preparation of the manuscript.

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Andisol Soil Utilization of Mount Lawu as Natural Adsorbent Multi Soil Layering Materials for Domestic Waste

Pranoto*, R. Sudaryanto*, Supriyadi*

Abstract

Allophane is an aluminosilicate mineral such as clays found in the land of Andisol. Non-crystalline Aluminosilicate and Fe oxides in soil and the essential minerals in the soil due to the many reactions and had the typical wide surface and have many functional groups are active. Problems in nature is the rapid development of the industry in various fields of life, which produce a variety of waste. So the need for research on "the potential of Mineral Allophane as material Multi Layering Soil to Natural Adsorbents". The purpose of this research is to create a useful natural adsorbents to adsorb various inorganic and organic wastes and to process the wastewater industry as well as the river water into water that is ready to use. The research will be made effective for eight months, starting in April to November 2013 at the laboratory of physics and soil chemistry, soil biology laboratory, greenhouse and Faculty of agriculture, Sebesas Maret University Surakarta. Measurement of the Fourier Transform Infra-Red (FT-IR), performed in the laboratory of Faculty of mathematics and Natural Sciences University of Sebesas Maret, and X-ray Diffraction (XRD) at Bandung Institute of Technology. Specific targets to be achieved is the availability of natural adsorbent material capable of absorbing the hazardous materials and toxic waste (B3), such as the batik industry liquid waste by utilizing mineral clays as components of Multi Layering Soil (MSL). The research of Mount Lawu soil which is used in this research have taught, characterized by a heavy volume of 0.79 g cm³, with Al oxalic acid extracted and half of the Fe oxalic acid extracted gives greater value to 2. NaF pH value larger than 11.09 1N 9.4 shows that there are allophane content. Allophane has a cluster of Mount Lawu, O-O-O, Si-Al-O, Si-OH-DH, Al, Si-O, Al O and OH at allophane. Allophane natural activation has to be done by increasing the contact time activator and a longer allophane; and conducted research on variation of a variation of composition Soil Layering, so the adsorbent material as allophane capabilities increase.

Keywords: characterization, allophane, multilayeringsoil, adsorbents, andisol

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Introduction

One type of pollutants that require a lot of attention in environmental management is that of heavy metals. The disposal of waste contaminated by heavy metals into water sources (ground water or surface water) becomes a major problem of pollution because of its toxic and nonbiodegradable characteristics. The types of heavy metals that are considered as having a high level of toxicity are Hg, Cd, Cu, Ag, Ni, Pb, As, Cr, Sn, Zn and Mn (Suprihatin and Indrastl, 2010). Some of the most significant techniques to remove heavy metals in liquid wastes are: chemical precipitation, filtration, ion exchange resin, and a membrane system. The main thing to think of with these technologies is that not all metals can be removed, the reagents are high and they require much energy and high operating costs (Esmaili, et al., 2003). Lately, adsorption has become an alternative method for dissolving metal ions from liquid wastes. It is also used to minimize costs, and thus, as a kind of extensive research using a low-cost adsorbent types of soil (Potgeiter, et al., 2005).

Allophane was found to be very good for adsorption of some heavy metals (e.g. Clark & McBride, 1984; Denai et al., 1999, Abd-Elfatah & Wada, 1981). Iyoda et al (2011) reported the adsorption of heavy metals...
(Cu, Cd, Pb, and V) by natural and synthetic allophanes. An Al-rich allophane has also been synthesized, and a portion of the organic matter was extracted from the clay fraction, and their reactivities towards Cu, Zn were studied by potentiometry (Lettill et al., 2003). The synthetic allophane was usually prepared due to Wada et al. (1979). Methods of Soil Multi-layering (MSL) is a processing method that utilizes the ability of soil to treat wastewater. This method is known cheap in terms of cost, but requires a large area when compared with the treatment system or technical machines. MSL also known for simple, easy operation and control terms, as well as environmentally friendly, because it uses natural ingredients and readily available, among which allophane clay from the mountains (Andisol), sawdust, coconut charcoal, and others as anaerobic layers, as well as gravel or other rock as aerobic layer. In the MSL system of aerobic and anaerobic conditions are the main factors affecting the elimination of pollutant parameters.

