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Leachate Treatment of TPA Talang Gulo, Jambi City by Fenton method and adsorption

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Abstract

Leachate from a landfill (TPA) contains organic substances in high concentrations by gravitational force, the leachate formed will move to the bottom of the landfill (TPA) and will enter the soil, by carrying contaminated material, and both suspended material and dissolved material that can pollute ground water. One of the leachate treatment processes is using Fenton reagent and adsorption. The effect of reagent Fenton molar ratio and stirring time on degradation of COD, BOD and TSS were also investigated. In this study leachate was processed for 30-120 minutes. the optimum conditions were achieved at a molar ratio of 1: 200, stirring time of 120 minutes, and adsorption using 120 minutes of activated carbon where the maximum decrease in COD, BOD and TSS achieved was 95%, 95% and 92% with a final concentration of 96 mg/L, 25.5 mg/L and 90 mg/L, which meet the environmental quality standard.

Keywords: Leachate, Fenton Reagent, Adsorption, COD, BOD, TSS

Abstrak (Indonesian)

Lindi dari sebuah landfill (TPA) mengandung zat organik dalam konsentrasi yang tinggi. Dengan adanya gaya gravitasi maka lindi yang terbentuk akan bergerak ke dasar landfill (TPA) dan masuk ke dalam tanah, dengan membawa bahan cemar baik material tersuspensi maupun material terlarut yang dapat mencemari air tanah. Salah satu proses pengolahan lindi adalah dengan menggunakan reagen Fenton dan adsorpsi. Penelitian ini bertujuan untuk mengolah lindi menggunakan reagen Fenton dan adsorpsi serta mempelajari rasio molar Reagen Fenton serta waktu pengadukan terhadap penurunan COD, BOD dan TSS. Pada penelitian ini lindi diolah selama 30-120 menit. Kondisi optimum dicapai pada rasio molar 1:200, waktu pengadukan 120 menit, dan adsorpsi menggunakan karbon aktif selama 120 menit dimana penurunan COD, BOD dan TSS maksimum yang dicapai berturut-turut 95%, 95% dan 92% dengan nilai konsentrasi akhir 96 mg/L, 25,5 mg/L dan 90 mg/L. dan telah memenuhi baku mutu lingkungan.

Kata Kunci: Lindi, Reagen Fenton, Adsorpsi, COD, BOD, TSS

INTRODUCTION

Talang Gulo waste processing final site, which has been used since 1999 is openly open dumping. The amount of waste that enters the Talang Gulo landfill is

1565m³/ day. The composition of waste disposed in the Talang Gulo landfill consists of 60% of the waste disposed from residential areas (households), 12% from the market and 28% from shops, restaurants, hotels, public facilities and industrial activities. The

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waste composition is in the form of 30% of waste disposed of by organic waste and 70% of waste disposed of inorganic waste [1].

Leachate is a liquid generated by waste due to the entry of external water that can dissolved materials, including decomposition of organic matter biologically. Generally, leachate from a landfill (TPA) contains organic and inorganic substances in a high concentration. With the gravitational force, the leachate that is formed will move to the bottom of the landfill (TPA) and will enter the soil by carrying contaminated material both suspended and dissolved material [2]. The leachate composition with a high content of organic and inorganic compounds is very dangerous if it is directly flowed to the soil or a body of water because it will disturb living creatures surround it [3].

Leachate treatment can be carried out by Advanced Oxidation Process (AOPs) [4]. AOPs technology is based on the process of oxidation of contaminants by strong oxidizing agents such as hydroxyl radical to CO_2 and H_2O [5]. The advantage of AOPs technology is the ability to degrade toxic compounds and non-biodegradable organic components [6]. One of the AOPs technology methods that is capable of producing hydroxyl radical oxidizers is Fenton method. The Fenton reagent, a mixture of Fe and H_2O_2 salts, with an oxidative system which produces radical OH [7]. The appropriate Fenton reagent molar ratio and initial pH were the two most important factors to achieve maximum COD removal performance [8]. In addition, Fenton's reagent is easy to handle, easy to implement, does not require energy to activate hydrogen peroxide, and has a short reaction time compared to other AOPs technology [9].

Several factors that need to be considered in achieving optimum leachate degradation efficiency using the Fenton method are H_2O_2 concentration, Fe^{2+} concentration, contact time, and pH [10]. In the Fenton method application, it is necessary to determine the optimum molar ratio in order to achieve maximum processing efficiency with efficient and affordable operational costs [11]. The combination of Fenton and adsorption can process leachate more efficiently, because adsorption with activated carbon can adsorb gases, liquids and chemical compounds, depending on the size or volume of the pores and its surface area. Absorption ability from the activated carbon itself is very large, 25% to 100% of the weight of the activated carbon. Because of this great adsorption capacity, a lot of activated carbon is used for waste treatment. There for on this, in this study a combination of leachate treatment by Fenton reagent and adsorption using activated carbon was carried out.

