Modeling Kinetic Growth Rate at Effect of Palm Oil Fronds and Zeolite ($NaHCO_3$) Utility in Palm Oil Mill Effluent Process Treatment

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ABSTRACT

This study aims to analyze and examine the effect of the use of palm fronds, and Zeolite (NaHCO3), the processing of palm oil mill effluent, which aims to reduce levels of COD palm oil mill effluent, to comply with quality standards issued by the Ministry of Environmental Living No. Kep-51 / MENLH / 10/95, where's final COD waste can be discharged into the environment is 350 mg / L, in this study also determine a suitable model, the cell growth curve modeling the microorganism used in the processing of oil mill effluent oil, as well as the impact of the use of agents thixotropic to process the COD reduction of waste.

Results of the study showed, that the use of palm frond at 100 grams, is able to gain COD removal efficiency of 90.6%, whereas without the use of palm fronds only 33.3%, with a duration of 8 days diving sewage treatment, whereas the addition of thixotropic agent, can improve COD reduction of waste by 320 mg / L for 10 days, it is within their premises Ministry of Environment standards, while a suitable model to model microorganism cell growth curve is Contoins model.

***Key Words**: Waste Water Palm Oil, COD, Palm Fronds, and Zeolite*

5. INTRODUCTION

Currently, Indonesia has one of the largest CPO producer in the world, which is included in the CPO commodity food industry. Known in 2012 Indonesia's CPO production reached 26.5 million tons of CPO, and in 2013 is predicted to reach 28 million tons (SawitNews, 2013). CPO production continues to increase causing a negative impact, as a result of a byproduct in the form of waste also increased, and the potential to pollute with the environment (Ditjen PPHP, 2006).

As an illustration for a palm oil mill, which has a production capacity of about 60 tonnes of fresh fruit bunches per hour (FFB / h), can produce water waste palm oil reached 650 m^3 / day with operating time of 20 hours the number of TBS reaches 1000 tons (Darnoko et al., 2006).

POME is waste produced palm oil mill can used as organic fertilizer, but the wastewater can not be directly applied to agricultural land, because the content of COD (Chemical Oxygen Demand) is still high, ranged between 25000-50000 mg / L for POME aged 75 days (Wadansari, 2009), so it is not feasible to use because it can pollute the waters environment. In order to meet the quality standards of raw sewage, then POME must pass through a couple of processes, which among others, through the process of anaerobic fermentation and aerobic (Wadansari, 2009).

To obtain the results of the processing of waste in accordance with the standards Ministry Living Environments No. Kep-51 / MENLH / 10/95, which states the end result of processing waste must have the COD of 350 mg / L, and a BOD of 100 mg / L. Processed system applied must have a technology that is efficient and environmentally friendly, so can applied in the process of final waste palm oil mills treatments. Previous research has suggested that the use of process technology waste water palm oil mill treatments, produces a rich end result of processing water waste with different characteristics depending, for example technology facultative treatment still much used mainly by processing mills, shows the efficiency of removal of COD by 91%, with retention time for 18 days, while research has been done by Ujang et al. (2005), sewage treatment aerobic use substrate fiber made of palm, have result removal efficiency of COD by 80%, with a span of 11 days, in other research, waste treatment aerobically without the addition of the substrate, obtained by the removal efficiency of COD by 50%, for 60 day (Abdullah et al., 2013), where this research needs to be done in order have result removal efficiency values were better, with a time range that is used over a very fast pace.

2. THEORETICAL BASIC

Processing oil palm fruits to be CPO (Crude Palm Oil) produces various types of waste. From plantation generated waste stem of the palm, and after arriving at the processing plant will produce two types of waste, namely, waste water and solid waste, to the type of solid waste generated is empty fruit bunches, shells and fruit fiber palm, while the water waste produced from POME (Palm Oil Mill effluent) (DG PPHP, 2006).

In general, the treatment of wastewater in the palm oil mill through several processes including, open Systems ponding, i.e. conventional biological wastewater treatment are based on anaerobic and aerobic decomposition process by certain microorganisms to break down organic pollutants in several pools lawyer and pond sediment separation (Wandasari, 2009), the general reduction process is anaerobic wastewater treatment system using bio digesters, with by using a pool with a depth of over 5 m with a time of treatment during 60-70 days, while in an aerobic treatment time for 21 day (Ditjen PPHP, 2006).

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The process of treatment of waste by using processing system aerobic, the system cost is quite large, this is due to the process required air flow minimum, the aeration in waste, because the power required is quite large (Mohammad et al, 2003), generally in the process of processing waste aerobically, stirred process is required, in order to distribution air into the waste more quickly and evenly. In the aerobic wastewater treatment processes that use microorganisms (Ritman and Mc Carty, 2002), which as a whole can be seen in Figure 1,

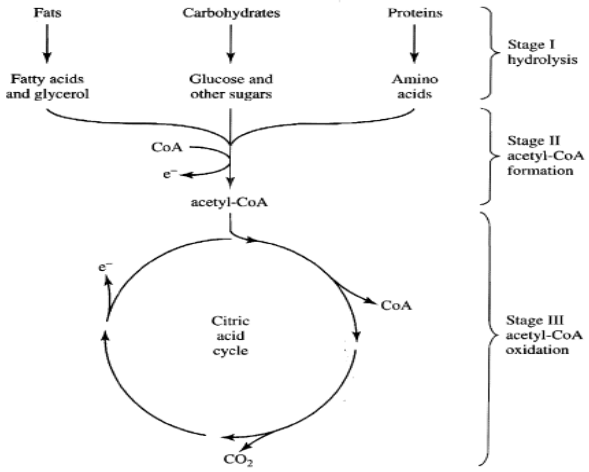

Figure 1. Step of Degradation Organic Sewage in Aerobic Process

Aerobic processing treatment with the help of microorganisms, aims to make the process of degradation of the waste so much faster, so that the process can be more efficient, so that the final processing results can be eco green products (DG PPHP, 2006)

The use of micro-organisms in sewage treatment, require a substrate as a medium to grow the cells, can substrate form elements of organic contained at sewage itself, as well as additional substrates from other sources (Fogler, 2004), the waste oil known to have large part contain organic materials such as fatty acids and amino acids, add some non-organic in small quantities (Wandasari, 2009) , it is known that frond is one waste of plantation palm oil, which utility still lacking, this study will try use of frond palm as substrate addition, since it is known that the fronds has value nutrition high enough good of nutrition organic and non-organic (Ditjen PPHP, 2006), so the potential to be a medium growth of microorganisms cells.

