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Research Article

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Ammonia and organic compound removal from dairy milk simulation wastewater by coconut shell (*Cocos nucifera*)

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ABSTRACT

One of organic compound which inhibits anaerobic waste water treatment is ammonia. Ammonia concentration can decrease with coconut shell as media in anaerobic wastewater treatment. This research using dairy milk simulated waste water. This research is studying ammonia concentration, COD, alkalinity, VFA, ammonia removal and COD removal after incubation 7 days. This research use square shaped reactor made of HDPE. The total Volume of the reactor is 12 L. The reactor mainly consists an influents port, effluent port and manometer. This research using anaerobic batch system. The reactor contained coconut shell activated carbon and dairy milk simulated wastewater after 7 days, the reactor is capable of ammonia and COD allowance for a maximum of 60.55% and 44.54% is the reactor with the addition of coconut shell activated carbon with an ammonia concentration of 1000 mg/L In this research also analyses the Scanning Electron Microscopy of coconut shell activated carbon after contact with dairy milk simulated wastewater.

Key words: Ammonia, biogas, Chemical Oxygen Demand

INTRODUCTION

Anaerobic digestion produced biogas Biogas consist some gas such as methane, carbon dioxide, and also other gas. The problems of low methane yield and process instability are often encountered in anaerobic digestion. Anaerobic digestion offers numerous significant advantages, such as low sludge production, low energy requirement, and possible energy recovery [1].

Biogas production can be decreased if the reactor conditions are not supported. Inhibitory substance are often found to be the leading cause of anaerobic reactor failure since they are present in substantial concentrations in wastewaters and sludge. Several factors that affect the stability of the anaerobic process can be derived from organic and inorganic compounds, such as ammonia, sulphides, metal ions, heavy metals, organic materials, and so on. But of some of these factors, ammonia is an organic compound that is often inhibits anaerobic processes mainly in the production of biogas. Biogas production will be reduced by the presence of inhibitors of ammonia in the anaerobic digestion. HRT may also have an impact on the increase in the amount of ammonia. In addition, the pH and temperature also affect the reactive of ammonia.

Highest ammonia concentration is the range of 5-200 mg N/L is used micro organisms as nutrients. Ammonia concentration of 200-1500 mg N/L did not significantly affect the micro organisms. The other side, the concentration of ammonia that can be inhibitors are currently on the value of 1500-3000 mg N/L. ammonia concentrations would be toxic to the anaerobic process if the concentration is more than 3000 mg N/ L [2].

One of the efforts to reduce the inhibitor properties of anaerobic ammonia and make the system more stable is to use the media. Ammonia can be removed by using a filter media, a media that is used to reduce the inhibitor properties

of ammonia, such as clay [3], activated carbon [4], Carbon Fiber Textile (CFT), zeolites [5], and etc. However, the use of such media requires a high cost. The research of [6] using coconut shell activated carbon for adsorption of heavy metals. Whereas there is less of studies using coconut shell activated carbon to eliminate ammonia. According to [7] the use of coconut shell activated carbon media to eliminate ammonia levels have been done, but the ammonia levels were set aside only in the range of 198 mg N/L to 3912 mg N/L. Whereas, if the ammonia will be the inhibitor concentration is 1500-3000 mg/L. This study examined the ability of coconut shell charcoal to eliminate ammonia at a concentration of 1000-3000 mg/L.

EXPERIMENTAL SECTION

Materials and instruments

The research used is a laboratory scale anaerobic batch system. It is a square shaped reactor made of HDPE. The total Volume of the reactor is 12 L. The reactor mainly consists an influents port, effluent port. This research use six reactor. Three reactors with code 0/1000; 0/2000; 0/3000 are reactor only fill with dairy milk synthetic wastewater with different ammonia i.e., 1000; 2000; 3000 mg/L. The other three reactor with code M/1000; M/2000; M/3000 are reactor fill with dairy milk synthetic wastewater with different ammonia i.e., 1000; 2000; 3000 mg/L and each reactor is added with coconut shell activated-carbon. Ammonia is analysed with nessler method. Alkalinity analysis by simple titration method as per bicarbonate and total volatile acids concentration in anaerobic digester simple titration. The COD analyses is according to the open reflux method described in standard method.

Characterization of dairy-milk synthetic wastewater

A synthetic dairy-milk waste water have been performed with providing additional seeds. The additional seed for experimentation have been obtained using pre-prepared culture media from synthetic dairy-milk waste. 100 ml nutrients solution has been used in 395 ml synthetic milk water and 5 ml sewage. Nutrients made from 20 gram glucose, 14,4 gram KNO_3, 30 gram $Na_2S_2O_3$, 100 gram $NaHCO_3$, 2 gram NH_4CL, 2 gram MgSO4 and 2 gram instant milk powder.

