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The effect of pH and operation mode for COD removal of slaughterhouse wastewater with Anaerobic Batch Reactor (ABR)

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Abstract - *Disposal of industrial wastes in large quantities was not in accordance with today's standards of waste into environmental issues that must be overcome with proper treatment. Similarly, the abattoir wastewater that contains too high organic compounds and suspended solids. The amount of liquid waste disposal Slaughterhouse (SW) with high volume also causes pollution. The research aim to resolve this problem by lowering the levels of BOD-COD to comply with effluent quality standard. Anaerobic process is the right process for slaughterhouse wastewater treatment because of high content of organic compounds that can be utilized by anaerobic bacteria as a growth medium. Some research has been conducted among abattoir wastewater treatment using anaerobic reactors such as ABR, UASB and ASBR. Our research focuses on the search for the optimum results decline effluent COD levels to match the quality standards limbah and cow rumen fluid with biodigester ABR (Anaerobic Batch Reactor). The variables used were PH of 6, 7, and 8, as well as the concentration ratio of COD: N is 400:7; 450:7, and 500:7. COD value is set by the addition of N derived from urea [$CO(NH_2)_2$]. COD levels will be measured daily by water displacement technique. The research's result for 20 days seen that optimum PH for biogas production was PH 7,719 ml. The optimum PH for COD removal is PH 6, 72.39 %. The operation mode COD:N for biogas production and COD removal is 500:7, with the production value is 601 ml and COD removal value is 63.85 %. The research's conclusion, the PH optimum for biogas production was PH 7, then the optimum PH for COD removal is PH 6. The optimum operation mode COD:N for biogas production and COD removal was 500:7*

Keywords: *Liquid Waste SW; COD removal; biodigester ABR; pH; operation mode; COD:N*

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INTRODUCTION

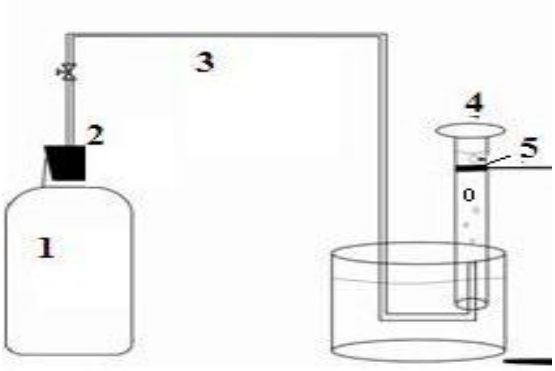
The waste water of slaughterhouse (SW) in large quantities is environmental issues that must be addressed immediately and it is needed right processing because of the content organic material and suspended solid in the waste water of slaughterhouse has high concentrations exceed the standard quality of waste water.

The wastewater of slaughterhouses (SW)) including domestic waste water containing organic materials with high concentration, suspended solids, colloidal materials such as fats, proteins and cellulose. This organic material can cause environmental problems if disposed of directly into the environment (Roihatin, 2006). Masse et al., (2001) were usingmethode ASBR (Squenching Anaerobic Batch Reactor) in the study of characters waste waterslaughterhouses at temperature 20 °C, 25 °C and 30 °C. Therefore it is needed a combinantion of several method tohandle waste water SW with beforehand studying characteristics of the waste. The research was done by knowing the pH influence and methods of operation COD: N best in COD removal as well as biogas produced at the ABR (Anaerobic batch Reactor).

MATERIALS AND METHODS

The main material that was used in this research is a wastewater slaughterhouse SW and rumen. Variable shift includes a comparison of COD: N (400: 7,450: 7,500: 7) and pH (6, 7, 8). Research procedures, namely (1) the preparation of materials, mix the wastewater

slaughterhouse SW and the Rumen with ratio F/M = 1. (2) Adjust the composition of nutrients the COD, nitrogen in the form of feedback with comparisons of COD: 400: N = 7; 450: 7; 500: 7.(3) Adjust the pH of each respective Variable 6,7, and 8 by adding 2N NaOH.(4) analysis of the content of the COD and the biomass everyday for 20 days.