MSL is composed of a mixture of layers of soil that have high absorption and arranged with a brick pattern (Matsunaga T et al., 2007). Nakatsuki et al. (1993) add that the MSL method is a method that utilizes the ability of soil to treat wastewater. In this research, aerobic layers (rock) reactor MSL is adsorbent allophane and isols contained in the soil.

Materials and Methods

Materials and Tools

The main materials used in this study were allophane taken from volcanic mountains in Java (Lawu), distilled water, NaOH, NaF, pH stick, HNO₃, ammonia, Whatman filter paper 42, and the model of solution of metals Fe, Mn, Cr, Cd, Cu, Pb 1000 ppm.

The particular tools used for analysis were furnace, 200 mesh sieve, a set of Atomic Absorption Spectroscopy (AAS) brand Shimadzu Type AA-6500 F, a set of X-Ray Diffraction (XRD) brand Shimadzu Type 600, a set of Fourier Transform Infrared (FT-IR) brand Shimadzu Type FT-IR 8201 PC, TOA pH meter, and desiccator.

Preparation of Activated Allophane, Physical Characterization and Measurements

The natural allophane was aerated and then crushed. The powder obtained was sieved, which was then soaked in distilled water, filtered, and dried at a temperature of 105 °C for about 4 hours. The final product of dried allophane powder was then identified and characterized by NaF, FT-IR, and XRD.

After activation process with 1 N and 3 N of NaOH within the time variations of 1, 3 and 5 hours, the activated allophane, was finally used to adsorb the heavy metals, Fe, Mn Cr, Cd, Cu, and Pb, to determine the adsorption isotherms, as well as to characterize the acidity. The natural allophane, without activation, was also used to absorb the metals for comparison.

Result and Discussion

An initial test of the presence of allophane on the andisol ground was done by means of NaF-pH test. The NaF test results for each of the samples are shown in Table 1. The pH of all samples being greater than 9.4 should confirm that it is due to the presence of allophane (Murin, 1996).

<table>
<thead>
<tr>
<th>Sample</th>
<th>pH NaF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mount Lawu</td>
<td>11.08</td>
</tr>
</tbody>
</table>

Infrared of allophane sample:

1. Analysis of FTIR

As shown in Figure 1, the IR spectra for all natural samples are similar one to another, and they are typical for allophane as compared to the IR spectrum of allophane recorded by Devnita et al. (2005). The details of analysis are recorded in Table 2.

![Figure 1. FTIR spectra of natural samples and FTIR spectrum of allophane (Devnita et al., 2005)](image)

<table>
<thead>
<tr>
<th>Functional groups</th>
<th>Devnita (2005)</th>
<th>Papandayan</th>
<th>Arjuna</th>
<th>Wills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration - OH (Al-OH/Si-OH)</td>
<td>3455</td>
<td>3437</td>
<td>3421.72</td>
<td>3444.87</td>
</tr>
<tr>
<td>Vibration</td>
<td>1108</td>
<td>960.55</td>
<td>912.33</td>
<td>912.33</td>
</tr>
<tr>
<td>AICOH/SiOH</td>
<td>973</td>
<td>951.48</td>
<td>1039.63</td>
<td>1035.77</td>
</tr>
<tr>
<td>The existence of Si-O bond</td>
<td>575, 485</td>
<td>428.2</td>
<td>468.7</td>
<td>426.27</td>
</tr>
</tbody>
</table>

Table 2. The comparison between the spectra of samples and the analysis by Devnita et al. (2005)
(Cu, Cd, Pb, and V) by natural and synthetic allophanes. An Al-rich allophane has also been synthesized, and a portion of the organic matter was extracted from the clay fraction, and their reactivities towards Cu²⁺ or Zn²⁺ were studied by potentiometry (Lattrill et al., 2003). The synthetic allophane was usually prepared due to Wade et al (1979).

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Preparation of Activated Allophane, Physical Characterization and Measurements

The natural allophane was aerated and then crushed. The powder obtained was sieved, which was then soaked in distilled water, filtered, and dried at a temperature of 105 °C for about 4 hours. The final product of dried allophane powder was then identified and characterized by NaF, FT-IR, and XRD.

After activation process with 1 N and 3 N of NaOH within the time variations of 1, 3 and 5 hours, the activated allophane, was finally used to adsorb the heavy metals, Fe, Mn, Cr, Cd, Cu, and Pb, to determine the adsorption isotherms, as well as to characterize the acidity. The natural allophane, without activation, was also used to absorb the metals for comparison.

