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Analysis of the Leaching Out Test on Solidification/Stabilization of Cu(II) Ions Using Polyacrylamide

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ABSTRACT

Copper metal (Cu) is one of the dangerous heavy metals. Copper metal (Cu) is one of the dangerous heavy metals. An increase in Cu levels that is too high and exceeds safe limits will have a negative impact on living things because it is carcinogenic and accumulates in body tissues. At that level, there will be no accumulation of Cu (II) in the normal body. The existence of heavy metal waste with high concentrations in the environment can endanger various species of life. An increase in Cu levels that is too high will have a negative impact on living things. This research was conducted using the solidification/stabilization(s/s) method using a mixture of CuC₁₂ metal ions and polyacrylamide binding agent (PAM) using a variety of different PAM concentrations, namely: 500 mg/L, 1000 mg/L, 1500 mg/L, 2000 mg/L and 2500 mg/L. This binder aims to reduce Cu(II) heavy metal contaminants/pollution in the environment and in industrial waste. This study aims to determine the interaction between Cu(II) metal ions and polyacrylamide mixtures. Interactions on polyacrylamide and Cu(II) mixtures were identified using the AAS instruments. Leaching out value of Cu(II) ion test with polyacrylamide obtained was 0.92%; 1.04%; 1.11%; 1.12%; 1.19%. The percentage results of the leaching out test from a mixture of Cu(II) ions and polyacrylamide showed a small value.

ARTICLE HISTORY

Submission:

Recevid:

Accepted:

Citation:

Keywords: Ions Cu(II);
Polyacrylamide;
Solidification/Stabilization;
Leaching Out Test.

1. Introduction

Copper metal (Cu) is one of the dangerous heavy metals. An increase in Cu levels that is too high and exceeds safe limits will have a negative impact on living things because it is carcinogenic and accumulates in body tissues. The maximum permissible copper content according to PP MenLH no.3 of 2010 is around 2 mg/L. At that level, there will be no accumulation of Cu (II) in the normal body. The existence of heavy metal waste with high concentrations in the environment can endanger various species of life. In this case an alternative method is needed to tackle copper (Cu) heavy metal pollution. The method that can reduce heavy metal levels in the environment is the solidification/stabilization (S/S) method [1]. The solidification/stabilization method is a waste treatment method that works by limiting contamination of B3 compounds and detoxifying toxins in the waste [2].

Copper Cu(II) contains elements necessary for plants, but copper is toxic to living things when used in large quantities. The need for Cu in living organisms is 0.005 mg/day/kg body weight. At that level, there is no accumulation of Cu in a normal body. The maximum permissible copper content according to PP RI No. 82 in 2001 is about 0.02 mg/L [3]. States that the toxicity of Cu will only work if it has entered the organism's body in large quantities. Increased levels of copper in the soil are generally caused by the use of fertilizers, the use of pesticides, building materials, rayon production, agricultural and municipal waste, and emissions from industry. Cu metal that enters the aquatic environment can occur naturally or as a side effect of human activities [4].

S/S method considered the best method by the US Environmental Protecting Agency (US EPA) to address the problem of toxic waste pollution. The S/S method was first used for the treatment of radioactive waste in 1960 and is considered the best method by the US Environmental Protecting Agency (US EPA) for toxic waste and soil [5]. The S/S method can use a variety of binders, inorganic binders such as cement, fly ash, mud, lime and organic binders (asphalt, rice husk ash, agricultural waste). The use of binding agents in the S/S method has the advantage of being able to provide high physical solidity and chemical stability. The binding agent is selected according to the specific contaminants and based on the conditions of the processing area. The binding agent must be able to regulate the contaminants so that they can be encapsulated into solids through the immobilization process physics. At high pH, the binding agent commonly used is portland cement because it precipitates various contaminant species and reduces mobility (stable). Commonly used binding agents are lime, portland cement, thermoplastic materials, bitumen, and sulfur polymeric cements [6,7].

In this solidification/stabilization method, a binder is required. Some examples of binders that can be used include: lime, Portland cement, fly ash and polymers. Polyacrylamide was used in this study because it has several advantages, including as a binding agent to stabilize contaminants in waste or contaminated areas [8,9]. Then it is able to influence the interactions that occur between heavy metals and polyacrylamide such as pore ratio, permeability and expansion potential.