Remark :
1. ABR (Anaerobic batch Reactor)
2. Closing
3. Pipe
4. *Measuring Cylinder*
5. Bubble of biogas

Figure 1. Anaerobic Batch Reactor

RESULTS AND DISCUSSIONS

The influence of pH to biogas production

This research aims to know the influence of PH on the amount of biogas production. Raw materials used in this research is the waste water slaughterhouse animals as much as 200 ml, with rumen fluid 200 ml nutrient additions in the form of urea and appropriate comparison of variable COD: N: 7 400, 450: 7, and 500: 7. In this study, the PH is set at 6, 7, and 8 with the residence time for 20 days to find out the optimum PH in the formation of biogas shows in figure 1.

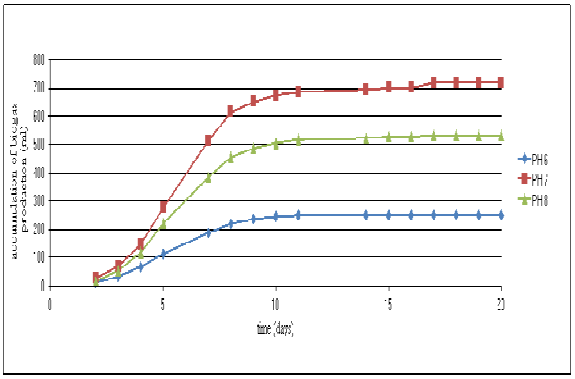


Figure 2. The effect of pH against the volume of biogas produced for 20 days

The graph depicts the accumulated biomass for 20 days. On zero day and first day of biogas was still not formed. The new Biogas formed on the second day and increased drastic to the 11th day. Then, additional production biogas declining and ultimately constant. It was because bacteria methanogen have been in phase growth (logs phase) so rapidly that biogas formed from reshuffle organic compounds increased sharply and slowly stop, when organic compounds which constitute the food for bacteria was up convertible into biogas so bacteria methanogen are in phase death

The PH of the waste water SW on this research was 5. Setting the ph2 based on variable desired using NaOH. On a graph above it appears that production of biogas most minimin in pH 6, it was 250 ml Biogas. Ph 7 showed which is optimum production of biogas , the production of biogas is 719 ml and the production of pH 8 is 525 ml .

The best range pH in process production of biogas is 6,5 – 8 (Droste, 1997). The PH factor is very instrumental in anaerobic decomposition because if the range PH on fermentation process is not appropriate then it can inhibit the growth of bacteria and the production of biogas. Biogas fermentation process consists of four stages, which are hydrolysis, acetogenesis, acidogenesis and methanogenesis. In the fermentation process there are two types of bacteria that play a role, namely acidogenik and metanogenik (Gaudy dan Lim, 1980). These bacteria convert organic compounds into metane and other gases in the biogas. At this stage, organic components split into monomers (Gaudy dan Lim, 1980). .In this phase, eksoenzim (hydrolase) from facultative anaerobic bacteria break down the bonds or obligatorily on the component that is not dissolved and thus more easily absorbed and digested by the bacteria in according. Bacteria acidogenik functions an important role on the stage of acidogenesis to degrade the monomers that form on phase hydrolysis of organic acid with short chains, which then will this acids are reduced to acid acetat in acetogenesis to avoid accumulation of volatile fatty acids that will inhibit the growth of methanogen bacteria and formation of methane in methanogenesis phases. At ph 6, the production of biogas most low because the process of

fermentation walk in the acid so as to the activity of bacteria acidogenik more dominant than bacteria methanogen. This caused too much organic the acids that forms on the stage acedogenesis that does all capable of being decomposed by the bacterium acetogenesis so happen accumulation of fatty acids that inhibits the formation of biogas on the stage methanogenesis by bacteria methanogen.On condition without buffer , pH values below 6 so activity of methanogen bacteria will be disturbed. If the PH reaches 5.5 then bacterial activity will cease (Yani dan Darwis, 1990). PH concentration in the reactor is strongly affected by volatile fatty acids and the amount of CO_2 produced. Biogas production maximum when pH is 7 where the growth of bacteria and acidogenikmethanogenik in balance condition for the formation of biogas methane which results with more than CO_2 and other gases (Jones et al., 1987).

