Vinasse Treatment With Aerobic Microbial Method Using Activated Sludge

I Utami*, D B Kautsar, R F Akbar, S Muljani

Chemical engineering Department, Engineering Faculty, University of Pembangunan Nasional “Veteran” East Java, Jl. Rungkut Madya, Gunung Anyar, Surabaya, East Java, Indonesia 60294

*isniutami@yahoo.com

Abstract. Vinasse liquid waste in this study obtained from the ethanol industry which has organic load of COD of 202,232.14 mg/L and BOD of 32,911.47 mg/L. Aeration is used to operate the activated sludge process unit to remove BOD from wastewater in the aerobic microbial method. The research was conducted by conditioning 3L of vinasse wastewater at pH 7 by adding 1 N NaOH, then the acclimatization process was carried out for 24 h using activated sludge with concentration of microorganisms is 13.578 g/L and 5 L/min of air flow rate in the aeration tank. The processing of vinasse wastewater 3L at pH 7 was carried out on the addition of acclimatized activated sludge microorganisms with quantity 13,578 through 40,734 mg and aeration times in the range of 2 - 10 h. Removal of organic matter from vinasse waste by activated sludge can be associated with the growth of microorganisms. The results showed that the addition of 40,734 mg of microorganisms for 8 h of aeration obtained the COD removal of 69.27 %, and BOD of 96.652%.

Keywords: Vinasse, Aeration, Microorganisms, Sludge

1. Introduction

The ethanol production includes fermentation and distillation with raw materials derived from plant biomass. At the end of the distillation process, waste disposal is called vinasse, a residue that is rich in organic matter and it is composed by the non-volatile compounds present in the ethanol fermentation tank, as yeast and sugarcane proteins [1], cell debris, phenolic structures, and other complex molecules. Vinasse is often used as fertilizer, but the use of large quantities can increase the soil load and pollute the surrounding water bodies [2,3].

Vinasse is a wastewater from bioethanol production with a very high concentration of organic matter, usually from 40 to 80 g COD L⁻¹ [4]. The presence of phenolic compounds (8,000 - 10,000 mg / L), melanoidin, caramel and furfural components contribute to color and make vinasse a complex and difficult waste water for degradation. Acidity level of vinase is quite high, namely pH which generally ranges from 3.5 to 5.0, brownish in color (indicated by melanoid) and high electrolytic conductivity (250-300 dS / m). The organic load in vinasse is very high with biochemical oxygen demand values ranging from 35,000-50,000 mg O₂ / L and chemical oxygen demand ranging between 70,000-150,000 mg / L. While the biodegradability index of vinase [1-7] is generally in the range of 0.2-0.7 mg BOD/mg COD [5].

The purpose of biological treatment is to eliminate or reduce the concentration of organic and inorganic compounds [6]. The biological process for wastewater treatment consists of mixed communities with various microorganisms. In the suspended growth process, there are
microorganisms responsible for processing, the waste is maintained in liquid suspension with the right mixing method. Many suspended growth processes are used in municipal and industrial wastewater treatment that are operated with positive dissolved oxygen (aerobic) concentrations. The addition of oxygen is one of the efforts to treat these pollutants, so that the concentration of pollutants will be reduced or even completely eliminated. One way to add oxygen is the process of entering pure air or oxygen into wastewater through a porous or nozzle object. [8,9] If the nozzle is placed in the middle, it will increase the speed of contact with the air bubbles with wastewater, so that the process of giving oxygen will run faster. Therefore, this nozzle is usually placed on the bottom of the aeration tank. The air entered from outside which is pumped into the wastewater by a compressor. Vinasse waste treatment is generally carried out using anaerobic microbial method in a UASB reactor [10-15], fluidized bed reactor [16,17], and physicochemical treatment [18]. Membrane technology [19] makes it possible to obtain high quality waste with perfect biomass retention, but high biomass concentration can cause membrane fouling. Another research about the reduction pollutants concentration using biological wastewater process with Rotating Biological Contactors (RCBs) using one of the Aerobic bacteria, *Acetobacter Xylinum* to reduced the BOD value from 2,006 mg/L to 1,023 mg/L. [20]. In the previous study, about the processing of petroleum wastewater in aerobic batch process with 2 h aeration time and microorganism concentration of 1,600 mg/L, the percentage of COD reduction was 86.35% and BOD reduction was 83.99%. The highest COD and BOD reduction were 67% and 75% [16, 21]. The high organic load causes aeration treatment using microorganisms often less successful in reducing the COD or BOD of vinasse waste. However, this study developed a microbial aeration method using activated sludge from the integrated waste treatment industry to process vinasse. To what extent the performance of activated sludge has been the focus of research by measuring the percentage of BOD/COD removal. The levels of COD and BOD of vinasse from ethanol industry in this study was 202,232.14 mg/L and 32,911.47 mg/L respectively.