Polyacrylamide (C₃H₅NO)_n is a synthetic polymer compound that has a high water solubility value and many important uses, so it can be utilized in various processes. Acrylamide is generally formed on the hydration of acrylonitrile with sulfuric acid at 90 to 100°C and possibly by catalytic hydration using a copper catalyst [10,11]. One type of polyacrylamide is anionic polyacrylamide. Anionic polyacrylamide exhibits an electronegative structure containing sulfonic acid, phosphoric acid or carboxylic acid functional groups. Due to the greater charge, the polymer molecular chains can stretch more in water which will increase the adsorption capacity and bridges to remove suspended particles [12]. Polyacrylamide is soluble in water, has a hydrophobic main chain and hydrophilic side groups, this can be used as as the polyethylene main chain with -CONH₂. [13,14].

The characterization that can be carried out with the s/s method is to use the AAS instrument. Atomic absorption spectrophotometer is an instrument using the principle of energy absorbed by atoms. Atoms that absorb radiation then cause electronic energy to be excited. This AAS is a method used to detect metals in aqueous samples it is done by reading the spectrum produced when the sample is excited by radiation. Atoms absorb ultraviolet or visible light and make transitions at high energy levels. The atomic absorption method measures the amount of energy in the form of light photons absorbed by the sample, the concentration is calculated based on the Beer-Lambert law [14].

Based on this description, this research will carry out waste treatment on the heavy metal CuCl₂ by using a mixture of heavy metal Cu(II) and polyacrylamide by varying the composition of the polyacrylamide using the AAS instrument characterization test. This research was conducted with the aim

of seeing how the ability of polyacrylamide to overcome pollution of wastewater contaminated by heavy metal Cu(II) and is expected to be used as a new alternative method for dealing with pollution of heavy metal Cu(II) waste.

2. Experimental

2.1 Tools and Materials

The tools used in this study include: beakers, stirring rods, funnels, volume pipettes, dropping pipettes, measuring cups, volumetric flasks, vaporizers, spatulas, mortar and pestle, rotary agitator, analytical balance, aluminum foil, centrifugal tubes, magnetic stirrer (MR Hey Standard), burette, stative and valve, pH meter. The instruments used in this research are: Atomic Absorption Spectrophotometry (AAS)-63 Shimadzu. The materials used in this study were anionic polyacrylamide, CuCl_2 , distilled water, CH_3COOH , NaOH .

2.2 Making Reagens

a. Preparation of CuCl_2 solution

20.46 gr of CuCl_2 metal was weighed using a watch glass, then CuCl_2 was dissolved with 100 ml of distilled water in a beaker, then the solution was stirred and homogenized, then the solution was transferred to a reagent bottle and labeled.

b. Preparation of 1 N NaOH Solution

The preparation of a 1 N NaOH solution was carried out by weighing 4 g of NaOH using a watch glass, then dissolving it with 100 ml of distilled water in a beaker, then the solution was stirred and homogenized. After that, the solution was transferred to the reagent bottle and labeled.

c. Extract Solution Preparation

A total of 2.85 ml of glacial CH_3COOH in 250 ml of distilled water was added to 32.15 ml of 1 N NaOH. Then the solution was added with distilled water up to 500 ml, if the solution is correct when tested for pH, the solution will have a pH of 4.93 [15]

2.3 Mixture of Cu(II) Metal Ions with Polyacrylamide

a. Making Polyacrylamide Solutions

The polyacrylamide solution is prepared by weighing polyacrylamide according to their respective variations, namely 500; 1000; 1500; 2000; 2500 mg/L using an analytical balance, then the polyacrylamide solution is put into a 250 ml beaker, dissolve using 100 ml of distilled water, then stir and homogenize the solution using a magnetic stirrer so that the polyacrylamide is evenly mixed.

b. Mixing of Cu(II) Ions with Polyacrylamide Solution

0.5 ml of CuCl_2 1.2 M solution was put into a 25 ml burette, then drop the CuCl_2 solution little by little into the polyacrylamide solution of each of the five polyacrylamide variations. After that, stir

until evenly mixed at high speed using a magnetic stirrer. Once mixed, stop the burette and turn off the magnetic stirrer until the final result is obtained, namely the formation of elastic white cloudy (precipitate) and clear filtrate. The precipitate from a mixture of Cu(II) and polyacrylamide ion solutions was filtered using filter paper, then air-dried until dry. After that, the filtrate obtained was stored in vials for testing using the AAS instrument, repeating the above work procedure for other different variations of polyacrylamide.

