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Treatment of Leachate from Garbage using Electrocoagulation Type MP-P (MonoPolar-Paralel) Methode

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Abstract. Leachate water is a very dangerous liquid due to its organic and inorganic content that can pollute water body around the landfill, hence treatment is needed. Electrocoagulation is one of the methods that can be used. The research aims to determine a characteristic of leachate water at TPA Sukawinatan (COD, pH, BOD₅, TSS, and Cd content), the effect to electrodes distance (aluminium anode and iron cathode) and optimum time of treatment Leachate Water using electrocoagulation type MP-P (MonoPolar-Parallel) method. The electrical potential was set at 12 volts and time variations of 30,60,75, 90 and 120 minutes and electrodes distances of 6, 7 and 8 cm. The result obtained shown that COD decreased to 529.20 mg/L, pH became 8.34, BOD₅ decreased to 17.6 mg/L, TSS became 108 mg/L and <0.0015 mg/L of Cd content. The optimum electrodes distance to treat leachate water was found 8 cm in 120 minutes fo electrocoagulation type MP-P.

1. Introduction

Garbage has become an important issue for the dense populated city due to many factors, one is unoptimal garbage treatment technology that slows down the decay process. This caused acceleration of increasing garbage volume rather than the decaying [1, 2]. Garbage problem in Palembang city has come to emergency state due to increasing of densely populated people and hence increasing garbage production, while the land to accommodate the left over consumption food has been limited. Based on City Environmental and Hygiene Service, Palembang city produces 600 – 700 ton of garbage every day and in a weekend can reach up to 900 ton, such fantastic amount that can be a threat to the city due to its impact to health and environment [3, 4].

Leachate water is highly organic concentration water developed in a landfill because of rain water entering the landfill. Leachate water is dangerous water because inspite of its high organic content, it also contains a metal element such as zinc (Zn) and mercury (Hg) that if it is not properly treated can be absorbed through the land and hence pollutes the groundwater around the landfill. Leachate water needs prior treatment that is by decreasing inorganic content after done, so the leachate water is then treated further to remove fully its inorganic content. Leachate water treatment can be conducted in several alternatives such as:

1. Recirculation of leachate water back to a landfill that can increase the decomposition rate of organic to biogas up to 70%. Recirculation leachate water can be performed during the dry season, whereas in the rainy season, leachate water must be treated to decrease its volume.
2. Leachate water treatment using biological waste treatment. This is usually conducted by means of active sludge to degrade organic content in leachate water. After decreasing the organic content



drastically, it then can be purified by filtration. The output water then hoped safely dumped to the environment because it is now harmless.

3. Chemical treatment of leachate water.
4. Leachate water treatment using a membrane, besides to decrease turbidity, treatment by the membrane is meant to decrease COD, BOD and metal content in leachate water. Generally, it is required some treatment stage to obtain waste that fulfills standard waste requirements such as membrane bioreactor or integrated ultrafiltration with active carbon [5-6].

Leachate water treatment by recirculation the water to landfill requires energy not to mention less effective during the rainy season. Microbial leachate water treatment is also less effective to decrease the metal content, and chemically leachate water treatment certainly is not efficient due to expensive chemical cost.

TPA Sukawinatan is one of garbage landfill in Palembang which is managed using landfill control system [7-12]. Therefore is need effective and efficient liquid waste water treatment using electrocoagulation method to decrease COD and TSS [13-15].

Electrocoagulation method is a cheap and effective industrial waste treatment. Electrocoagulation is an electrochemical method to treat water and waste using anoda as releasing active coagulant of metal ion (usually Aluminium or Iron) to the solution, whereas in cathode electrolysis is taking place by releasing hydrogen gas [16, 17]. Electrocoagulation has 3 modes of assembling electrode in the reactor, those are MP-P (MonoPolar-Parallel), BP-P (BiPolar, Parallel) and MP-S (MonoPolar-Serial). MP-P mode is the most effective electrodes assembly among three due to efficient cost [15].