2. Materials and Methods

2.1. Materials
The materials in this research is vinasse liquid waste taken from PT. Energi Nusantara Agro which has COD levels 202,232.14 mg/L, BOD levels 32,911.47 mg/L, and pH 4. Activated sludge obtained from PT. Surabaya Industrial Estate Rungkut with microorganism concentration 13.578 g/L. Vinasse treatment is carried out in an aeration tank that has length 100 cm and width 20 cm as shown in Figure 1.
2.2. Acclimatization process
The neutralization process was carried out on vinasse liquid waste by adding 1 N NaOH solution, until pH 7, after that the 3L of activated sludge containing 13.578 g/L of microorganism was adding into aeration tank. Next step is vinasse liquid waste is put into aeration tank as much as 3L. After that, an aeration process was carried out for 24 h by flowing air using a compressor with an air flow rate is 5L/min. After 24 h the remaining water is removed, and activated sludge from this acclimatization process is used for the waste water treatment process.

Vinasse treatment.
The vinasse liquid waste was carried out the neutralization process until pH 7. The initial COD and BOD content was analyzed. The acclimatized activated sludge microorganisms were added as MO1 = 13,578, MO2 = 20,367, MO3 = 27,156, MO4 = 33,945, MO5 = 40,734 mg into aeration tank. Vinasse is put into aeration tank as 3L. The aeration process is carried out in a time for 2, 4, 6, 8, and 10 h by drain the air using a compressor with an air flow rate 5L/min. Sampling is carried out every aeration period for analysis of BOD and COD.
COD analysis is used to show the amount of oxygen needed to decompose all organic matter contained in wastewater. This analysis using a strong oxidizer, which is potassium bicarbonate in acidic conditions and by increasing the silver sulfate as catalyst, so that all types of organic matter, both biodegradable and difficult to decompose, will be oxidized. BOD analysis is used to show the amount of oxygen needed by microorganism to decompose all organic matter under aerobic condition.

3. Results and Discussion
3.1 Growth of microorganisms
Figure 2 showed the correlation of aeration time to the concentration of microorganisms (MO). The concentration of microorganisms is increase with the addition of aeration time. The longer of aeration time cause the greater concentration of microorganisms obtained. This is due to the longer aeration time, would cause the more sludge growth so that the concentration of microorganisms increases. The highest concentration of final microorganisms was 52.9214 gr/L which was found in the addition of initial activated sludge of MO5 = 40,734 mg and 8 h aeration time.

![Figure 2. Correlation of aeration time to the concentration of microorganisms](image-url)
3.1. COD removal

Figure 3 showed the correlation of aeration time to the COD removal. The addition of aeration time from 0 to 8 h can be decreased the COD when approving the initial activated sludge microorganisms of MO1= 13,578 to MO5= 40,734 mg into vinasse of 3L. The percent of removal in COD is directly proportional to the time of aeration, where the longer the aeration time, the greater of percent decrease in COD obtained. This is because the longer the aeration time, cause more organic matter decomposes into carbon dioxide and water by microorganisms in the activated sludge. The highest percentage of COD removal was 69.237% it found at 8 h aeration time and the addition of initial activated sludge microorganisms was 40,734 mg and the final concentration of microorganisms was 52.9214 gr / L.

![Figure 3. Correlation of aeration time to the COD removal](image1)

![Figure 4. Correlation of aeration time to the BOD removal](image2)

3.2. BOD removal

Figure 4 showed the correlation of aeration time to the BOD removal. The longer the aeration time from 2 to 8 h, the greater the percent removal of BOD obtained. This is due to the longer the aeration time, the more organic matter decomposes into carbon dioxide, water and ammonia gas by activated sludge microorganisms. The highest percentage of BOD removal was 96.652% which was found at 8 h aeration time and the addition of 40,734 mg activated sludge microorganisms which the final microorganism concentration was 52.9214 g / L.

3.3. Effect of aeration time on pH value

Figure 5 showed the effect of the aeration time on the pH value of the addition of the initial activated sludge microorganisms 13,578 to 40,734 mg into vinasse liquid waste of 3L. On the results of changes in pH value, when used for 10 h of aeration time obtained a pH value below 6, which is pH 5.2 - 5.6 so it is recommended aeration time for 8 h so that the pH value remains in accordance with the quality standards of 6-9. The lowest pH value was 5.2 which was found at 10 hours aeration time and the initial addition of activated sludge microorganisms was 40,734 mg.
4. Conclusion
The processing of vinasse treatment by aerobic microbial methods using activated sludge can reduce the levels of pollutants by breaking them down into safer and more stable substances such as carbon dioxide, water and ammonia gas. The high removal of COD and BOD levels was 69.273% and 96.652% in the 8 h aeration period. The removal of organic material from vinasse waste by activated sludge process can be attributed to the growth of microorganism. The addition of initial activated sludge microorganisms was 40.734 g and the final microorganism concentration was 52.9214 g / L pH value 6.1. The 10 h aeration time is not recommended because it can provide a pH value below 6 which is pH 5.2 - 5.6. should be avoided whenever possible. If required they should be used only for brief notes that do not fit conveniently into the text.

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**Acknowledgments**

We would like to thank the PT Energi Agro Nusantara for providing the vinasse waste and PT Surabaya Industrial Estate Rungkut. We also thank to the team of Waste Water Treatment Research group, Chemical Engineering Department, UPN Veteran Jawa Timur.