2.4 Leaching Out

A total of 1 gram of sample was taken from the CuCl₂-polyacrylamide mixture which was previously obtained from different variations of polyacrylamide. Then, the sample was put into 5 different tubes containing 20 mL of extraction solution. The sample in the centrifuge tube is rotated using a machine Rotary Agitator for 18 hours at 30 rpm [16]. Furthermore, the centrifuge tube that had been rotated with a rotary agitator machine was centrifuged again for 20 minutes at 20°C with a speed of 10,000 rpm. Then the solution was filtered and the filtrate was tested using AAS to determine the levels of Cu(II) ions released into the extraction solution.

2.5 Characterization of Cu(II) Metal Ions with Polyacrylamide

The characterization of the results of mixing CuCl₂ solution with polyacrylamide was carried out using several instruments. Then for the AAS instrument used to see the concentration of metal ion Cu(II) released from the leaching out test and to test the levels of the filtrate mixing Cu(II) solution with polyacrylamide.

3. Results and discussion

3.1 Leaching Out

Leaching is the process of breaking down metals in a concentrate using an appropriate solvent. There are two stages to the leaching process, the first stage is the contact between the solution and the solid which causes the mass to move from the solid into the solution then, the second stage is the solution and the solid will separate after the first stage is complete [17]. The leaching out test is one of the benchmarks for determining whether a waste is hazardous or still considered safe. Leaching is carried out in research aimed at leaching of waste B3 after adding the extract solution and a certain pH. The results of the leaching out test of a mixture of Cu(II) and Polyacrylamide ions based on variations of polyacrylamide can be seen in Table 1 and Figure 2 below:

Table 1 Leaching Out Results

Polyacrylamide (mg/L)	Nilai Leaching (%)
500	0,92
1000	1,03
1500	1,12
2000	1,13
2500	1,19

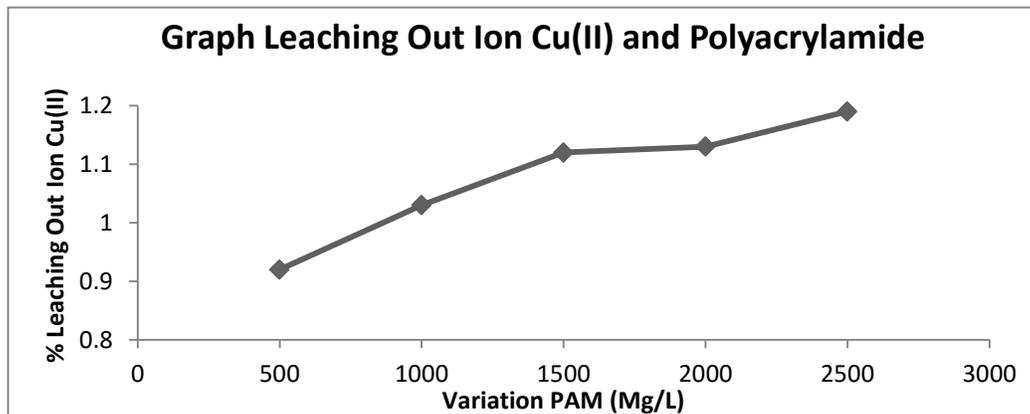


Fig. 1. Graph of Cu(II) and Polyacrylamide Ion Leaching Out

Based on the TCLP test results from table 1 and figure 1 it can be seen that the leaching out test value is small, this indicates that the stabilization/solidification method with polyacrylamide on Cu(II) ions is very helpful in reducing the solubility or leaching of metal ions into the extractor solution. The small percentage of Cu(II) leaching out indicates that polyacrylamide is able to stabilize Cu(II) metal ions. Then, the interaction of the polyacrylamide mixture.

4. Conclusion

The conclusion obtained is that the value of Cu(II) ion leaching out with polyacrylamide obtained is 0.92%; 1.03%; 1.11%; 1.12%; 1.19%. The percentage results of the leaching out test from a mixture of Cu(II) ions and polyacrylamide showed a small value. This shows that the use of polyacrylamide as a binder can be effectively used in the stabilization/solidification method for processing cu(II) metal waste.

Acknowledgements

The author thanks the lecturer mentors and to colleagues who assist in finish writing this article. After that the authors would like to thank the Department of Chemistry, Faculty of Mathematics and Natural Sciences, Padang State University, which has allowed to provide Chemical Laboratory facilities in completing this research.

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