2. Methodology

The research was conducted by means of electrocoagulation method using aluminium and iron electrode. The research has experimental designed as followed:

- a. Taking liquid waste water at TPA Sukawinatan.
- b. Initial characterization (pH, TSS, COD, BOD, Cd metal content).
- c. Constructing reactor (minimal volume 3500 mL).
- d. Cutting electrode plate.
- e. Assembling electrodes with some distance variation.
- f. Leachate water treatment using electrocoagulation method.
- g. Measuring pH, TSS, COD, BOD, Cd metal content.

3. Results and Discussion

3.1. Leachate water characteristic

Analysis of leachate water taken from TPA Sukawinatan, Palembang

Table 1. Result in prior treatment

No.	Type of Analysis	Standard	Result obtained
1.	pH	6 – 9	7,86
2.	TSS (mg/L)	100	2.810
3.	BOD ₅ (mg/L)	150	391,7
4.	COD (mg/L)	300	1150
5.	Cd content (mg/L)	0,1	0,004
6.	Mercury	0,005	
7.	Total N content (mg/L)	60	

Source:[7]

3.1. Result analysis of leachate water after treatment

The experiment conducted to determine the effect of plate distance and process time to the increasing pH value and the decreasing values of TSS, BOD₅, COD, Cd metal content and compare the final analysis of each assembly to the initial analysis value.

3.2. The Effect of electrocoagulation time to the flow of electrical current

According to current observation every 10 minutes for 120 minutes as the diagram below, it can be analyzed that the closer the distance between the electrode the smaller resistance hence causes the greater current flow. Mathematically it can be explained using $V = IR$ equation for static voltage of 12 Volt. The current is inversely proportional to resistance (R), so if the distance of electrodes is closer, then the R is smaller therefore the current is greater.

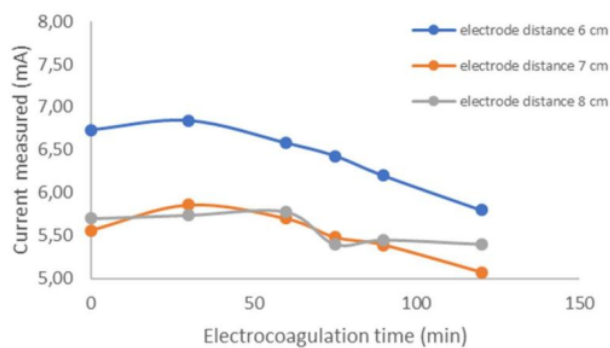


Figure 1. Current changing during electrocoagulation process

Figure 1 shown at the beginning of the electrocoagulation process, the current flow in reactor increasing the at a certain point the current decreasing. This is because at the beginning the current dissolve the aluminium metal at anode so the metal solute which is the good conductor act in closing distance between the plate and decreasing the resistance.

At the same time, flocculation and coagulation process is taking place caused by interaction between dissolve aluminium metal and hydroxyl ion and hydrogen gas. Eventually, the floc became many and bigger and covered the cathodes and anodes. These flocs are indirectly increasing resistance hence decreasing the current flow.

But the increasing current at minutes 120 for distance 8 cm due to the longer time of electrocoagulation process, some of particles that have been flocculated and coagulated are getting heavier and sink because of gravitation, and hence reduce the resistance. Hence to stabilize the current can be accomplished by removing the floc formed.

3.3. The Effect of Electrocoagulation Time to pH at Electrode Distance Variation

Based on analysis data can be said that the closer and the longer time of electrocoagulation then the pH values increase. This can be explained according to the prior research, in electrocoagulation, ion OH^- produced through water reduction at the cathodes. The amount of ion influence pH measured. Because 6 cm distance has greater current than 7cm and 8 cm, so the pH of 6 cm distance is higher. This indirectly said that ion OH^- produced is much greater than at a distance 7 cm and 8 cm. However at point minutes 75 using 7 cm distance the pH drop, this is suspected because, at separation time of float, the sample has been exposed long to open air hence O_2 and CO_2 from the air.