Result and Discussion

An initial test of the presence of allophane on the andisol ground was done by means of NaF-pH test. The NaF test results for each of the mountains are shown in Table 1. The pH of all samples being greater than 9.4 should confirm that it is due to the presence of allophane (Munir, 1996).

<table>
<thead>
<tr>
<th>Sample</th>
<th>pH NaF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mount Lawu</td>
<td>11.08</td>
</tr>
</tbody>
</table>

Table 1. pH NaF of samples

Infrared of allophane sample:

1. Analysis of FTIR

As shown in Figure 1, the IR spectra for all natural samples are similar one to another, and they are typical for allophane as compared to the IR spectrum of allophane recorded by Devnita, et al. (2005). The details of analysis are recorded in Table 2.

![Figure 1. FTIR spectra of natural samples and FTIR spectrum of allophane (Devnita, et al., 2005)](image)

Table 2. The comparison between the spectra of samples and the analysis by Devnita, et al. (2005)

<table>
<thead>
<tr>
<th>Functional groups</th>
<th>Devnita (2005)</th>
<th>Papandiyau</th>
<th>Arjuna</th>
<th>Wills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration- OH (Al)</td>
<td>3455</td>
<td>3457</td>
<td>3421.72</td>
<td>3444.87</td>
</tr>
<tr>
<td>Vibration- OH/S-OH</td>
<td>1108</td>
<td>960.55</td>
<td>912.33</td>
<td>912.33</td>
</tr>
<tr>
<td>Vibration- AOH/S-SOH</td>
<td>973</td>
<td>991.41</td>
<td>1039.63</td>
<td>1035.77</td>
</tr>
<tr>
<td>The existence of Si-O bond</td>
<td>579; 485</td>
<td>428.2</td>
<td>443.63</td>
<td>426.27</td>
</tr>
</tbody>
</table>

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1. XRD of Natural Allophone

X-ray powder diffraction for the three samples were recorded, and as shown in Figure 2 they are similar each other's. The details of particular d-spacing are confirmed with JCPDS for allophone as shown in Table 3.

Adsorption of the Activated Allophone

The natural (without activation) and the activated allophones were then applied to adsorption of the solutions containing metal ions of Fe, Cr, Cu, Cd, Pb, and Mn within 30, 60, 90, and 120 minutes contact time of adsorption. The number of the heavy metals adsorbed was analysed by AAS. The results were collected in Table 4 (for Cr and Fe), Table 5 (for Pb and Mn), and Table 6 (for Cd and Cu).

The adsorption performed on the initial concentration of 1 ppm and 5 ppm of metals Cr and Fe respectively produced the adsorbsents weighing 0.25 g and 0.5 g respectively. Table 4 shows that the optimum condition for metal adsorption of Cr-Ions is on the activation with NaOH (3 N) for 90 hours within 120 minutes contact time, while that of Fe-Ions is on the activation of NaOH (3 N) for 1 hour within 30 minutes contact time. The percentages of the maximum adsorptions of Cr and Fe metals to the activated allophone are 97% and 99.9% respectively. While for the iron adsorption there is not so significant

![Figure 2. XRD spectra of Samples](image)

### Table 3. Typical d-spacing data of the samples compared to that of JCPDS

<table>
<thead>
<tr>
<th>d-spacing (Å)</th>
<th>JCPDS</th>
<th>3.300</th>
<th>2.250</th>
<th>1.850</th>
<th>1.400</th>
<th>1.230</th>
</tr>
</thead>
<tbody>
<tr>
<td>(38-0419)</td>
<td>Lawu</td>
<td>2.500</td>
<td>2.210</td>
<td>1.850</td>
<td>1.640</td>
<td>1.630</td>
</tr>
</tbody>
</table>