Besides fronds and Zeolites can also be used as place attached to the cell microorganisms, especially for bacterial nitrite, and bacteria solvent phosphates, like other research conducted by Rasti (1999), add Zeolite by 10%, can create growth and an optimal environment for cell microorganisms. Aside from being a microorganism cell fastening Zeolite is also useful as an agent thixotropic the water waste solution, this is because the ability of zeolite which

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can reduce shear stress (Shear Stress) of the solution, along with the length of stirring (Barnes, 1997)

The stirring process need the electric power, the amount of which depends the stirring speed, parameter of reactor, the density of the waste, and the parameters large of pedal stirred, because the parameters of the reactor, pedal stirrer, and speed stirred have considered of power value, in cell growth of microorganisms increased number of TSS (Total Suspended Solid) (GOW, 2009), which have an impact on changes in density values, which interaction empirical equation between power needs to change the density, and the amount of TSS can be seen in Equation 1 (Casa et al., 2006),

$$P = \mu_a \gamma^2 V \qquad (1)$$

Where P is the required power (kW), γ is a shear rate (s^{-1}), μ_{app} is caused by the viscosity of stirring (Pa.s) and V is the reactor volume (m^3), where the value of μ_{app} can be calculated using Equation 2, the following:

$$\mu_{app} = K\gamma^{n-1} \qquad (2)$$

$$\gamma = \left(\frac{\rho\epsilon}{K}\right)^{1/(n+1)} \qquad (3)$$

Where ε is the amount of empires energy input can be written using the following equation:

$$\epsilon \approx N^3 D^2 \qquad (4)$$

While n and K can be written in the form of empirical equations as follows:

$$K = (8.9(TSS)^2 - 80.7(TSS) - 70.4)10^{-3} \qquad (5)$$

$$n = (996 - 44.7(TSS) + 0.6(TSS)^2)10^{-3} \qquad (6)$$

For values of n and K, is only valid for the fluid solution have Shear Rate value 1-80 s^{-1}, to the temperature must be above 20 0C (Chisti and Haza, 2002).

Throughout the growth of the microorganism cells, in growth rate can used some models, one of which is using the model Contoins, this model has a sensitivity that is almost the same as the model of Monod, who make into is the value kinetics B, which are model equations Contoins (Gomez, 2011), which can seen in the following equation:

$$r_g = \left(\mu_{max} \frac{C_s}{B.C_c + C_s} - k_d\right).C_c \qquad (7)$$

Where μ_{max} is the maximum cell growth rate, Cc is the cell concentration (mg / L), Cs is the concentration of substrate (mg / L), and B is the cell growth kinetics parameters (kg VSS (kg COD) $^{-1}$) (Gomez, 2011) ,

3. METHODOLOGY

In general, this research method uses the help of cell cultures of microorganisms, which is obtained from the activated sludge coming from effluent

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pool aerobics at a palm oil mill, which through some stage preparation of cultured cells, to fronds, zeolite, and Sodium Bicarbonate (NaHCO3), as follows :

Preparation Cell Culture Microorganisms

Culturing microorganisms in this study using the media as much water as 4L, which is then added 200 grams of sugar, 25 g of urea, 10 grams of TSP fertilizer, which is then stored on
room temperature, between 27-30 0C, and aeration is done every day, and pH control is done every day, by conditioning the value is in the range of pH 6 to 7.2, and when the pH is too acidic can be done adding 6N NaOH, and when the state too it can be done adding alkaline solution of 6N H2SO4, and the addition of activated sludge from palm oil mill waste by 5% (v / v) (Charlena, 2011).

Preparation of Water Waste and sheaths

Water waste used in this study came from the influent primary aerobic pond is on palm oil mill PT. Dwi Mitra Daya Riau with COD values with range of 2000-5000 mg / L. while the palm fronds taken from oil palm plantations in the area around Pekanbaru, where only part of the stem of the fronds taken, while the leaves are not. Number of fronds taken as much as 20 kg, then the palm frond stems chopped with chopper machine, to obtain an average size of 1-2 cm, then the sheath results in weighing chopped back, followed by drying in the sun for 1-2 days to reduce levels water, and keep the fronds to prevent rapid decay.

Preparation zeolite and Sodium Bicarbonate

Sodium Zeolite made by mixing the sodium bicarbonate with zeolite, the number of 50 g of sodium bicarbonate with 100 grams Zeolite in a state shaped solid powder, wherein the powder of sodium bicarbonate and Zeolite stir until evenly mix between Potassium Bicarbonate with zeolite, to obtain a comparison both with the ratio of 1: 2 (w / w) (Schulmann, 2013).

Use of Cell Culture

The minimum amount of the microorganism used in the decomposition of 1 kg of liquid substrate is at least 0.4 grams of cells. So the number of culture needs microorganisms to process per 1 kg of waste.

Stirring and aeration reactor

Stirring waste assisted by electric motor, using a mixer that uses a four-leaf impeller, with stirring time for 24 hours, with a stirring speed of 200 rpm setup, where stirred design can be seen in the figure below:

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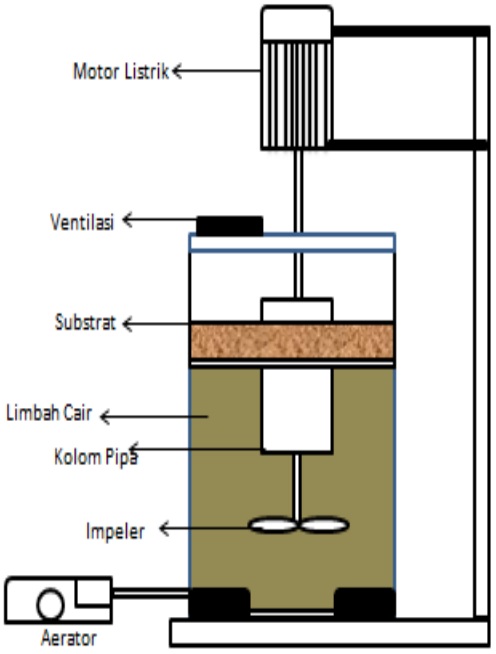

Figure 2. Waste Water Reactor Batch Treatment Design

Measurement of Physical Parameters include the physical and chemical measurements

Measurement of temperature, TSS, VSS, and the density of the water waste, whereas chemical measurements include: pH, COD, carbon, potassium, nitrogen, and phosphorus.