MATERIALS AND METHODS

Materials

Leachate sample comes from final processing site of Jambi City garbage. the other chemicals were supplied from Merck and Sigma Aldrich such as hydrogen peroxide (H_2O_2 30% w/v), ferrous sulfate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$), sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$), sodium hydroxide (NaOH), sulfuric acid (H_2SO_4) and the activated carbon used is made of coconut shell.

Method

Preliminary testing of COD used the APHA 5220 D-2012 method, BOD used SNI 6989-72-2009 method and TSS used the APHA 2540 D-2005 method in the laboratory. Prepare jar test and add 250 ml leachate into a glass beaker, add FeSO_4 catalyst. $7\text{H}_2\text{O}$ and stir using jar test, for 30, 60, 90 and 120 minutes, adjust the pH to 3 by adding H_2SO_4 , add 30% H_2O_2 according to the specified ratio, in each sample after stirring for one hour add 0.5 ml $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ to stop the reaction. calculate the value of COD, BOD and TSS after getting the optimal concentration ratio continue with adsorption using activated carbon, fill the adsorption column with activated carbon with a height of 20 cm and as much as 60 grams. Enter the solution previously oxidized with Fenton reagent in the ratio of the optimal concentration of Fenton reagent to the adsorption column for 120 minutes. Calculate the value of the adsorption column for COD, BOD and TSS.

Analysis Data

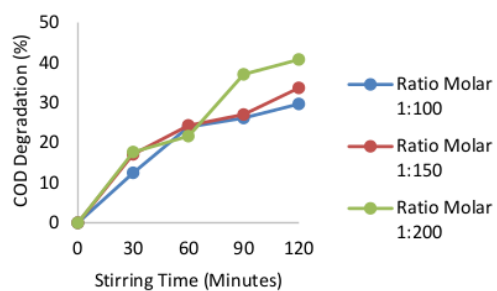
The samples were taken periodically for analysis of COD, BOD and TSS degradation, COD degradation was determined by titrimetric method, BOD degradation was determined by and TSS degradation was determined by.

RESULT AND DISCUSSION

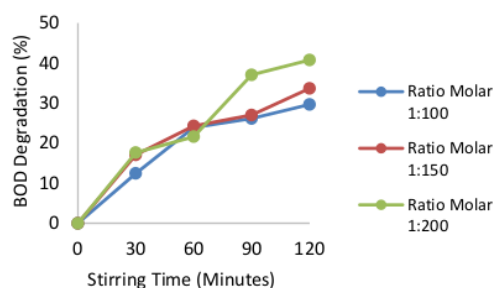
Effect of ratio molar and stirring time on COD, BOD and TSS degradation

The oxidation process was examined for 120 minutes with a molar ratio of 1: 200, the effect of stirring time and molar ratio on the decrease of COD, BOD and TSS can be seen in Figure 1.

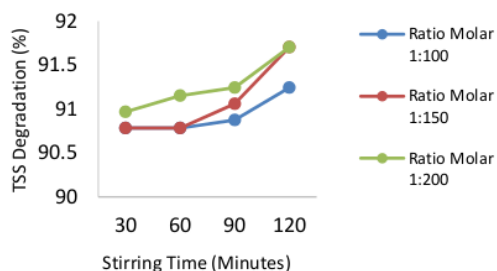
The stirring time has an effect on COD, BOD and TSS. The best stirring time is the 120 minutes. The longer time will also greatly affect the process. Because the longer the stirring time is used, the more processes for collisions occur [12].



(a)



(b)



(c)

Figure 1. Effect of stirring time and molar ratio on the reduction of COD, BOD and TSS on leachate (a) COD, (b) BOD, (c) TSS

COD reduction changes with time can explain that all treatment by using a variation of the molar concentration causing greater reduction obtained with increasing stirring time in Figure 1 (a). Leachate processing with Fenton had a COD decrease of 67%, using Fe^{2+} 1000 mg/L and H_2O_2 5000 mg/L concentrations this shows that the Fenton process decreased COD [13]. The highest decrease of all treatments derived minutes to 120. Graph time

relationship with the decrease can be explained that longer reaction time showed H_2O_2 has been used to reduce COD. Leachate treatment with Fenton experienced a COD decrease of 68% at 120 minutes, using concentration, FeSO_4 12.8 g/L and H_2O_2 747.8 mg/L [14].

Decreasing BOD levels to time can explain that all treatments using ratio variations cause a decrease the greater the gain along with the increase of reaction time in Figure 1 (b). This shows that in the Fenton process BOD compounds was occurred. For the all treatments the highest decrease was obtained at 120 minutes with a ratio of 1: 200. Graph of the relationship of time with a percentage reduction in BOD can explain that the longer the reaction time the more BOD are reduced. leachate treatment with Fenton had a COD decrease of 46%. In the 120 minutes, using a concentration of FeSO_4 200 mg/L and H_2O_2 1100 mg/L [15]. Leachate decrease over time can explain that all treatments using various Fenton Reagent concentrations cause greater decreases as the reaction time increases. In the 1: 200 molar reaction there are more deposits formed, this shows that in the Fenton process there is a reduction in TSS in figure 1 (c). For all treatments, the highest decreasing was obtained at 120 minutes.