### Table 4. The percentage of metal ions uptake of Cr and Fe

<table>
<thead>
<tr>
<th>Sample</th>
<th>Metal</th>
<th>Treatment</th>
<th>The percentage of adsorption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>30'</td>
</tr>
<tr>
<td>Chromium</td>
<td>Cr</td>
<td>Without activation</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 1 hour</td>
<td>51.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 3 hours</td>
<td>51.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 5 hours</td>
<td>70.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 1 hour</td>
<td>76.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 3 hours</td>
<td>82.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 5 hours</td>
<td>64.2</td>
</tr>
<tr>
<td>Mount Lawu</td>
<td>Cr</td>
<td>Without activation</td>
<td>96.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 1 hour</td>
<td>97.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 3 hours</td>
<td>98.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 5 hours</td>
<td>97.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 1 hour</td>
<td>99.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 3 hours</td>
<td>95.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 5 hours</td>
<td>97.2</td>
</tr>
</tbody>
</table>

The adsorption performed on the initial concentrations of 40 ppm and 3 ppm of metals Pb and Mn respectively produced the adsorbsents weighing 0.25 g and 0.5 g respectively. Table 5 shows that the optimum condition for metal adsorption of Pb and Mn is on the activation with NaOH (3 N) for 5 hours within 90 minutes contact time. The percentages of the maximum adsorption of Pb and Mn metals to the activated allophone were found to be about 46.9% and 88.8% respectively. Thus, there is an increasing adsorption of Pb for about nearly three times from 15.5% (without activation) to 46.9% (for

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The increasing adsorption of Mn was also observed in more significance; it is about nine times from only 9.21% (without activation) to 88.8% (for the activated).

The adsorption performed on the initial concentrations of 2 ppm of Cd and 4 ppm of Cu produced the adsorbents weighing 0.5 g. Table 6 shows that the optimum condition of adsorption of Cd were in the activation of NaOH (3 N) for 3 hours within 120 minutes contact time, while that of Cu is on the activation of NaOH (3 N) for 5 hours within 60 minutes contact time. The percentages of the maximum adsorption of Cd and Cu metals to the activated allophane were found to be about 98.8% and 87.4% respectively. Thus, there is an huge increasing adsorption of Cd for more than sixteen times from 5.21% (without activation) to 98.8% (for the activated). The increasing adsorption of Cu was also observed in a slightly lesser significance; it is nearly three times from only 30.6% (without activation) to 87.4% (for the activated).

It is not surprising that the difference in optimum adsorption conditions for each sample is affected by the difference in ability of the adsorbent to adsorb the adsorbate and by the difference in characteristics of the adsorbate to be absorbed.

Table 5. The percentage of metal ions uptake of Pb and Mn

<table>
<thead>
<tr>
<th>Sample</th>
<th>Metal</th>
<th>Treatment</th>
<th>The percentage of adsorption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>30'</td>
</tr>
<tr>
<td>Lead</td>
<td></td>
<td>Without activation</td>
<td>13.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 1 hour</td>
<td>8.34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 3 hours</td>
<td>8.74</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 5 hours</td>
<td>9.93</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 1 hour</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 3 hours</td>
<td>16.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 5 hours</td>
<td>41.6</td>
</tr>
<tr>
<td>Mount Lawu</td>
<td></td>
<td>Without activation</td>
<td>42.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 1 hour</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 3 hours</td>
<td>41.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 5 hours</td>
<td>50.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 1 hour</td>
<td>56.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 3 hours</td>
<td>79.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 5 hours</td>
<td>82.8</td>
</tr>
</tbody>
</table>

Table 6. The percentage of metal ions uptake of Cd and Cu

<table>
<thead>
<tr>
<th>Sample</th>
<th>Metal</th>
<th>Treatment</th>
<th>The percentage of adsorption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>30'</td>
</tr>
<tr>
<td>Cadium</td>
<td></td>
<td>Without activation</td>
<td>5.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 2 hour</td>
<td>90.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 3 hours</td>
<td>98.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 5 hours</td>
<td>64.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 1 hour</td>
<td>64.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 3 hours</td>
<td>98.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 5 hours</td>
<td>90.7</td>
</tr>
<tr>
<td>Mount Lawu</td>
<td></td>
<td>Without activation</td>
<td>31.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 1 hour</td>
<td>73.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 3 hours</td>
<td>69.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1N 5 hours</td>
<td>66.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 1 hour</td>
<td>67.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 3 hours</td>
<td>74.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3N 5 hours</td>
<td>70.6</td>
</tr>
</tbody>
</table>
Determination of the Type of Adsorption Isotherms

The determination of adsorption isotherms aims to know the types of adsorption to occur. The type of adsorption is performed only for the activated allophane at the optimum conditions. Linear regression test is performed by using Langmuir and Freundlich equations (Sleijko: 1985; Helferich: 1952), and the results are shown in Figure 3 to Figure 8.