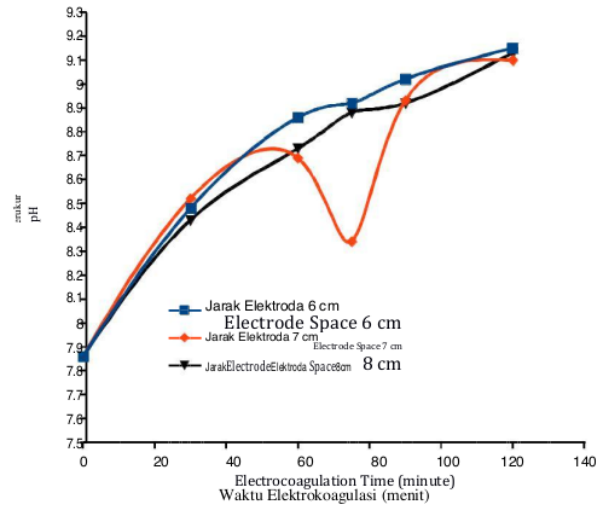


Figure 2. Value of pH at each electrocoagulation time

3.4. The effect of electrocoagulation time to TSS (Total Suspended Solid) at each variation distance of the electrode

Based on data of TSS (Total Suspended Solid) the value of TSS tends to decrease after electrocoagulation. As explained earlier, the distance influence the current flow. The higher current at 6 cm distance causes quicker coagulation process hence the solute suspended is less.

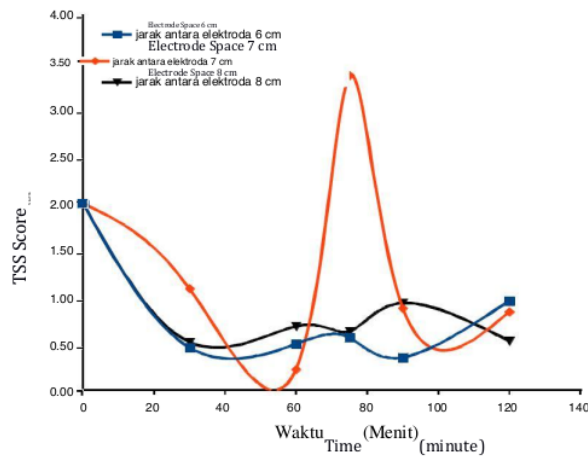


Figure 3. TSS value at each electrocoagulation time

Inlinierity of decreasing total suspended solid is caused the samples are not directly tested and stored at 4°C according to SNI. This cause microbiological decomposition. However, there is an odd value for plate 7 cm at minute 75 because prolonged exposed of the sample at free air after float separation.

3.5. The Effect of Electrocoagulation Time To Value of COD (Chemical Oxygen Demand) at Each Distance Electrode

Base on figure 4, the COD value before and after electrocoagulation is decreasing. Due to disability of colloid by metal cation forming *polyvalen polyhydroxide*. This complex has higher adsorption side to promote aggregation with some polutan and form bigger material which then can be separated using filtration [16]. Samples separated from float contained lower complex than initial sample. This causes a decrease in COD value.