Characterization of Coconut shell-activated carbon

Coconut shell-activated carbon is prepared in one steps. The coconut shell pre carbonization then activated in a furnace at 800^o C. After cooling, the coconut shell pre carbonization is washed successfully several times with hot water until the pH became neutral and finally with cold water to remove the excess phosphorous compounds. The washed samples were dried at 110^o C to get the final product.

RESULTS AND DISCCSSION

Concentrations of ammonia, COD, VFA, alkalinity, pH, temperature in the processing of coconut shell media mediated anaerobic.

Ammonia concentrations used in this study have the range of 1000-3000 mg / L. This range have selected as the ammonia concentration of the inhibitor in this range. In Figure 1 looks ammonia decreased from zero day to 7^{th} day. Ammonia is used by micro organisms as a source of electrons in degrading organic matter. While the reactor containing coconut shell activated carbon is also a decline in ammonia, it is due to ammonia ions attached on the surface of coconut shell activated carbon [8].

This study also examines the decline of COD in the reactor (Figure 2). COD concentration in the reactor decreased from 1000-2000 mg / L to the range of 750-900 mg / L either using media in the reactor or not. COD concentration reduction is due to the anaerobic degradation process, the process of hydrolysis, acid formation process, as well as the formation of methane gas [9].

Environmental conditions in the reactor has a role in the reactivity of ammonia as an inhibitor of microbial work in organic material degradation. Environmental factors that involved are alkalinity, pH, and temperature. The concentration of alkalinity which suitable for the anaerobic reactor ranges from 1500 mg/L. However, this synthetic waste water has alkalinity of 2000-4000 mg/L (Figure 3). this condition cause ammonia increasingly reactive in inhibiting microbes to degrade COD. In addition, the pH fluctuates on the 6-7. This led to less than optimal coconut shells in absorbing ammonia. The range of temperature is $35\text{-}29^0$ C in the reactor which still reasonable limits.

In this study also analysis the content of Volatile Fatty Acids (VFA) in the reactor. On a zero day, VFA concentration reaches 250-450 mg/L (Figure 4). This case shows the organic matter content is also high. VFA concentration in the reactor is fluctuate. VFA concentration decreased indicating that the organic matter is converted into more simple organic matter. VFA is the content of acetic acid and other acids degradation of complex organic materials. VFA value indicates the organic matter content is simple and quite dynamic.