1. Measurement of temperature and pH, use thermometer, and pH meters.
2. Measurement of COD using standard APHA, 1998 (GAW 2009), while the TSS and VSS use Standard APHA, 1998 (GAW 2009).
3. Measurement of carbon, potassium, nitrogen and phosphorus standards use AOAC (2007).

4. RESULTS AND DISCUSSION

Initial characteristics Palm Oil Mill Effluent water waste used in this study came from CPO processing factory PT. Dwi Mitra Daya Riau in the village of Bukit Badak, where the waste is taken derived from primary anaerobic effluent pond with characteristics which can be seen in Table 1.

Table 1. Characteristics of Palm Oil Mill Effluent PT. Dwi Mitra Daya Riau

No	Parameter	Value
1	pH	5,4
2	Temperature (^{0}C)	28

3	*COD* (mg/L)	4300
4	N total (mg/L)	490
5	P (mg/L)	759
6	K (mg/L)	915
7	*TSS* (mg/L)	3700

The amount of COD in the palm oil mill effluent which amounted to 4300 mg / l, can not directly applied to the land because it does not conform to the quality standards of waste issued by the Ministry of Environment No. Kep-51 / MENLH / 10/95, the effluent quality standards mills, namely: 100 mg / L BOD, 350 mg / L COD, the final pH of 6-9, the end of the suspended material 100 mg / L (Wandansari 2009). Further processing is required so that the final waste obtained equal quality standards ..

Characteristics fronds of palm fronds used in this study came from the estate of citizens in the area Jl. Garuda Sakti Km. 2, Simpang Baru Village, District Tampan, Pekanbaru. With age of fronds used in this research is 6-7 years. With the content c, NPK on the stem of which can be seen in the following table:

Table 2. Nutrient on palm fronds are used in Research

Nutrient Content (w/w%)	Nitrogen	Phosphate	Potassium
Palm Oil Fronds	2.18	0.144	1.02

Addition Fronds Effect with COD Reduction

The process of wastewater treatment in this study, carried out aerobically, by using aeration air discharge at 4 L / min, with an initial trial with 4 treatment, wherein the amount of weight each fronds treatment are varied, and fronds inserted into the reactor using a batch mixer speed to 200 rpm, and based on the observation for 10 days each sample, have result relationship between the amount of data fronds by lowering the amount of COD.

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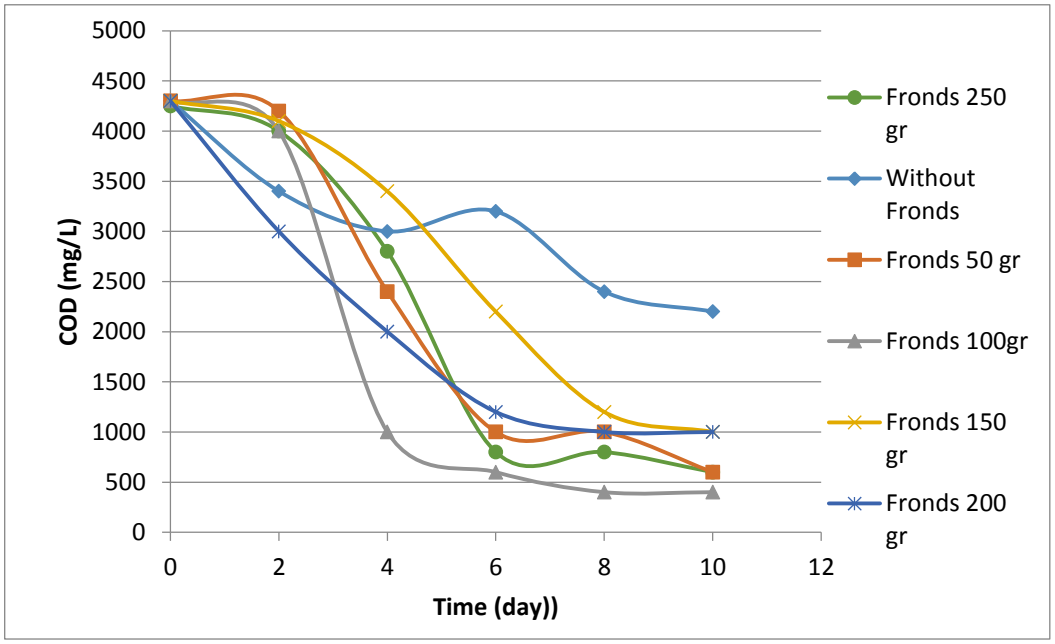

Figure 3. Graph The Relationship between the Changes of COD with Palm fronds Weight

Figure 3 shows the interaction between severe degradation of COD with palm fronds used in this study. In the figure 3 also shows that the use of stem of oil have an influence on the value of changes in COD, which in Figure 3 shows that without the use of stem of oil has an impact on changes in the value of COD in the process of wastewater treatment palm in this study, as shown in the chart by the treatment without using the fronds, which showed a decrease in the value of COD from time to time, it also shows that the batch reactors that work aerobically can function well for the process of wastewater treatment. While in Figure 3 also appears that the use of fronds with a weight of 100 grams addressed by the graph using the treated 100 grams fronds of palm , providing downward trend COD value significantly, where the initial values of COD is equal to 4300 mg / L, fell to 400 mg / L within 10 days, but the values of 400 mg / L still do not meet the quality standards of the Ministry Living Environment (Wadansari, 2009).

