# Removal of Heavy Metal Mercury (Hg) Liquid Waste through Electrolysis Method in Paya Ateuk Village, Pasie Raja District, South Aceh

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## Abstract

Electrolysis is a chemical reaction process in which an electrode is immersed in an electrolyte solution when a voltage is applied to the electrode to remove metal. The aim is to reduce the mercury content in the reservoir, used to dispose of and accommodate gold mine liquid waste. This research is a laboratory experiment conducted in batches. The result showed there was a significant decrease in mercury (Hg) levels up to 1.30% by applying 12 volts of electricity in 100 minutes. Besides, the lowest decrease was at 3.3 volts by applying 25 volts in 100 minutes. Heavy metal removal technique through electrolysis method could be applied and managed properly by the community and local government to minimize the heavy metal contamination in the surrounding environment due to the community's traditional gold processing.

Keywords: Mercury, Electrolysis, Processing, Gold, Traditional

**Introduction**

Mercury metal is a poisonous and dangerous chemical element. Mercury comes to the environment through human activities, as found in gold mining process. The gold mining process is known as amalgamation (the process of extracting gold by mixing gold ore with mercury). The amalgamation process has become a trend in the community due to the simplicity method and lower cost than other processes. Gold ore processing can increase people's income, but it can cause losses if not done properly and will produce waste (Mirdat, 2013). Another impact of mercury can be accumulated either through the process of bioaccumulation and biomagnification on the food chain. It is dangerous for humans to consume food and water from contaminated source of mercury (Irsan, et al 2020).

Mercury pollution is found in many places in Indonesia, but there have never been any investigations or reports regarding to Minamata disease or mercury poisoning sufferer. Unlegalized Traditional gold mining (PETI) is found in various places. In Pongkor, West Java, it was reported that the concentration of Hg in river sediments ranged from 0-2,688 ppm, while the concentration in soil was 1-1300 ppm (Gundari in Soemirat, 2003). The research in Central Lombok and West Lombok in 2014 showed that mercury levels in the soil were detected in 72% of soil locations around gold mining. The results of the analysis of the mercury content in the soil exceed the allowable threshold (Astiti & Sugianti, 2014). The other studies also showed that mercury levels in three sample locations, namely A, B, and C, respectively: 1.392 ppm, 1.5912 ppm and 3.1975 ppm, have exceeded the standards set by the government through the Decree of the Minister of the Environment of the Republic of Indonesia Number 115 of 2003; the mercury (Hg) threshold in class C water is 0.002 ppm (Mariwy, et al, 2019).

Electrolysis is a chemical reaction process in which an electrode is immersed in an electrolyte solution when a voltage is applied to the electrode (Vogel & Dogra in Soemargono, 2006). This is in accordance with (Skoog et al., 1993) which states that electrolysis is an event when a solution is decomposed into its ions; positive ions (cations) and negative ions (anions) when direct current is flowed into the electrolyte solution through the electrodes. Oxidation-reduction, or redox reactions, involve changes in the oxidation states of the reactants. In simple, there is an actual loss of electrons by one reactant and the gain of an equivalent electron by another. When the flow of electrons accompanying a reaction creates a current for electricity, the chemical change is referred as electrochemistry. In other words, electrochemistry is a study of chemical properties and reactions involving ions, electrolysis, and electric cells, and using an electric current through an electrolysis process to reduce metals and particles in water (Daintith, 1994).

South Aceh has natural resources spread in several locations including Labuhan Haji, Meukek, Sawang, Pasie Raja and Kluet Tengah. From these sub-districts there are 12 villages that have traditional gold processing logs. Based on the results of an initial survey conducted in Paya Ateuk Village, Pasie Raja District, South Aceh Regency, it was found the community used gold ore processing equipment with logs. Gold mining waste in Paya Ateuk Village, Pasie Raja District, South Aceh comes from local mining carried out by the community. The impact of mercury on gold mining process (Hg) is very dangerous to the aquatic environment and the degree of public health. Therefore, a solution to reduce mercury (Hg) levels from the processing of the gold ore by means of electrolysis of liquid waste treatment methods is needed.

Research on the removal of mercury (Hg) liquid waste in gold mining in Paya Ateuk Village, Pasi Raja District, South Aceh Regency is conducted to reduce the mercury (Hg) content in the reservoir used to dispose of and accommodate gold mine liquid waste. The purpose of this study was to find out how electrolysis removal techniques in mercury waste can reduce mercury levels in wastewater from traditional gold processing in Paya Ateuk Village, Pasi Raja District, South Aceh.

**Method**

Research sample was taken from traditional gold processing water waste in Paya Teuk village, Pasi Raja District, South Aceh. This research is a laboratory experiment conducted in batch. The electrolysis equipment consists of 2 components: electronic tub and electrode plate. The electronic tub are 15 cm long, 10 cm wide and 15 cm high. Besides, electrode plate consists of 3 cathodes and 3 anodes made from aluminum. Variable measure in this research were varying residence times (1 hour, 1.5 hours and 2 hours) and variations in electrical voltage (3 volts, 5 volts and 12 volts) to remove mercury from heavy metal on the quality of the effluent degradation product as seen from the parameters pH, color, Hg, COD, TSS waste and heavy metals*.* Model of electrolysis method by collecting the main parameters measured, namely degradation, dyestuffs, heavy metals, and parameters. filtration through bio sand to determine the amount of bacteriological is used as the support.