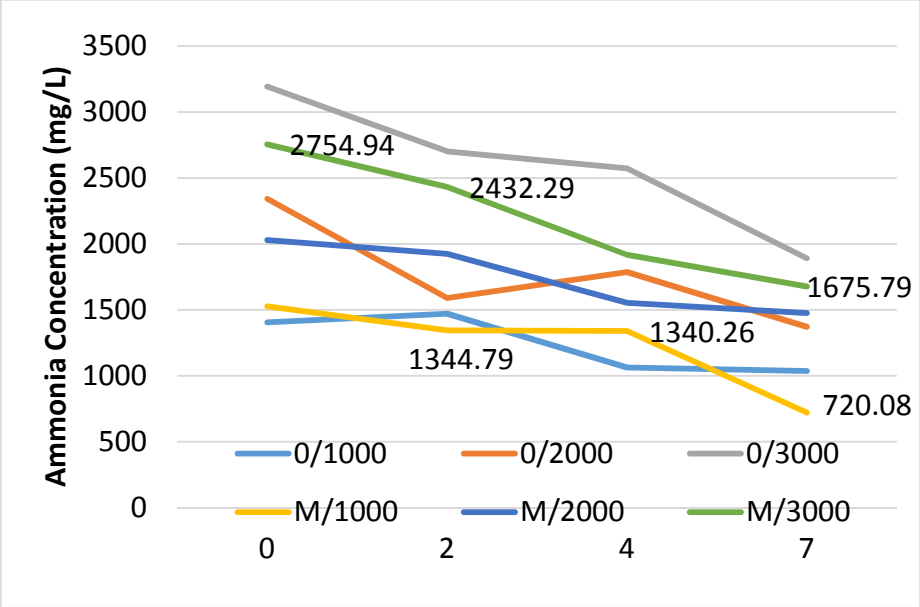


Figure 1 Ammonia Concentration in reactor

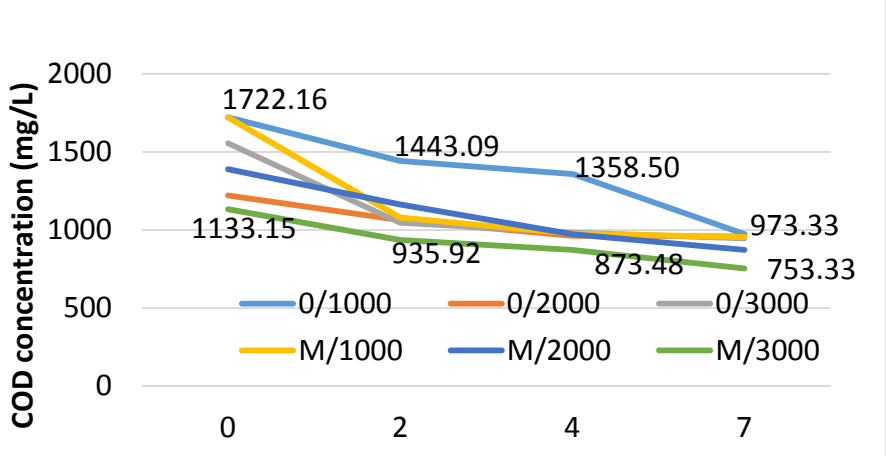


Figure 2 COD Concentration in reactor

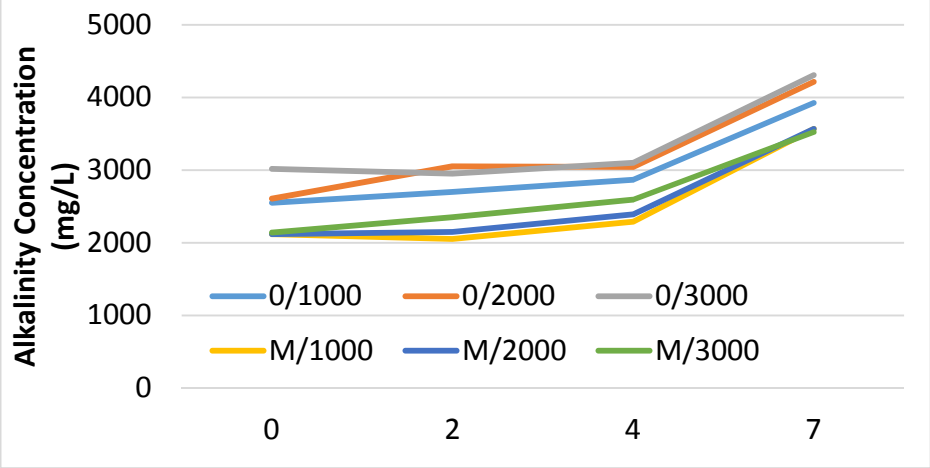


Figure 3 Alkalinity Concentration in reactor

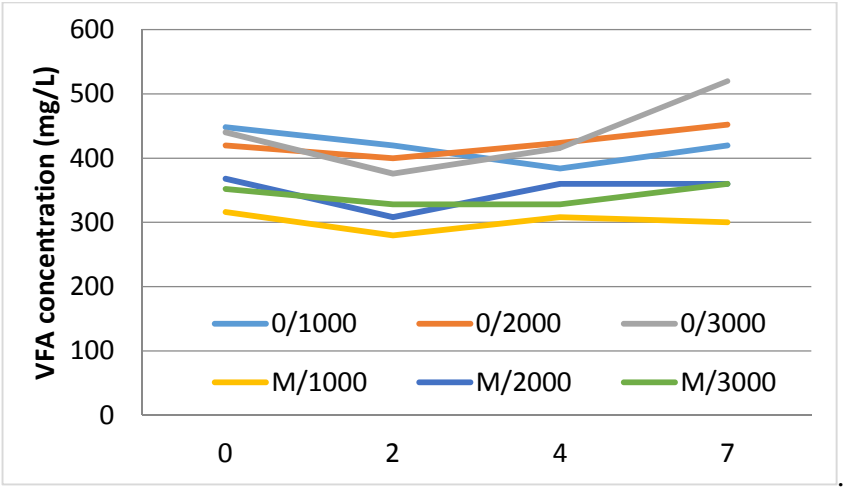


Figure 4 VFA Concentration in reactor

The ability of elimination for ammonia and COD in the anaerobic treatment which using coconut shells

Ammonia removal without using the media tends to fluctuate. Average fluctuation on 0/1000 treatment (without media, concentration up to 1000 mg/L) was 26.22%. The 0/2000 (without media, concentrations up to 2000 mg/L) treatment and 0/3000 treatment (without the media, the concentration up to 3000 mg/L) have almost the same capabilities removal. In the treatment of M/1000 (medium, the concentration up to 1000 mg/L) showed an average removal 60.55%. Ability removal for the treatment of M/1000 is capable of removing ammonia treatment the highest compared to other reactors. In the treatment of M/2000 and M/3000 only removes ammonia with an average of 27.24% and 39.17% (Figure 5). That ability different from the treatment of the M / 1000. It shows that the adsorption ability of activated carbon have a maximum capacity. When it compared to the reactor without activated carbon media, it is known that the ability of elimination for the addition of ammonia to the reactor with activated carbon is better.