Chart with treatment using the stem of the palm as much as 100 grams in Figure 3 also shows the decrease COD of 4000 mg / L on day two, this shows that the process of decomposition has occurred, and in accordance with the expected purpose of this study, that the use of stem of the palm have a positive impact on Traffic reactor in decomposing waste, although downward is not so great, al is due to the adaptation process the cells of microorganisms in adapting to his new environment, which is a media fronds of palm, and condition is commonly referred to as condition phase lag (Mohammed et al ,. 2003). But when the fourth day onwards decreased COD seemed to significant, it is because microorganisms attached to the liquid waste and the fronds of palm began to be

in a growth phase, and the process of decomposition of organic solids contained in the liquid waste palm oil mill faster, THAT this shows that a growing number of microorganisms that help the decomposition process then lowering the value of COD is also better (Ujang et al, 2010)

Graph in Figure 3 shows the interaction between severe degradation of COD with palm fronds used in this study. Figure 3 shows that the use of stem of oil have an influence on the value of changes in COD, which in Figure 3 shows that without the use of stem of oil has an impact on changes in the value of COD in the process of wastewater treatment palm in this study, as shown in the graph with colored lines blue, which showed a decrease in the value of COD from time to time, it also shows that the batch reactors that work aerobically can function well for the process of wastewater treatment. Whereas in Figure 3 also appears that the use of fronds with a weight of 100 grams addressed by the graph in green, giving the change in value of COD significant, where the initial values of COD is equal to 4300 mg / L, decreased to 400 mg / L in 10 day, but the values of 400 mg / L still do not meet the quality standards of the Ministry Living Environments (Wadansari, 2009). The graph in green in Figure 3 also shows the increase COD of 6000 mg / L on day two, which is where the value is greater than the value of COD initially from water waste palm oil mills were used in this study, where the value of COD initially amounted to 4300 mg / L this is due to the decomposition process that contributes to increase in value of COD (Mohammad et al ,. 2003). But when the fourth day onwards occurred COD reduction, it is because microorganisms attached to the palm fronds participate in the decomposition of organic solids contained in palm oil mill effluent, it indicates THAT growing number of microorganisms which are helping the decomposition process then lowering the value of COD is also getting better.

Efficiency Degradation of COD Cause Using Palm fronds

In Figure 3 in each treatment contributes to the efficiency reduction in COD value in the wastewater treatment plant palm oil used in this study, where value of efficiency at each treatment can be seen in Figure 4:

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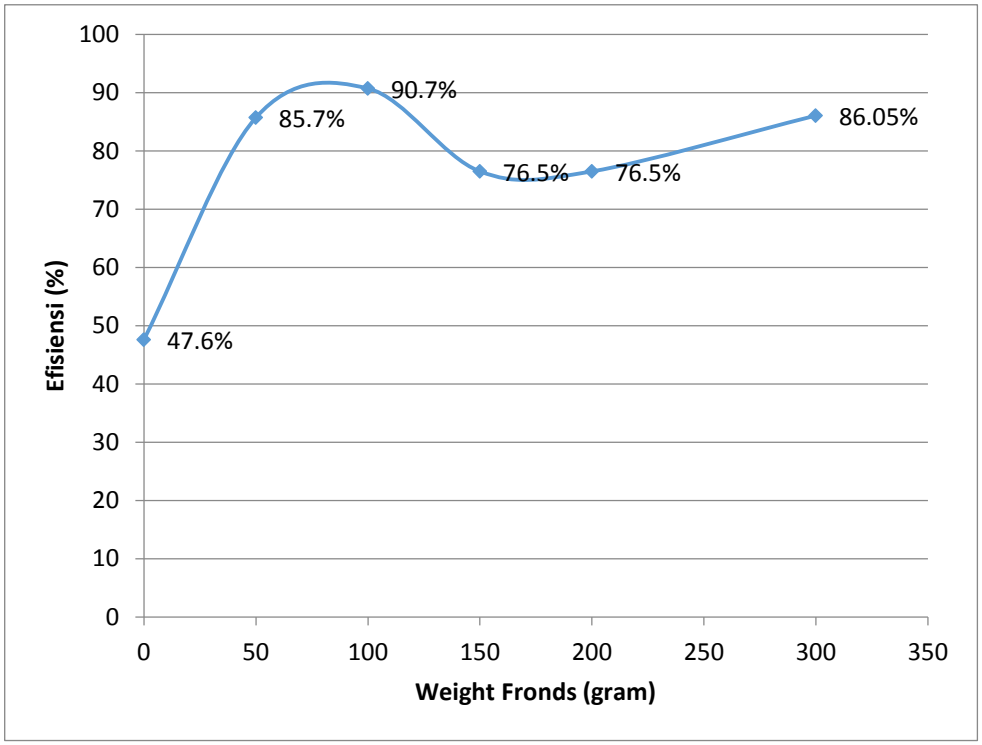

Figure 4. Graph The Relationship between the Weight of palm Fronds with Efficiency Degradation of COD

Figure 4 above shows that each treatment value COD removal efficiency of different values, but shown in Figure 4 at the time of treatment using the midrib weighing 100 grams gives COD considerable lowering efficiency optimum, where the amount obtained by 90.7% within 10 day, whereas with to value the efficiency of treatment without using midrib obtained by 47.6% within 10 days, this is due to the use of stem of the palm on the processing of POME contribute in improving the process of decomposition of COD, wherein the substrate frond palm acts as a medium for immobilizing cells microorganisms, known for some microorganism cells tend to be more active and grow optimally in media remain (Evans and Furlong, 2003), in addition to the substrate stem of the palm also provide some nutritional needs by cells of microorganisms used in the process of growth, and also contain mostly cellulose, which contains carbon is high enough, so that it can be utilized by the cells of microorganisms as cell growth promoter (David et al, 2014).

