

Adsorbing Ability of Soluble Heavy Metals In Acid Mine Drainage By Zeolite From Gedangsari Area, Gunungkidul Regency, Special Region of Yogyakarta

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Abstract: Zeolite is a mineral which is presence quite abundant, especially in the Tegalrejo and surrounding areas, Gedangsari District, Gunungkidul Regency, Yogyakarta Special Region. This zeolite mineral is found in tuff claystone, tuffaceous sandstone and sandstone tuff. The cation exchange capability possessed by zeolites has long been of particular interest. This interest is proven through several previous studies to determine the cation exchange ability of zeolites. This research is important because it aims to identify the zeolite cation exchange capability of metal cations found in acid mine water samples. The cation exchange capability is carried out through a batch method which results are adjusted to the adsorption isotherm model. AAS analysis showed the sorbent sample had a K value of 0.243 with a maximum cation absorption value of 0.1681 mg / g of zeolite samples for Zn cation (zinc); K value 0.116 with a maximum cation absorption value of 0.8836 mg / g zeolite sample in the copper cation. Adsorption of Zn and Cu cations by zeolite samples is in accordance with the Langmuir isotherm adsorption model. Measurement of the pH value shows an initial pH value of 5.2 to 5.4 changed to 7.36-7.46 after the experiment. The results of the study concluded that zeolite can be used as an alternative to acid mine remediation, especially for Cu and Zn cation adsorption

Keyword: Mine Drainage, tuff claystone, tuffaceous sandstone and sandstone

1. Introduction

Water is the main source in life, without which there might be no life (Fetter, 2001). Every living individual needs to fulfill the need for water to survive. The need for water for the environment, especially humans, is the fulfillment of the necessities of life, related to the quality of water that is better than the quantity. Remediation of acid mine drainage becomes important with the main goal of reducing the amount of dissolved metal. Remediation can be done in various ways and tools, using zeolite is one of them (Putra et al., 2010; Warmada et al., 2010).

Acid mine drainage is characterized by AAS analysis then compared to the quality standard of waste water for gold or copper ore mining activities based on the Decree of the State Minister of Environment No. 202 of 2004. This study is still intended to determine the absorption ability of Cu and Zn metal cations in the characterized acid mine water samples.

2. Experiment

2.1. Materials

The samples of mine acid water used are acid mine water samples sent by P.T. Amman Mineral Nusa Tenggara. The acidity level of the water was measured using hanameter before

the experiment showed the figures of 5.2-5.4. The metal cation value before the experiment shows varying numbers, namely: Zn value 0.7410 ppm; 0,5026 ppm; 0.5910 pmm and Cu value 1.2613 ppm; 4,8226 ppm; 4,3369 ppm.

The adsorbent samples used are natural zeolites contained in tuffaceous siltstone lithology from Tegalrejo, Gunungkidul, DIY. Samples are crushed and sieved using a mesh sieve, taken in mesh numbers 100 to 200 then used directly without activation. XRD and SEM analysis (Figures 1 and 2) show that tuffaceous siltstone samples are composed of zeolite minerals in the form of mordenite.

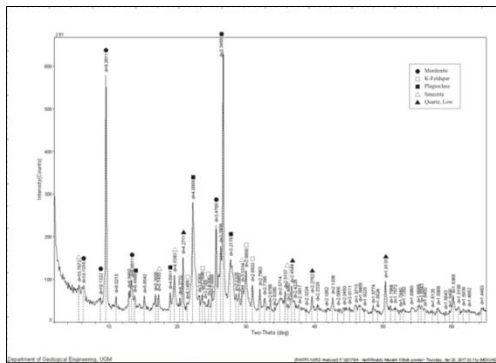


Fig. 1. Graph of XRD results on tuffaceous siltstone samples which indicate the presence of several mineral phases including mordenite.

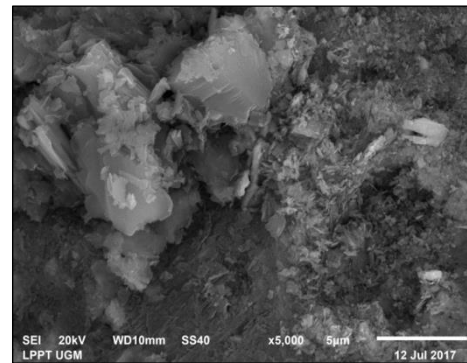


Figure 2. SEM results on tuffaceous silt samples which show mordenite (mor) with a fibrous shape.