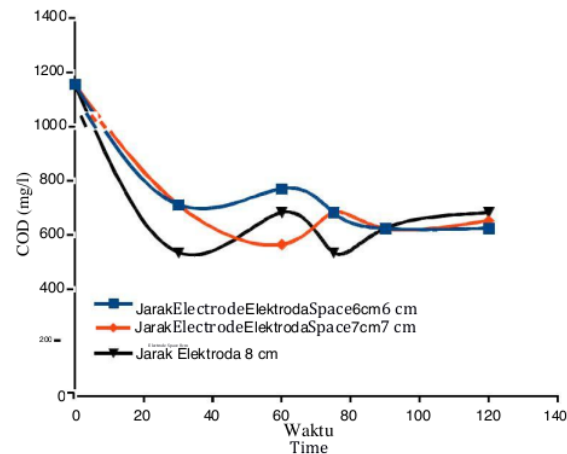


Figure 4. COD value at each electrocoagulation time

This inlinierity decreasing caused by a lot of factors, namely storage, environment and analytical technique. Storage factor for instance, if the sample is kept at room temperature instead of kept at 4 °C can change COD characteristic. From analytical technique, if the technique is not properly carried out, for example, sample test is using SNI standard but only 20 % of it is used such as the sample used supposed to be 10 mL by instead changes to 2 mL, the end point of the titration with FAS solution will probably close hence reduce accuracy of titration.

3.6. The effect of electrocoagulation time to BOD₅ (Biological Oxygen Demand)₅ value.

The first and last sample (120 minutes) shown the highest BOD₅ value at the maximum time. Determination of BOD₅ is carried out at a maximum time to observe maximum BOD₅ value, because according to the prior research the longer the electrocoagulation time the lower BOD₅ value.

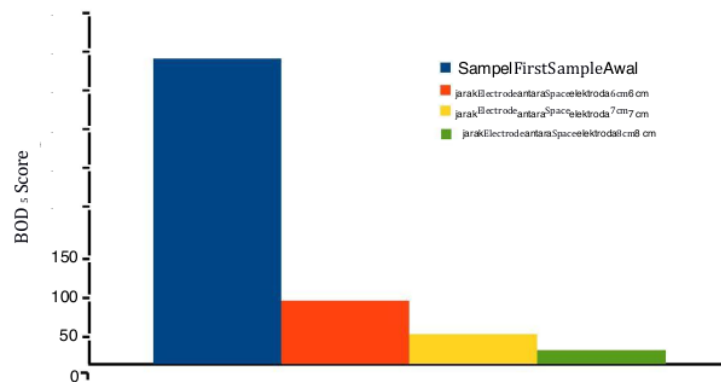


Figure 5. Value of BOD5

From figure 5 the best decreasing BOD₅ is at a distance 8 cm.

3.7. The effect of electrocoagulation time to the decreasing Cd metal content at each distance

From figure 5, the content of Cd is decreasing at minute 30 but increasing at minute 60 and 75 for 7 cm and 8 cm distance. This irregularity is suspected because of the shaking of the bottle, hence the metal that was settled in the bottom present in the sample solution for Atomic Absorption Spectrophotometry (AAS) analysis. Moreover, the initial content of metal was very lower therefore is not detectable by AAS analysis.

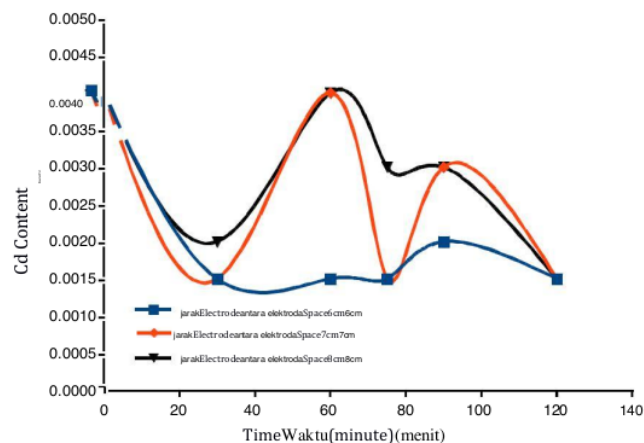


Figure 6. Cd content at each electrocoagulation time

4. Conclusion

The optimum distance between electrodes (aluminum anode and iron cathode) at 12 volt voltage conditions to reduce leachate pollutant levels with MP-P type electrocoagulation is 8 cm and processing time 120 minutes.

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