pH Interaction with Palm Fronds

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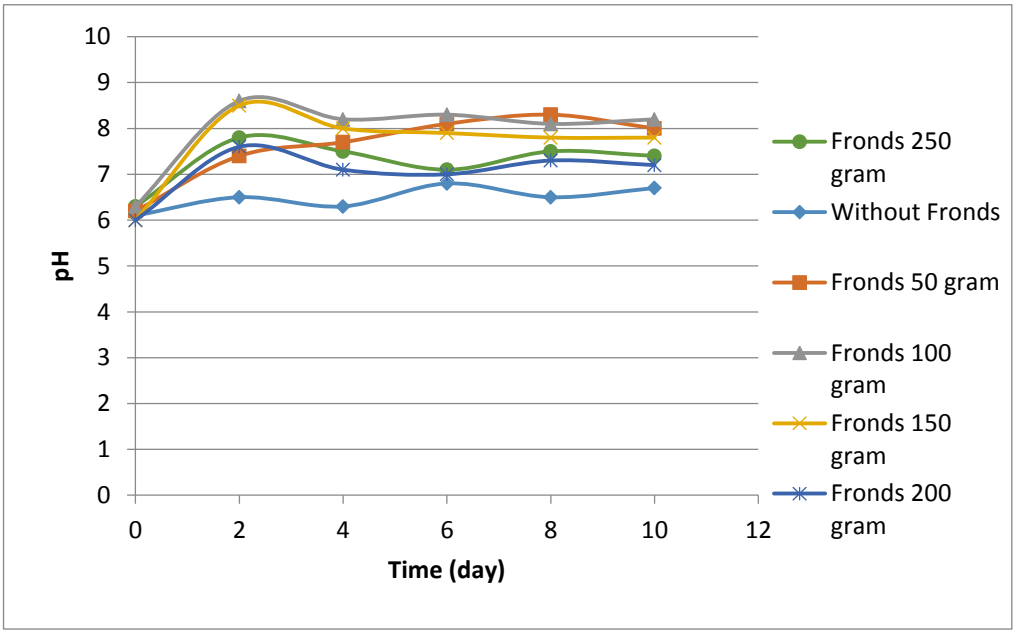

Figure 5. Graph interaction between pH by weight Fronds

In the process of decomposition of liquid waste palm oil mill in aerobic, changes in pH value can not be avoided, because of the processes of nitrification and denitrification, in which the aerobic conditions the organic nitrogen is converted into nitrite, which is then converted into nitrates with the help of microorganisms, and it's nitrate the greatest role in a decrease in the pH value (Muhammad et al,. 2003). This is shown in the graph is in Figure 5, wherein the pH value changes from time to time, and the pH range 7-9 which is an optimal condition for the formation of nitrate (Mohammed et al., 2003), so that fluctuations in the pH of the reactor used in this process is not a problem.

Effects of Changes in COD with addition of Zeolite (NaHCO3)

It is known that the interaction between the growth of microorganisms with Zeolite were acting as agents of inoculant microorganisms, as was done in the treatment of this study, by using a treatment using the addition of Zeolite and sodium bicarbonate, the composition compared one in two(1:2), where the interaction both with regard to the treatment of processing palm oil mill effluent on in this study, where the value of COD is a parameter that want changing, as shown in Figure 6,

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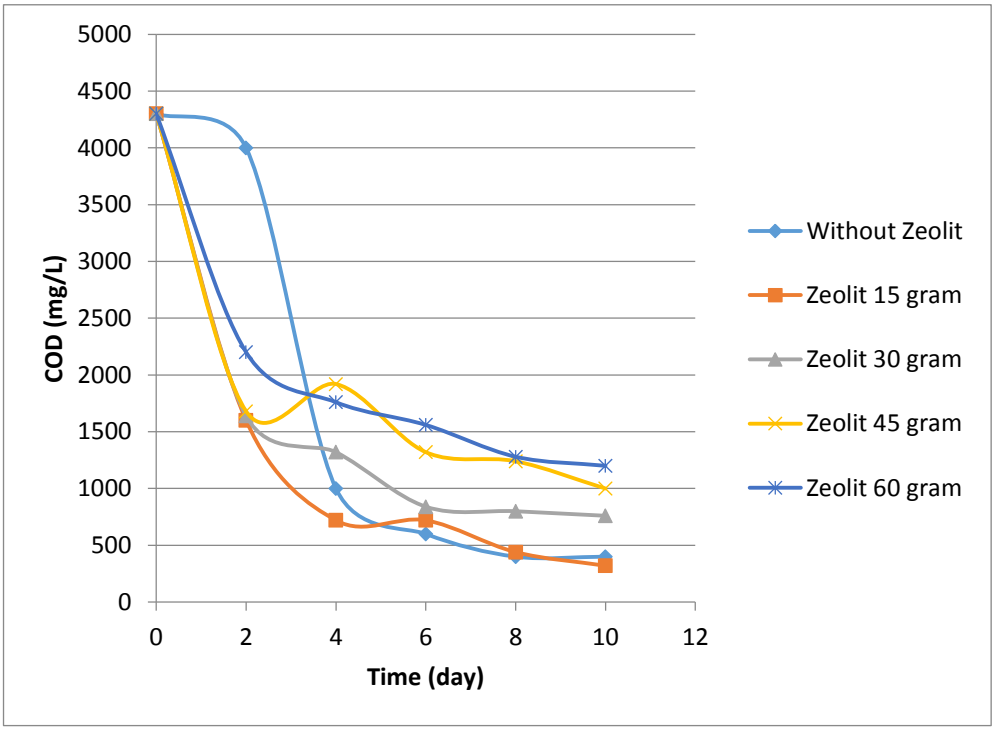

Figure 6. Graph interaction between the COD value of the weight of zeolite (NaHCO3)

In Figure 6 appears a graph that uses treated effluent treatment plant palm oil using the midrib weighing 100 grams, and without the use of Zeolite (sodium bicarbonate), showed a decline in the value of COD initially 4300 mg / L to 4000 mg / L, this is due the process of absorption of nutrients organic on the midrib used in the waste treatment process, where the impact has been visible at the beginning of sewage treatment, because in the process of waste decomposition, the decomposition process midrib also occur caused by microorganism cells derived from activated sludge wastewater oil factory Oil, which microorganism cells also play a role in changing the organic nitrogen from waste and midrib into nitrates, which in the process is in desperate need great amounts of oxygen, which is then converted back to nitrite, which in this process only requires oxygen in small amounts, as a result environment lacking oxygen as effect of the nitrification reaction (Ritmann and McCarty, 2002).