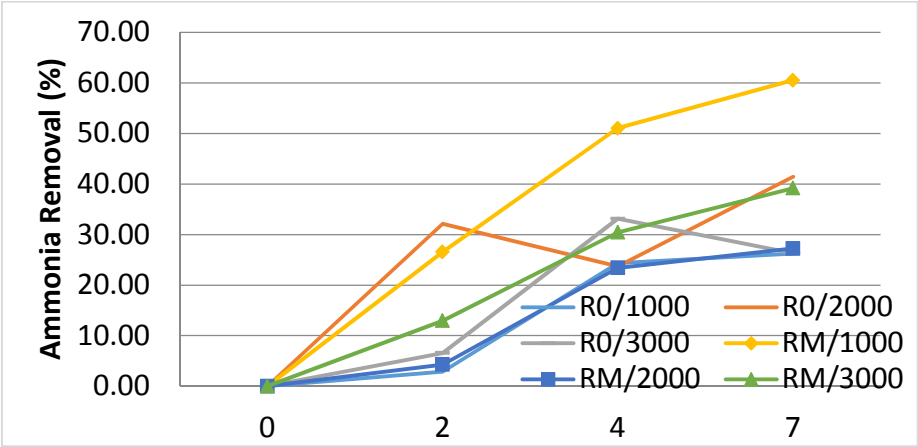


Figure 5 Ammonia removal in reactor

The average percent removal of COD at different 0/1000 with an average percent ammonia removal M/1000 as well as in 0/2000 with M / 2000 and 0/3000 with M / 3000. it is because the activated carbon media is more likely to absorb organic matter in this case COD compared to ammonia.

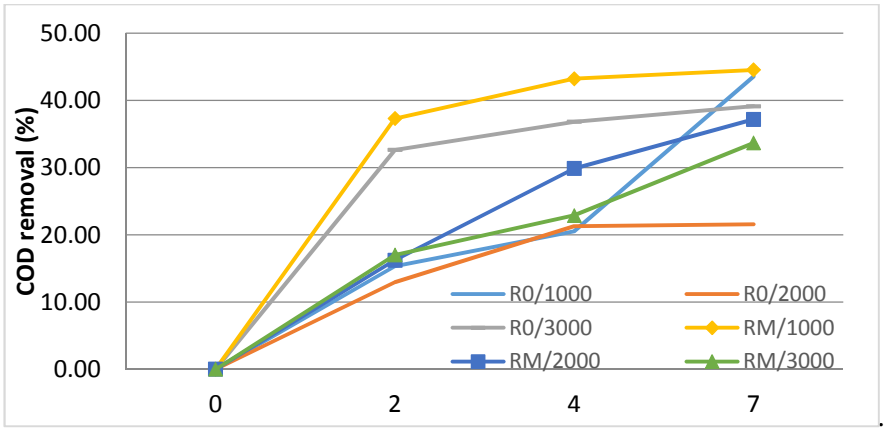
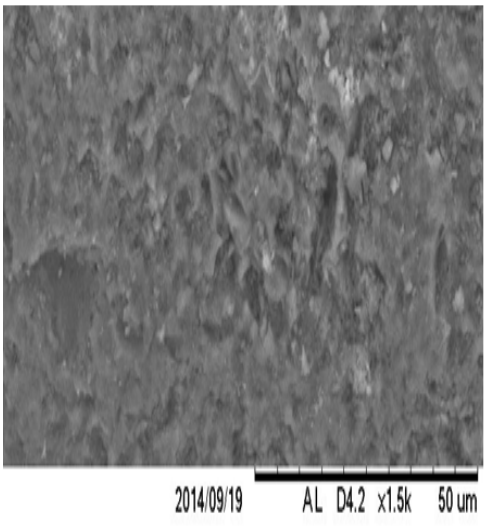
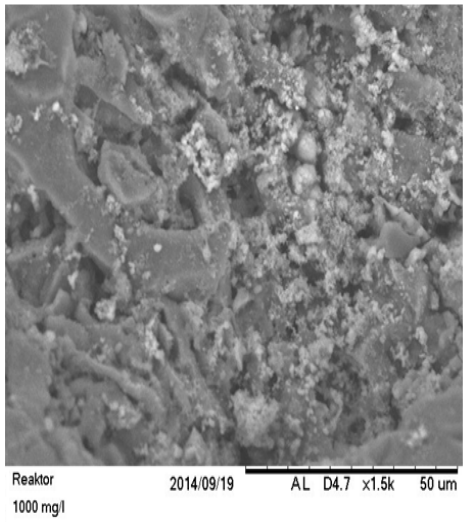