The effect of PH to COD removal.

This research aims to know the optimum PH for the COD removal . The relationship between PH and the COD removal during the 20 days of biogas fermentation process is presented in Figure 3.

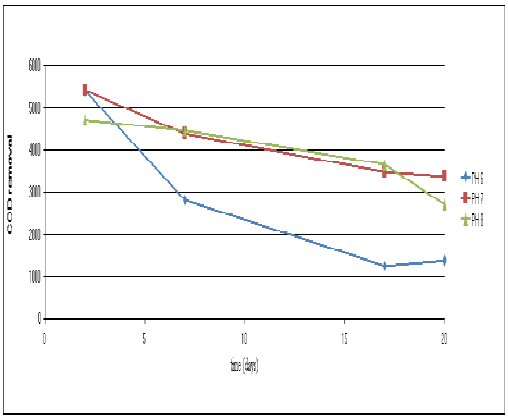


Figure 3. The effect of PH to COD removal

There are two changed variables in the research, that is comparison of COD and PH, where for PH, there are 3 variables ,it is 6,7 and 8. That variables has done to know effect of PH to COD:N removal for 20 days like the figure 3. At the figure 3 shows decrease of COD that can be found from initial and final measurement, The process od effect PH to COD removal is 72,39 %. At PH 6, The process fermentation in a place acid condition where bacteria acidogenik can growth well in acidogenesis stage so the organikcoumponds can be changed to organix acids more and COD will be decreased. The COD removal for 20 days shows ini table 4.1 .

Table 4.1 The COD removal based on PH

VARIABLES		COD (mg/L) Days of				% COD removal	Average % COD removal
PH	COD:N	2	7	17	20		
6	400:7	5274	3165	1135	1295	75.4455821	72.39068668
	450:7	7468	3223	1664	1569	78.99035886	
	500:7	3494	2068	988	1302	62.73611906	
	Average	5412	2818.667	1262.333	1388.667		
7	400:7	4427	4561	4073	3685	16.76078609	35.91187601
	450:7	6069	4318	3325	3529	41.85203493	
	500:7	5757	4278	3057	2929	49.12280702	
	Average	5417.667	4385.667	3485	3381		
8	400:7	2865	5755	3662	2852	0.453752182	35.67816332
	450:7	5680	3619	5160	4154	26.86619718	
	500:7	5605	4018	2163	1137	79.71454059	
	Average	4716.667	4464	3661.667	2714.333		

In first day, each variables be set to changes variables that the setting of PH have done with add NaOH and H_2SO_4, whereas for the setting of comparison COD:N with add urea so can be found the comparison COD is 400:7 ; 450:7 dan 500:7. The results shows it happen the condition non steady and concentration of COD be fluctuative from initial measurement until 20th day. After 20th day, Thefluctuative COD is already low from berfore condition. For PH 6,7 and 8 can be found the result is lowest than initial measurement.PH 6 with comparison of COD is 1295, 1569 and 1302 , PH 7 with comparison of COD is 3685, 3529dan2929, and PH 8 with comparison of COD is 2852, 4152, dan 1137 .

At table 4.1 . there are several levels of COD increase tendency after week 2, as at PH 6 COD: N 500: 7 levels of COD increased from 988 to 1528 when the 20th, at PH 7 COD: N 450: 7 levels of COD increase of 3325 became 3529 when the 20th, and at PH 8 COD: N 450: 7 COD has increased levels of 3619 be 5160. According to (Sunartodkk, 2013) that after the 15th day in the fermentation process, Methanogen bacteria will increase the the levels of COD will increase too in 20th. If viewed from the difference in the content of the COD obtained from measurements of the beginning and end of the process, the influence of pH on the content of the COD decline the most good is at pH 6.