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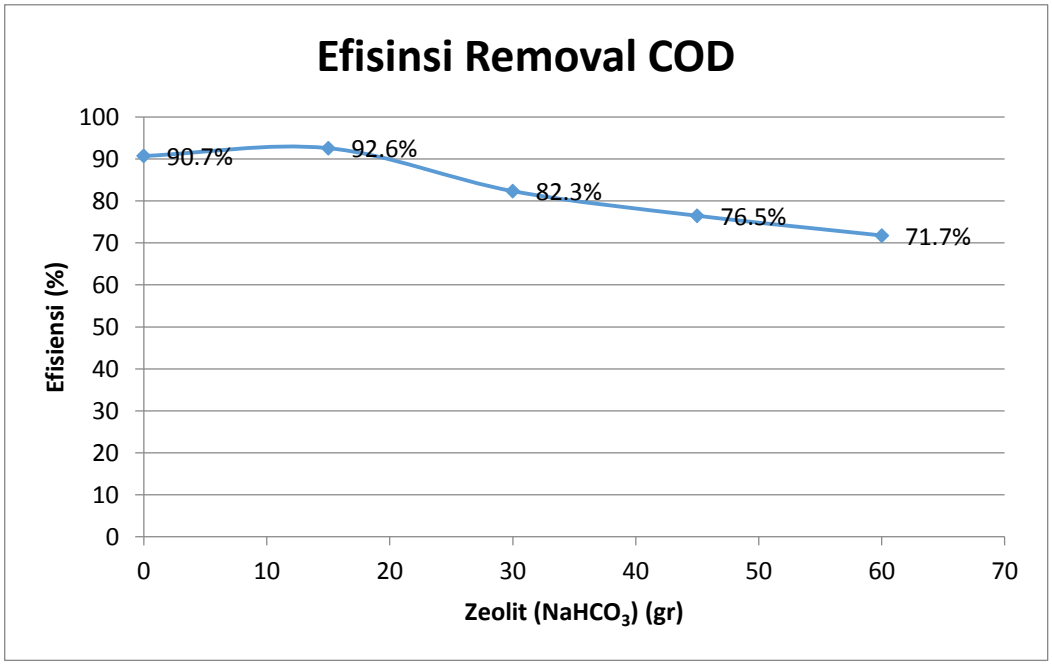

Figure 7. Graph Interaction COD Removal Efficiency of the zeolite ($NaHCO_3$)

In Figure 7 it appears that use of zeolites with a weight of 15 grams gives contribution COD reduction at its best, this matter as a result used of Zeolite ($NaHCO_3$), can reduce the efficiency of COD reduction of waste, due to the increase in pH due to adding $NaHCO_3$ excessive, causing delays nitrification, and denitrification, because in the process of nitrification and denitrification only optimally at pH 7-8 (Ritmann and McCarty, 2002)

The interaction between pH by addition of Zeolite ($NaHCO_3$)

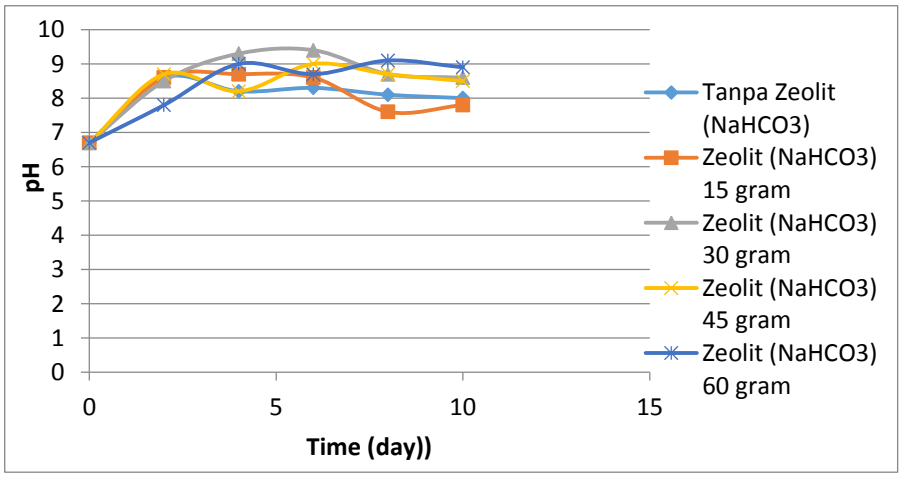

Figure 8. Interaction pH with Weight Adding Zeolite ($NaHCO_3$) Graph

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Seen on the graph that uses treatment without zeolite, and zeolite as much as 15 grams in Figure 4.8, the pH value in the two graphs do not look any significant surge, wherein the pH value in the range of 7- 8 (± 0.5), use can midrib caused the rise in pH at first, because the decomposition process midrib, process nitrification much more dominant, where it's nitrification who increase in the pH value, plus the presence of midrib placed with the surface of the waste, which caused circulations air for the better, with the aeration system Good then nitrification process can be occurred rapidly, and the equilibrium pH form again, because of the formation of nitrate and nitrification process will cause the state of the solution has a low oxygen content, the state is then continued with the process of denitrification, in which this process causes the decomposition process waste has a pH value that tend to be stable (Ritman and McCarty, 2002). While on the chart with the treatment of waste using the midrib 100 grams, and zeolite (Sodium Bicarbonate) 15 grams, there is also increased pH significantly, even on days eight and ten, pH decreased slightly, this shows the growth of microorganisms have good environment (Ochoa and Gomez, 2009), despite the addition of zeolite (sodium Bicarbonates) which tend to cause even though no significant increase in pH