Figure 1 (a)–(c) shows Leachate processing using the Fenton method using a concentration of 1: 200 and 120 minutes achieved a decrease in COD by 41%, BOD by 41% and TSS by 92% with a final concentration of 1150 mg/L, 301 mg/L and 98 mg/L.

Fenton oxidation continues with adsorption with activated Carbon

Leachate processing using Fenton has not met the quality standards. In accordance with the Minister of Environment Regulation No. 59 of 2016, concerning Lindi Quality Standards for Businesses/Activities of Final Processing Sites. Because it still contains COD, BOD that has not met quality standards. Therefore, it is necessary to do a second treatment by adsorption. After getting the optimum time in each treatment process using Fenton followed by adsorption using a column with an activated carbon height of 20 cm for 120 minutes.

Adsorption with activated carbon can be one of the advanced treatments due to the presence of a large pore and surface area [16]. Organic pollutant molecules can be absorbed on the pore wall or surface of activated carbon, so that COD and TSS in the waste will drop [17].

Fenton oxidation continues with adsorption with activated carbon can be seen in Figure below.

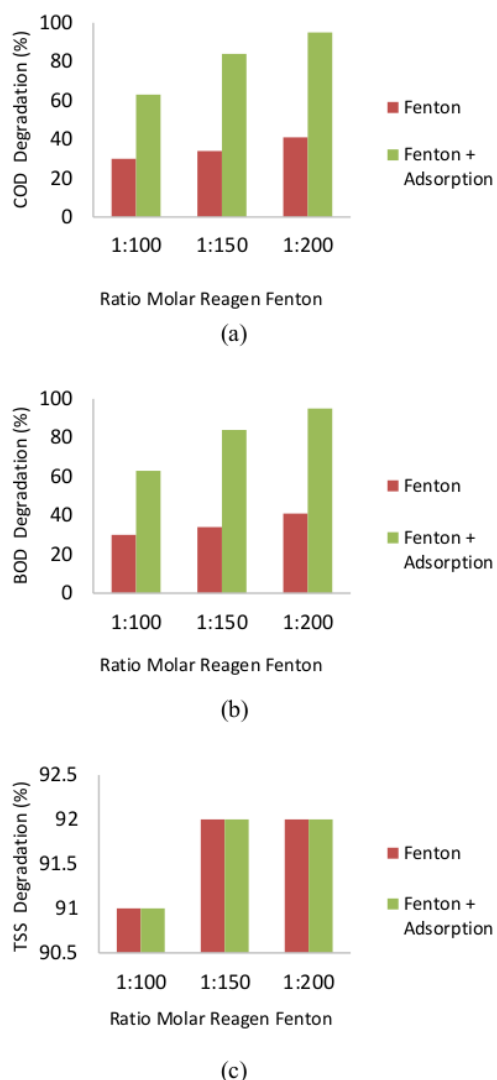


Figure 2. Fenton oxidation continues with adsorption with activated carbon (a) COD, (b) BOD), (c) TSS

Figure 2 (a)-(c) shows oxidation with Fenton (using the Fenton ratio and the optimum time) is the Fenton 1: 100, 1: 150 and 1: 200 molar ratio with 120 minutes continued adsorption with 20 cm column bed height and filled with granular activated carbon with 60 cm adsorption column height. the optimum conditions were achieved at a molar ratio of 1: 200, stirring time of 120 minutes, and adsorption using 120 minutes of activated carbon where the maximum decrease in COD, BOD and TSS achieved was 95%, 95% and 92% with a final concentration of 96 mg/L,

25.5 mg/ L and 90 mg/L and has met the quality standard to be discharged into the environment. In accordance with Minister of Environment Regulation No. 59 of 2016, concerning Leachate Quality Standards for Businesses/ Activities of Final Processing Sites [18].

In Figure 2 (c), it can be seen that with the increase in the molar ratio of addition of adsorption, it can actually be seen visually decreasing TSS, because TSS has been filtered before being analyzed so that the decrease in TSS with adsorption is not clearly seen. Based on this, it can be concluded that leachate treatment with Fenton combination and adsorption can process leachate in Talang Gulo landfill, Jambi City. So that it meets the quality standards and is safe to dispose of in the environment and does not cause groundwater pollution.

CONCLUSION

Leachate processing using the Fenton method using a concentration of 1: 200 achieved a decrease in COD by 41%, BOD by 41% and TSS by 92% with a final concentration of 1150 mg/L, 301 mg/ L and 98 mg/ L. Decrease in leachate processing using the best Fenton method at 1:200 molar ratio. Continued adsorption of COD decreases by 90 mg/L, BOD 25.5 mg/L and TSS by 90 mg/L and has met the quality standard for disposal to the environment. In accordance with the Regulation of the Minister of Environment No: 59 of 2016, Regarding the Quality Standards of Leachate for Businesses/Activities of Final Processing Sites. The molar ratio of $[\text{Fe}^{2+}]$: $[\text{H}_2\text{O}_2]$ the best is 1: 200 and the best time for Fenton in leachate processing is 120 minutes.

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