Effect of Operating Mode COD: N against the Volume of Biogas produced

Chemical Oxygen Demand (COD) or the chemical oxygen demand is the amount of oxygen required to oxidize the oxidizing the entire material, both organic and inorganic matter in the water (Metcalf & amp; Eddy, 2003). If the organic or inorganic compounds is too large then dissolved oxygen content in the water can be passed zero so as not to allow any plants or aquatic animals to live.

The purpose of this research is to know the mode of operation of COD: N optimum for the production of biogas. Comparison of COD: N used in this research is 400: 1, 450 and 500: 7: 7. In Figure 1, to see that the same ratio at PH COD: N the most optimum is 500: 7 as at PH 7 the volume of biogas generated in comparison of COD: N 500: 7 is 322mg/L, larger than 450: 7 and 400: 7 are 202mg/L and 195mg/L. Similarly to PH 8 volume of biogas generated in comparison of COD: N 500: 7 is 259 mg/L, greater than 450: 7: ; 400: 7 is 150 mg/L and 124mg/L. The resuls shows in figure 3.

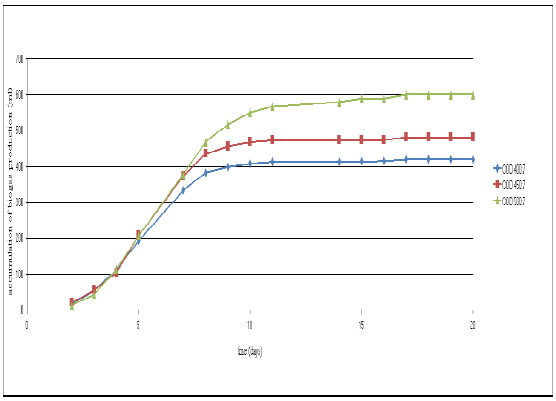


Figure 4. Effect of Operating Mode COD: N to the Volume of Biogas produced

Figure 4 shows the influence of the operating mode: N COD against volume of biogas formed during 20 days where the volume of biogas formed from each comparison on PH COD: N the same accumulated. In the graph looks the highest volume of biogas accumulation amount of PH 6, PH7 and a PH of 8 is shown by the comparison of COD: N 500: 7, while the lowest is 400: 7. Biogas by vitue od operating mode of COD:N for 20 days every PH shows figure 5,6 and 7.