Microorganisms Growth In Waste Water

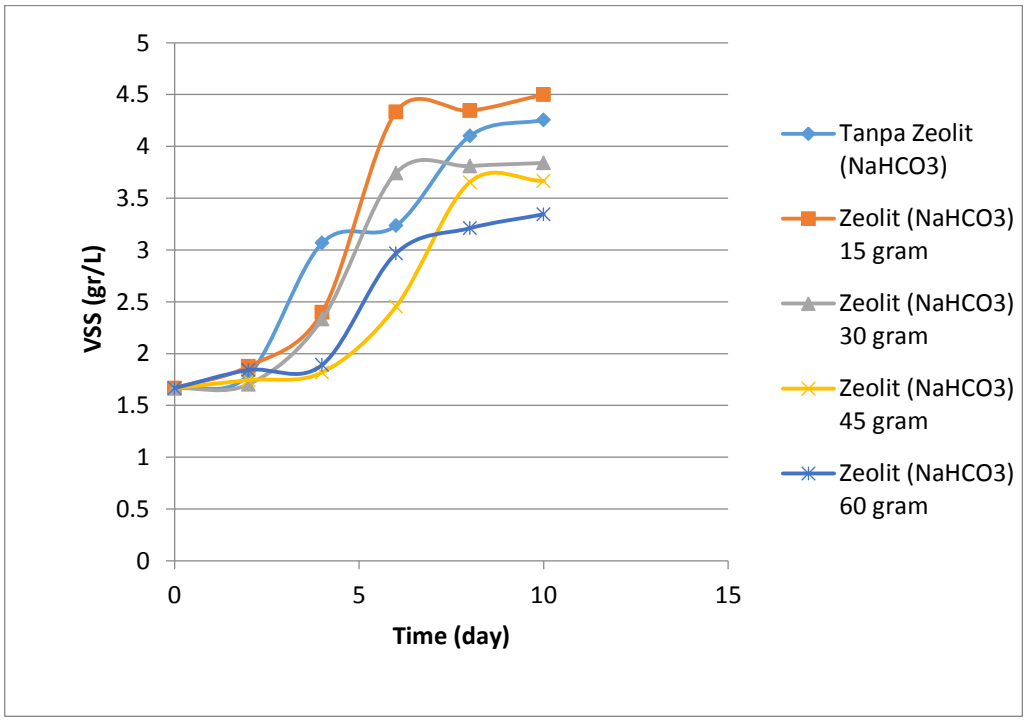

Figure 9. Graph interaction between weight changes VSS to weight Zeolite (NaHCO3)

In Figure .9, it appears that graph treatment with zeolite as much as 15 grams, shows the cell growth of microorganisms is quite optimum, when compared with the graphic treatment of others, it is because in addition to the use of Zeolite (sodium bicarbonate) as agents thixotropic, Zeolite (NaHCO3) as well as regulating the stability of pH in wastewater, make good for the growth of microorganisms cells. As an agent thixotropic zeolite (Sodium Bicarbonate) provide benefits in the process of mixing the liquid waste, which profit from stirring the liquid waste to be much more perfect, which caused the oxygen dissolved in the liquid waste is much better, and the temperature distribution of the waste to be evenly distributed, known that the temperature rise at above 5 0C waste from room temperature, to reduce Traffic of dissolved oxygen in the effluent (Aygun et al., 2012). Besides increasing the oxygen transfer performance, Zeolites can also making good environment by absorbing metals that can inhibit cell growth of microorganisms, such as metallic lead, so that the cell growth of microorganisms be grown better (Simbolon et al, 2008).

Modeling Growth Rate Cell Microorganism

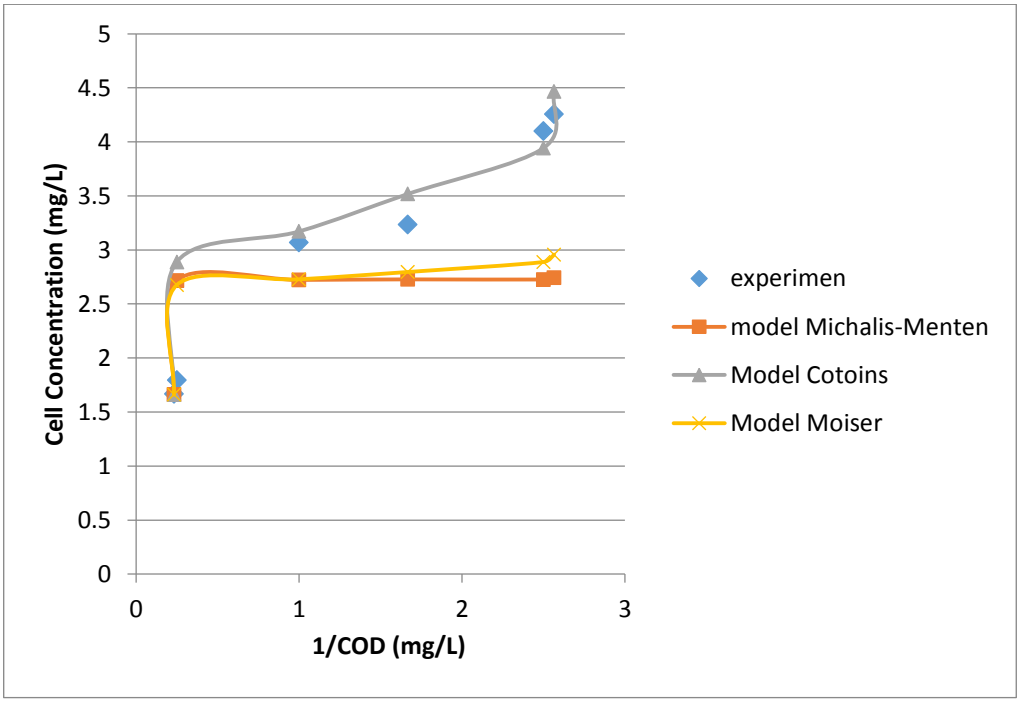

Figure 10. Interaction of Cell Concentration with Substrates (COD) Graph.

In the Figure 10 can be seen there are three models that describe the interaction between the specific growth rate of cells of microorganisms are grown in a substrate of organic waste originating from liquid waste palm oil mills, where

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the treatment is used for waste is to use a substrate an additional form of fronds of palm as much as 100 grams and zeolite (NaCO3) as much as 15 grams and liquid waste as much as 3 kg. Chart with a cross in Figure 10 shows the pattern of the rate of cell growth of microorganisms that use the model Michaelis-Menten, where the graph shows that in the initial state, namely when the amount of the substrate is equal to zero, then there is no cell growth of microorganisms, but with a concomitant increase in the number substrates the specific growth rate of cells of microorganisms growing in logarithmic, it they are due on the model of Michaelis-Menten simply explained that in the initial state or when cells microorganisms grown on media waste, yet are in the growth phase, or in other words a cell microorganism entered is cells that develop while on media growth is liquid waste palm oil mill, the rate of cell growth have not improved significantly because the model of Michaelis-Menten view that when the cells undergo deficits improve the number, then the cell will also produce a product that can inhibit cell growth itself, while on the model Cotoins shown by the chart pattern rhombus, where the case of cell growth is quite significant when compared Michaelis-Menten model, it cause Cotoins model have factors inhibiting specific growth rate of cells directly, in addition to the model Cotoins one of the factors that inhibit cell specific growth rate is a factor of death, where it's neglected (Gomez, 2011).