Figure 6 COD removal in reactor



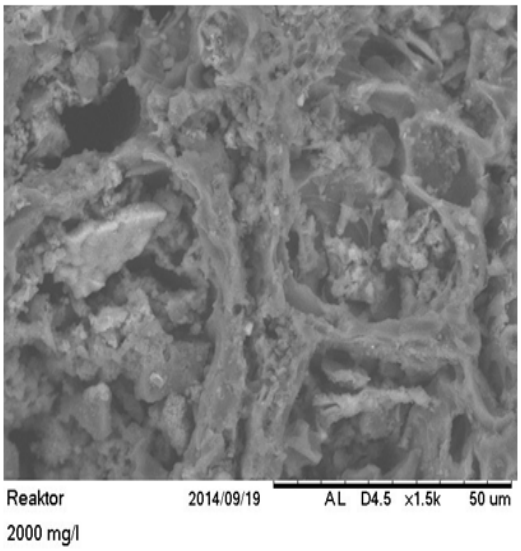
(a)

Coconut shell activated carbon



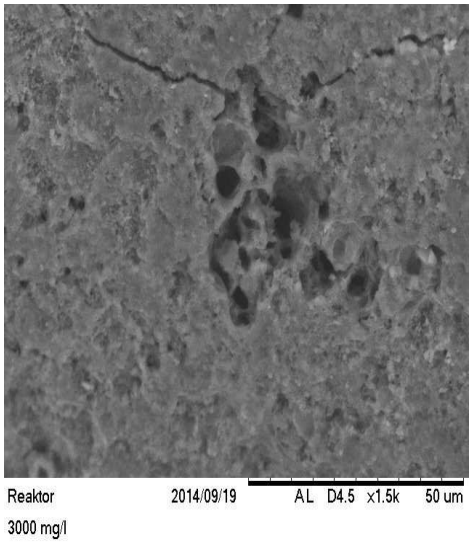
(b)

Coconut shell activated carbon with wastewater ammonia concentration 1000 mg/l



(c)

Coconut shell activated carbon with wastewater ammonia concentration 2000 mg/l



(d)

Coconut shell activated carbon with wastewater ammonia concentration 3000 mg/l

Figure 7 SEM analysis

The morphology of coconut shells before and after ammonia adsorption is observed by SEM (*Scanning Electron Microscopy*). The surface morphology of coconut shells before and after adsorption are shown in Figure 7. Based on figure 7 (a) visible surface of activated coconut shell are pores and to be thin. Whereas in Figure 7 (b) shows that the thickening occurs on the surface of the media and a lot of white dots on the surface of the media. The white dots are attached on the surface media is the ammonium ions. Whereas in Figure 7 (c) and (d) also occur in the media thickening, the presence of a white spot on the surface of the media is not as picture 7 (b). it is because the reactor with the media to eliminate the ammonia concentration of 1000 mg/L had the highest ability percent elimination than ammonia levels of 2000 and 3000 mg/L. it shows that the media have limitations in wastewater treatment with ammonia having a concentration of more than 1000 mg/L. so it is necessary to more study advanced modification of coconut shell activated carbon media.

CONCLUSION

Large range of ammonia concentration without coconut shell activated-carbon 1035.9 to 1889.073 mg/L reactor with coconut shell activated-carbon from 720.08 to 1675.79 mg/L. COD concentration in the reactor without coconut shell activated carbon is from 946.67 to 973.33 mg/L and the reactor with coconut shell activated-carbon is 753.33 to 955 mg/L. alkalinity in the reactor without coconut shell activated-carbon was from 3925 to 4216.67 mg/L and the reactor with coconut shell activated-carbon is 3500-3526 mg/L. VFA concentration in the reactor without coconut shell activated-carbon is 450-520 mg/L and the reactor with activated coconut shell charcoal is 300-360 mg/L. The reactor contained coconut shell activated-carbon and without coconut shell activated-carbon after 7 days in reactor capable of ammonia and COD allowance for a maximum of 60.55% and 44.54% is the reactor with the addition of coconut shell activated carbon with an ammonia concentration of 1000 mg/L.

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