2.2. Batch Method Experiment

Experiment with batch method was carried out 3 times to determine the ability of zeolite samples to absorb metal cations from acid mine drainage. Different amounts of adsorbent samples (1 g, 2 g, 4 g, 8 g, and 15 g) were placed into 250 mL of acid mine drainage with an initial pH of 5.2 to 5.4. Acidic mine water solution that has been given zeolite is then stirred at a speed of 115 rpm and the room temperature remains for 24 hours to reach equilibrium. Measurement of Zn and Cu metal cations after the experiment was carried out using the AAS method and the pH value was measured using a pH meter.

3. Results and Discussion

Data from the absorption of Zn and Cu into sorbent samples can be seen in Figures 3 and 4. The data shows that after 24 hours an equilibrium condition has been achieved with a variation in the weight gain of sorbent does not significantly affect the reduction of metal cations in the solution. The Langmuir adsorption isotherm model is adjusted to the data of the absorption of Zn and Cu metal cations into the sorbent sample by formula:

$$C_{ads} = \frac{Q^0 K C_{soln}}{1 + K C_{soln}} \quad (1)$$

with C_{ads} the Zn concentration adsorbed into the sorbent sample divided by sorbent (mg / gr), Q^0 is the maximum ability of every gram of zeolite to adsorb metal cations (mg / gr), K is the absorption coefficient of metal cations from the dissolved phase in the sample into solid phase zeolite sample as sorbent, and C_{soln} is the final concentration of metal in solution.

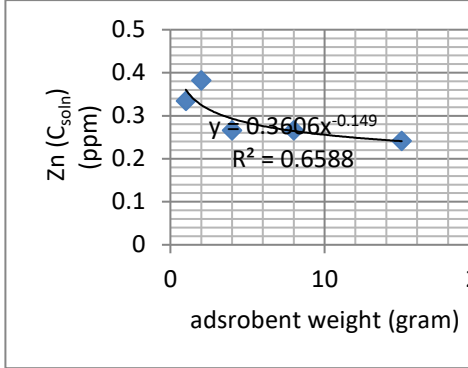


Fig. 3. The adsorption of Zn cation in the sorbent sample which occurs for 24 hours at a fixed temperature with varying adsorbent weight.

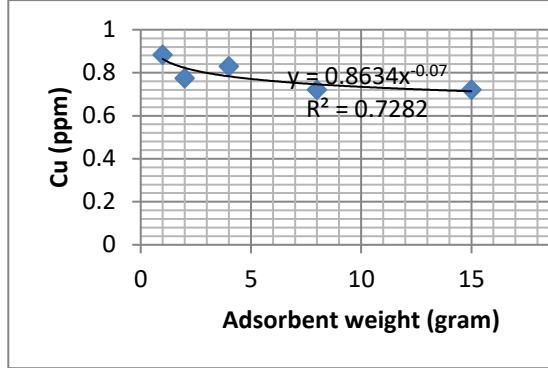


Fig. 4. The adsorption of Cu cation in the sorbent sample which occurs for 24 hours at a fixed temperature with varying adsorbent weight.

The Langmuir model is suitable for the data of Zn metal cation absorption into the sorbent sample with R^2 is 0.5805 and the absorption of Cu metal into the sorbent sample with R^2 is 0.6223. The maximum ability of sorbent samples to absorb Zn is 0.1681 mg / g zeolite with a K value of 0.243. The maximum ability of sorbent samples to absorb Cu is 0.8836 mg / g zeolite with a K value of 0.116 (Figures 5, 6, 7 and 8). The Q° and K values are then entered into equation (1) so as to produce an absorption equation for each metal cation into the sorbent sample.