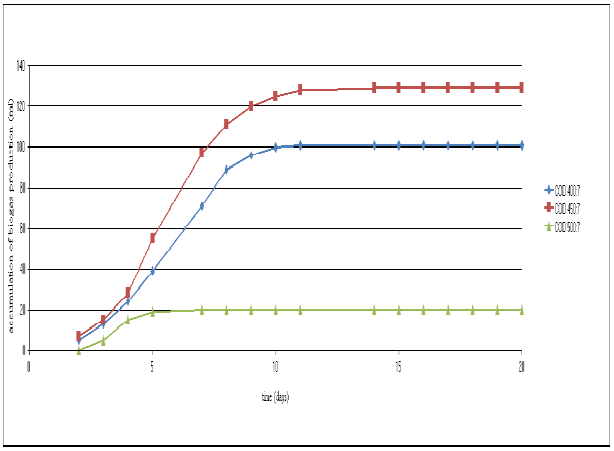


Figure 5. Production of Biogas at PH 6

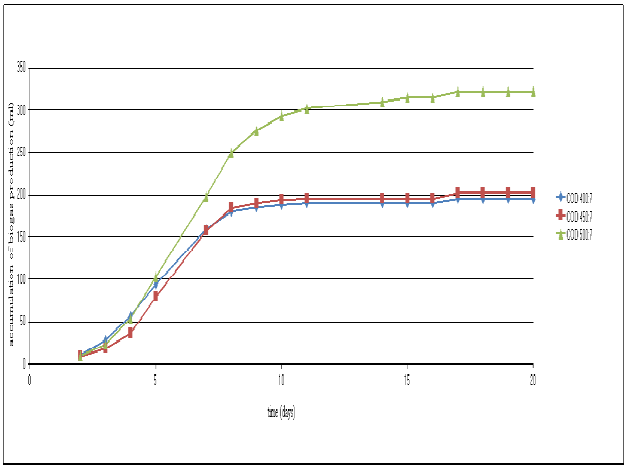


Figure 6. Production of Biogas at PH 7

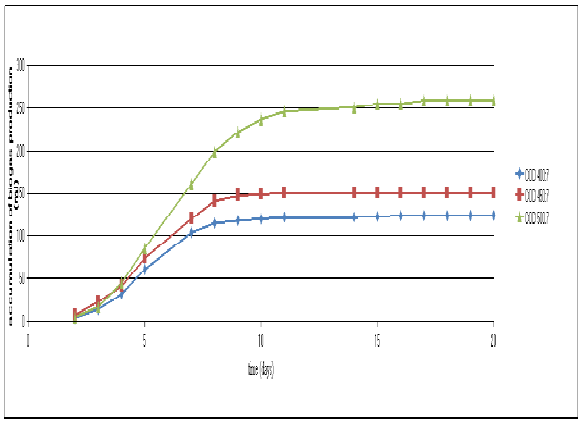


Figure 7. Production of Biogas at PH 8

A figure 4 seen the number of the volume of biogas formed with the mode pf the operation COD: N 500: 7 shows the largest number that is 601 mg /l, 450: 7 (481mg /l). The production of biogas lowest is modes of operation cod: n 400: 7 with an accumulation of the volume of biogas of 420 mg / l.

COD of the waste water SW is 6679: 7. Variable setting of COD: N is done by addition of nutrient in the form of urea. Operating mode on COD: N 400: urea is added by 0.065 grams, while the operating mode COD: N 450: 7 of 0.044 gr, and the addition of urea on the operating mode: N 400 COD: 7 of 0.0217 gr. Nutrient is added in this case greatly affects the results of biogas production. Protein and urea will be into Ammonia/ammonium. Ammonia (NH3) and ammonium (NH4) used the bacteria as a source of nitrogen. COD: N Range which is optimum for the formation of biogas is 350: 7 - 1000: 7 (Speece ,1996). . In a comparison of COD: N is very low, the amount of nitrogen that is too high can cause toxic because the nitrogen will accumulate in the form of ammonia that can raise the PH and resulted in the formation of biogas processes take place on conditions of alkaline and inhibits the activity of bacteria to overhaul the organic compounds into biogas (De-Baere et al., 1984). The concentration of ammonia is needed for the growth of bacteria forming biogas ranging between 100-140 mg/l. Bacteria can't grow well when the content of the above 200 mg/l ammonia (De-Baere et al., 1984). If COD:N is very high, say, 1000: 7, then the number of organic compounds that must be overhauled very large, exceeding the capacity of methanogen bacteria, are not proportional to the amount of nitrogen that is too small so that bacteria are not enough according to nutrition for metabolisme (Budiyono et al.,2010). The number of organic compounds that are too sour atmosphere also raises huge on biogas fermentation process, so the activity becomes more dominant acidogenesis bacteria and inhibit bacteria methanogen in generating biogas with a maximum amount of methane (Vicenta et al., 1984).

In this study, the operating mode: N 500 COD: 7 is the optimum operating mode for establishment of biogas because on this comparison, the bacteria gaining enough according to the amount of nutrients for a balanced so that bacteria are easy to decipher the organk compounds into biogas.

The effect of Operation method of COD: N to COD removal.

Chemical Oxygen Demand (COD) shows the number of the inorganic and organic compounds in the water. In this study, the content of the COD on waste water considerable SW is 6679mg/l which would damage aquatic ecosystems if discharged directly dumped into the environment. To that end, anaerobic wastewater treatment is expected to lower the levels of environmental quality standard according to the COD that is 400 mg /l.