Thixotropic on Palm Oil Mill Effluent

Based on this research note density values initially of liquid waste palm oil mills used in empirically this, and before being subjected is 1.023 g / mL, but along with the treatment with the addition of cultures of microorganisms, stem of the palm, and Zeolite (NaHCO3), then change the density and viscosity of the waste, for example, to a liquid waste treatment using the stem of 100 grams, and with no additional zeolite (NaCHO3), the value of densities early beginning was 1.023 g / mL, on the tenth day turned into 1,038 g / mL, this is due to all the addition of microorganisms and midrib of palm on waste, which causes the release of solids contained in the wastewater, where the release is characterized by the increase in the value of TSS in wastewater from day to day, the increase of TSS is also affected from thixotropic nature of waste The liquid, because of the addition of cell culture treatment microorganisms, palm fronds, and zeolite (NaCHO3).

It is known that the nature thixotropic fluid is the ability of a material to lower the shear stress (Shear stress), and the viscosity of a fluid (Fluid), along with the length of stirring, where the length of the stirring is usually represented by the value of the Share Rate (Barnes, 1997), where interaction both can be seen in Figure 11.

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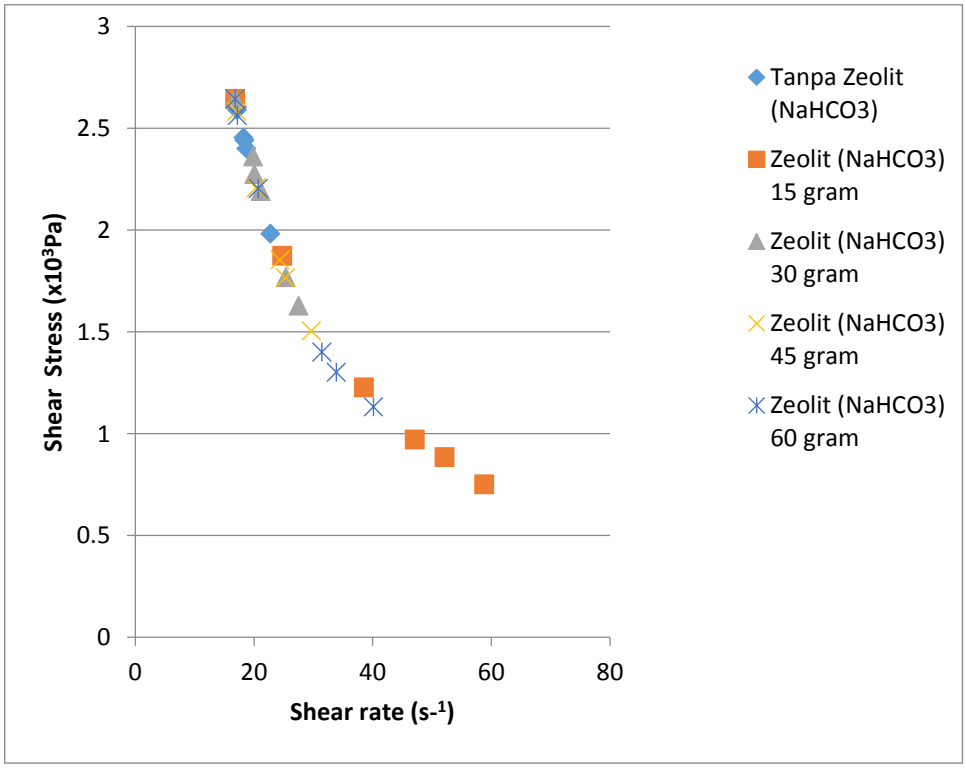

Figure 11. Interaction of Shear Stress and Shear Rate in Stirred Waste Water

In Figure 11 it appears that all treatments provide trend values are declining, indicating that all the waste treatment process the magnitude of the shear stress has decreased, but the value is different for each treatment, as shown in the chart point of blue, where the value decline value of shear stress is not so significant when compared to other wastewater treatment, this is due to the blue chart, sewage treatment does not use the addition of Zeolite ($NaHCO_3$), which in this study acts as an agent thixotropic. As for graphics dots red, showed significant change in the value of the shear stress at wastewater using the treatment use of Zeolite ($NaHCO_3$) at 15 grams, this is due to the use of zeolite (NaHCO3) which as an agent thixotropic can play optimally in lowering the value of the shear stress of the liquid waste used in this study, because the use of Zeolite ($NaHCO_3$) for 15 grams of providing optimal conditions of stirred process waste and waste growing conditions, due to the use of Zeolite ($CaCO_3$) as much as 15 grams with a comparison between the zeolite with NaHCO3 at 2: 1, the optimum pH conditions can form, i.e. in the range of 7-8 (± 0.5) (Mohammad et al., 2003). As for the graphics green dots, purple, and blue light contained in Figure 4.14 experiencing a trend decline in the value of the shear stress, but not so significant when compared with point chart red contained in Figure 11, this is due to the growth of microorganisms less optimal. Model shown the chart in blue, red, green, purple, and blue in Figure 4.14, shows the type of agent thixotropic formed a kind of type thixotropic non-linear or so-called inelastic thixotropic, where these properties is state solution fluid is stirred together with the use of

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thixotropic agent from time to time can not be returned to its original nature, although there is now a process of pacification of the solution, where this can be caused by several factors (Barnes, 1997).

1. The similarity in the direction of the particles similar to fibers, during the mixing process.
2. A change in the composition of microstructures that exist in suspended solution and emulsion during the mixing process.
3. Fouled of mud clot.

5. CONCLUSIONS

Conclusions From this research obtained some conclusions as follows:
1. The use of sheaths At 100 grams for a reactor with a capacity of 3 kg of waste, providing COD removal efficiency of 90.69% within 10 days, and provide the most optimal efficiency then treated wastewater use fronds on the other.
2. The use of agents thixotropic Zeolite (NaHCO3) at 15 grams, lowering COD increase in palm oil mill effluent that is used in this study, which previously amounted to 4300 mg / L to 320 mg / L, with a duration of treatment for 10 days.
3. Use of an agent in the form thixotropic Zeolite (NaHCO3) at 15 grams, can reduce COD in accordance with quality standards issued by the Ministry of Environment No. Kep-51 / MENLH / 10/95.
4. The use of zeolites ($NaHCO_3$) can reduce (Shear Stress) of the waste solution.

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