**Result**

1. Results of Mercury (Hg) Decreasing Parameters with Variations of Electric Voltage Volts and Electrolysis Time

**Table.1. Result of Parameter Decrease**

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***Source. Primary Data 2021***

Based on the results of testing in the laboratory as shown in table 1, there was a decrease in mercury (Hg) parameters in gold mining liquid waste by testing parameters through electric current voltages of 0.3, 3.5, and 12 with electrolysis time of 0, 25, 50, 75 and 100 minutes. The most significant decrease in mercury (Hg) parameter of 0.0534 occurred at 12 volts with a time of 100 minutes. The lowest decrease was at 3.3 volts at a voltage of 25 volts.

**Table 2. Calculation Results for Mercury Hg. Parameter Decrease**



***Source. Primary Data 2021***

The results of observations in table 1 and table 2 can also be presented in graphical form in the following figure:

***Graph 1 . Decrease in Mercury (Hg) Parameters with Variation of Electrolysis Time with Electric Voltage Vol***

Based on Figure 1, there was a significant decrease in mercury (Hg) levels from 1.30% with the provision of 12 Volt electricity for 100 minutes. The lowest decrease was at 3.3 volts at a voltage of 25 volts in 100 minutes.

**Discussion**

1. **Mercury (Hg) Parameters Decrease**

The decrease in mercury (Hg) parameters in this study varied greatly in traditional gold mining liquid waste where the sample was taken in Uteun Ateuk Village after testing through the electrolysis method. The mercury (Hg) parameter decreased by 1.30% which occurred at 12 volts with a time of 100 minutes. While the lowest decrease was at 3.3 volts at a voltage of 25 volts. Furthermore, it can be seen in the concentration of mercury Hg at the cathode where there is a reduction in positive ions in the direction of the cathode and receiving current signals from electrons, negative ions also move towards the anode and release electrons. The released electrons will be attracted by mercury ions (Hg) and form mercury metal Hg. The reaction that occurs through the electrolysis method at the cathode as a reaction from reduction, then the reaction of the mercury metal ion (Hg) has precipitated on the cathode plate, the water solvent will turn into hydrogen gas (H2).

According to Fraday's First Law which describes how electrolysis works which states that the number of electric volts and the time of electrolysis. Based on the results of the research in Tables 1 and 2, the highest decrease in mercury (Hg) parameters did not occur at small currents because of the expected side reactions. However, it is very difficult to predict what reactions occur at the electrodes during the electrolysis process. The reactions that occur in the electrolysis process are not always the reverse of the spontaneous electrolysis cell reaction. The actual reaction that will occur in the electrolysis process will follow the relative potential value, namely the standard of the substances involved in the reaction. Wastewater treatment using an electrolysis process requires a device to regulate the voltage called a voltage regulator. Voltage regulator is a device mounted on a generator to regulate the voltage or wave amplitude so the generator remains stable (Gunadin, 2008).

The concentration that is owned varies greatly as well as the time specified at the time of testing. In addition, other factors that affect the mercury parameter are that the concentration increases at each variation of the test time as the process of examining waste through a pump to an electrolysis reservoir and perfect mixing does not occur in a non-homogeneous reservoir. In this study, the volts used were 25, 50.75 and 100 while the volume treated was 3 liters at the stage. Because the waste treated in the range has not exceeded the quality standard threshold so that the electrolysis process runs smoothly and uses a small voltage volt so that the process runs well, a decrease in mercury parameters in wastewater is seen.

The results of the study analyzed the mercury content of Hg in sediments in the waters of Kao Bay, North Halmahera, which did not meet the Quality Standards for Quality Raw Materials in accordance with Government Regulation No. 82 of 2001 class I. 0.001 mg/L class II. 0.002 mg/L class III. 0.002 mg/L and class IV 0.005 mg/L (Kahirunnisa, 2017). Gold processing activities also require large amounts of water. Therefore, gold processing sites are often found along rivers. This condition resulted in waste containing mercury being distributed into the Wamsai River and Kayeli Bay. As a result of the use of mercury, in a study conducted by Male et al. (2013), it was found that the mercury concentration in the waste pond was 680 ppm (mg/Kg) and in the sediments of the Wamsait River and Kayeli Bay of 0.35-7.66 ppm or had exceeded the threshold (Male et al., 2013).

This is due to the existence of gold mining activities around which the presence of pollution will increase the risk of the community being exposed to mercury in the long term and it will be harmful to health if there are no good management efforts from various parties, both gold mining managers and the local government to reduce the amount of mercury concentration in the surrounding environment.

**Conclusion and Suggestion**

Based on the results of this study, it can be concluded mercury levels in the waste from gold mines processing can be reduced by the electrolysis method with a time of 100 minutes and with a voltage of 12 volts decreased significantly by 1.30%. The researcher suggests to reduce mercury levels more in 100 minutes by adding a larger amount of electrical voltage so that under these circumstances the mercury contained in the waste processing at the gold mine does not pollute the environment around the gold mine in Paya Teuk Village, Pasi Raja District, South Aceh. The results of the mercury waste analysis will be used as a reference for further processing using the electrolysis method. In addition, the results from this research will also be disseminated in the future to the Bappeda Aceh Selatan as a policy holder.

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**Author Contribution**

The first researcher is the main researcher whose role is to prepare ideas, arrange research proposals, determine research locations, determine research budgets as needed, process data, and make journals. Besides, the second researcher is a member of researchers who participates in assisting all processes, preparing the necessary equipment needed and assisting the research process in the field.

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