The purpose of this research is to know the mode of operation the most optimum COD: N to COD removal. COD indicates the number of the inorganic and organic compounds in the water, the greater the decrease in levels of COD and the content of organic compounds on a waste will decrease and increase the quality of wastewater. Operating Mode COD: N used in this research is 400: 7; 450: 7 and 500: 7.

Table 4.3 Measurement of COD

COD						
VARIABLES		**COD (mg/L) Days of**				**% COD removal**
PH	**COD:N**	**2**	**7**	**17**	**20**	
6	400:7	5274	3165	1135	1295	75.4455821
	450:7	7468	3223	1664	1569	78.99035886
	500:7	3494	2068	988	1302	62.73611906
7	400:7	4427	4561	4073	3685	16.76078609
	450:7	6069	4318	3325	3529	41.85203493
	500:7	5757	4278	3057	2929	49.12280702
8	400:7	2865	5755	3662	2852	0.453752182
	450:7	5680	3619	5160	4154	26.86619718
	500:7	5605	4018	2163	1137	79.71454059

The table 4.3 shows measuring on each variable cod levels ph and modes of operation. On the table shows that the effectiveness of the operating mode COD: N in lowering levels of COD in the study of the influence pH. It is because at PH 6 establishment of biogas fermentation process takes place on the condition that resulted in bacterial acid acidogenesis of methanogen bacteria more dominant. At PH 6 biogas formation process will be hampered and will stop if the PH in under 5.5 therefore the bacteria need a little addition of nutrient for bacterial metabolism and increases the PH so that the asidogenik and methanogenic bacteria be balanced and organic compounds break down to the maximum. The greater the organic compounds decompose then increasing COD levels will be decreased. At PH 8, The comparison of COD: N most effective for COD removal is 500: 7 (from 5605mg/l to 1137mg/l) with 79,71 %COD removal. It's because The anaerobic fermentation takes on base condition so it just needs a little nutriens in order to normal condition. Whereas at PH 7, COD: N the most effective look at the ratio of 500: 1 from 5757mg/l be 2929 with% COD removal 49,12%, due to a PH of 7 is the optimum PH for the growth of methanogen bacteria and operation method if COD 500:7 provide enough nutrients to bacteria in the outlines of organic compounds.

Table 4. The elimination of average COD in comparison COD:N

COD							
VARIABLES		**COD (mg/L) Days of**				**% COD removal**	**Average % COD removal**
PH	**COD:N**	**2**	**7**	**17**	**20**		
6	400:7	5274	3165	1135	1295	75.4455821	30.88670679
7	400:7	4427	4561	4073	3685	16.76078609	
8	400:7	2865	5755	3662	2852	0.453752182	
6	450:7	7468	3223	1664	1569	78.99035886	49.23619699
7	450:7	6069	4318	3325	3529	41.85203493	
8	450:7	5680	3619	5160	4154	26.86619718	
6	500:7	3494	2068	988	1302	62.73611906	63.85782222
7	500:7	5757	4278	3057	2929	49.12280702	
8	500:7	5605	4018	2163	1137	79.71454059	

Table 4.4 shows the decrease in average every mode operation of where the looks that the efficiency of the largest COD levels decrease 500:7(63.85%), then 450: 7 (49.24%) and the lowest efficiency at operating mode of COD: N is 400:7(30.89%). The number of COD indicates organic compounds will be elaborated by microorganisms. If COD:N is in high concentration , it means COD levels will be decreased because there are many substrate contacts with microorganisms. The optimum COD: N is 500: 7 where contact with microorganisms is proportional to the amount of nitrogen as a nutrient source for microorganisms in the outlines of the organic compounds.

CONCLUSIONS

The result shows that the highest decrease levels COD at ph 6 is 72.3 % and comparison COD:N is 63.8%. The optimum production of biogas obtain at PH 7 that is 719 ml and comparison COD:N 5007 is 601 ml. To COD removal and productions of biogas of waste water SW is needed 20 days

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