Figure 3. The isothermic curves of adsorption of Fe within contact time of 30 minutes by allophane of Mount Lawu activated with NaOH (3 N) in 1 hour.

Figure 4. The isothermic curves of adsorption of Cr within contact time of 120 minutes by allophane of Mount Lawu activated with NaOH (3 N) in 3 hours.

Figure 5. The isothermic curves of adsorption of Mn within contact time of 90 minutes by allophane of Mount Lawu activated with NaOH (3 N) in 5 hours.
Figure 6. The isothermic curves of adsorption of Pb within contact time of 90 minutes by allophane of Mount Lawu activated with NaOH (3 N) in 5 hours.

Figure 7. The isothermic curves of adsorption of Cd within contact time of 120 minutes by allophane of Mount Lawu activated with NaOH (3 N) in 3 hours.

Figure 8. The isothermic curves of adsorption of Cu within contact time of 60 minutes by allophane of Mount Lawu activated with NaOH (3 N) in 5 hours.

Langmuir isotherm fits for the adsorption of a single adsorbate onto a series of equivalent sites on the surface of the solid. It may indicate that the adsorption process occurs "chemically" in which each group of active adsorbers will only absorb one adsorbate species (metal ion), so it is limited only to the formation of a single layer (Stejko: 1985; Heiferlich: 1962). This is a specific adsorption. On the other hand, the Freundlich isotherm is the most important multilayer adsorption isotherm for rough surfaces of the (allophane) solid (Futomo, et. al:1998). It may describe that the adsorption occurs physically. Metal ions will only stick to the surface of allophane and is not chemically tightly bonded so that they will be easily separated.

Figure 5 and 8 exhibit significantly that the data of adsorption of the metal ions by the allophane follows readily Freundlich isotherm equation as indicated by the values of $R^2$ fitting to the linearity of the lines. This is in line with the adsorption by natural as well as synthetic allophane reported by Iyoda et al. (2011). Therefore, it might be interpreted that the interaction that occurs in the adsorption is likely only physically in nature.

Acidity Characterization

The measurements of acidity was performed with alkaline ammonia adsorption method, and again, this is only to the activated allophane at the optimum conditions and the non-activated for comparison.
results of acidity measurement are recorded as shown in Table 6.

Table 6. The Acidity of Volcanic Allophanes

<table>
<thead>
<tr>
<th>Sample</th>
<th>Treatment</th>
<th>Acidity (mmol/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mount</td>
<td>Without</td>
<td>1.7045 ± 0.0856</td>
</tr>
<tr>
<td>Lawu</td>
<td>activation</td>
<td></td>
</tr>
<tr>
<td>3N 1 Hours</td>
<td>2.2355 ± 0.1670</td>
<td></td>
</tr>
<tr>
<td>3N 3 Hours</td>
<td>2.8240 ± 0.1660</td>
<td></td>
</tr>
</tbody>
</table>

From the data in Table 6, it suggests that the acidity of the activated allophanes is greater than that of the non-activated natural allophanes. This is likely due to the fact that the activation process can get rid of the impurities attached to the allophanes and then the acid sites become visible.

Conclusions

A series of volcanic soils of Mountain Lawu was found to contain natural allophanes with difference in acidity and in capacity for adsorbing the metal ions. Activation with NaOH solution of 3N (within 1-5 hours) to the allophanes resulted in the optimum and significant increase of adsorbing the metal ions in a various contact time of 30 to 120 minutes. It was found that the allophane of Papandayan was to be typical for adsorbing the metal ions of Cr and Fe, while allophane of Wils was for the metal ions of Pb and Mn, and that of Arjuna was for the metal ions of Cd and Cu. The type of adsorption isotherm follows freely Freundlich equation, suggesting typically for the rough surfaces of the allophanes and likely physical adsorption. Thus, the potential of allophanes in the adsorption of heavy metal ions (Cr, Fe, Pb, Mn, Cd, and Cu) which pose a serious threat to the environment and human health shall be investigated soon with an eye on an economic and viable water treatment technology, and the result should be reported immediately.

References