Zn metal cations are adsorbed following the equation:

$$C_{ads} = \frac{Q^\circ K C_{soln}}{1 + K C_{soln}} \quad (1)$$

$$C_{ads} = \frac{0,1681 K C_{soln}}{1 + K C_{soln}}$$

$$C_{ads} = \frac{0,1681 0,243 C_{soln}}{1 + 0,243 C_{soln}} \quad (2)$$

$$C_{ads} = \frac{0.0408483 C_{soln}}{1 + 0,243 C_{soln}}$$

Cu metal cations are adsorbed following the equation:

$$C_{ads} = \frac{Q^\circ K C_{soln}}{1 + K C_{soln}} \quad (1)$$

$$C_{ads} = \frac{0,8836 K C_{soln}}{1 + K C_{soln}}$$

$$C_{ads} = \frac{0,8836 0,116 C_{soln}}{1 + 0,243 C_{soln}} \quad (3)$$

$$C_{ads} = \frac{0.1024976 C_{soln}}{1 + 0,243 C_{soln}}$$

Analysis of variations in zeolite sample weight as sorbents showed that weight gain from 4 g to 8 g then 15 g into 250 mL of acid mine drainage did not significantly influence the absorption of Zn and Cu metal cations from acid mine drainage.

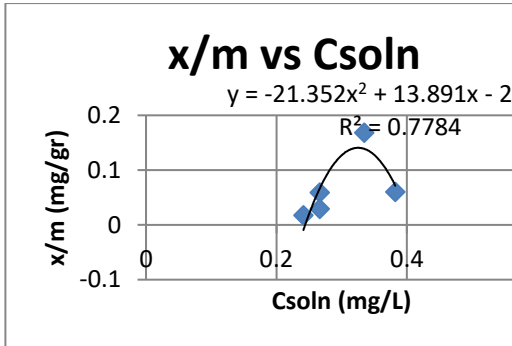


Fig. 5. Plot of the Zn adsorption value into the sorbent sample which shows the suitability of the data with the Langmuir adsorption model.

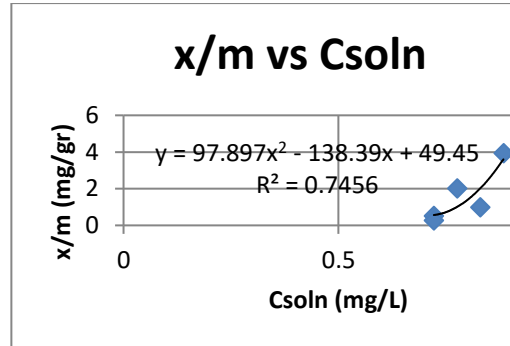


Fig. 6. Plot of the Cu adsorption value into the sorbent sample which shows the suitability of the data with the Langmuir adsorption model.

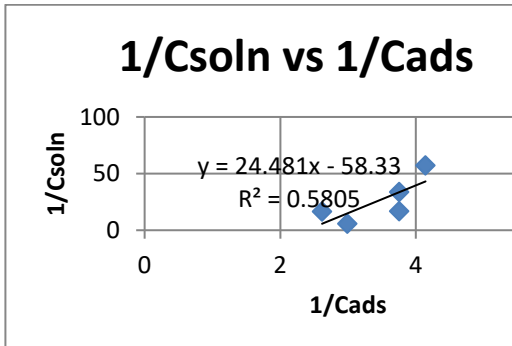


Fig. 7. Form of linearisation of Cads and Csoln values on the absorption of Zn cations showing the suitability of the Langmuir model to the data.

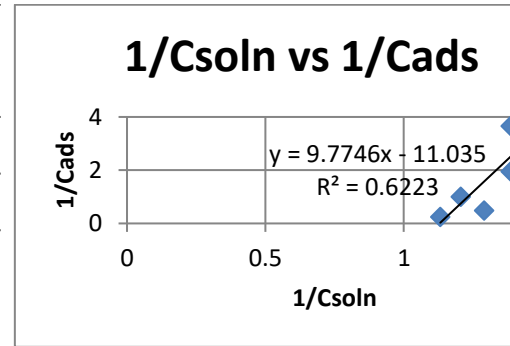


Fig. 8. Form of linearisation of Cads and Csoln values on the absorption of Cu cations showing the suitability of the Langmuir model to the data.

4. Conclusion

This study then concluded that tuffaceous siltstone samples from the Tegalrejo region had a composition of zeolite (mordenite) which was good for use as a sorbent on Cu and Zn cations. The maximum absorption ability of Cu is 0.8836 mg / g zeolite greater than the absorption capacity of Zn which is 0.1681 mg / g zeolite based on the Langmuir equation. The weight of the sample sorbent used if more than 4 g per 250 mL of acid mine drainage does not have a significant effect on the absorption of Cu and Zn metal cations.

References

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