The Impact of Solvent of Absorption CO_2 from Biogas Vinasse

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Abstract *— Reduced energy reserves that occurred in Indonesia today, it needed a new source of alternative energy. Biogas is one of the alternative energy sources. Typical biogas contains 50–65% methane (CH4), 30–45% carbon dioxide (CO2), moisture and traces of hydrogen sulphide (H2S). Purification of biogas done to remove the impurities (inhibitor) on biogas such as carbon dioxide (CO_2). Chemical absorption involves formation of reversible chemical bonds between the solute and the solvent. Chemical solvents generally employ either aqueous solutions of alkaline salts (i.e. sodium, potassium and calcium hydroxides). In the process of purification chosen liquid NaOH, KOH and $Ca(OH)_2$ because theirs as absorbent material is highly reactive with CO_2. This study aims to determine the The CO_2 absorption using NaOH, $Ca(OH)_2$ and KOH with the same consentration (15 %). Absorption method used is missed biogas in the ` alkaline solution.The results showed that the absorption by using 15 % KOH concentration produced the higest CO_2 absorption with the lowest CO_2 content and the highest content of methane. The KOH solution can increased the CH_4 content of biogas 70,3 % from 33,64 to 57,29 % by volume.The absorption of CO_2 content of biogas was 100 % from 30,18 % to 0 % by volume.The NaOH solution can increased the CH_4 content of biogas 67,07 % from 55,37 to 82,56 % by volume.The absorption of CO_2 content of biogas was 100 % from 42,33 to 0 % by volume . The absorption of CO_2 content usage Ca(OH) solvent was the lowest from the others.*

Key words – absorption, CO_2, CH_4, Biogas

I. INTRODUCTION

Reduced energy reserves that occurred in Indonesia today, it needed a new source of alternative energy. Biogas is one of the alternative energy sources. Biogas is sustainable energy source that contains 50-75% methane gas, 30-50% carbon dioxide, small amounts of other gases (CO, N_2, H_2, H_2S, O_2), depending on the substrate [4-5] .The high of CO_2 content of biogas would interefere in the combustion process. Chemical absorption involves formation of reversible chemical bonds between the solute and the solvent. Chemical solvents generally employ either aqueous solutions of alkaline salts (i.e. sodium, potassium and calcium hydroxides) [7]. In the process of purification chosen liquid NaOH, KOH and $Ca(OH)_2$ because theirs as absorbent material are highly reactive with CO_2. . Some authors studied the purification of CO_2 content by absorption usage NaOH solvent increased CH_4 content from 49,95 to 64,56 % of volume [2]. According [6] studied that absorption CO_2 content by added 2 M lime water ($Ca(OH)_2$), would increase Metane content from 44,814 to 69,871 % in porous of nozel. Methode of decreasing CO_2 content by absorption usage KOH solvent would increase usage KOH solvent would increase CH_4 from 15 to 75 % volume [3].This study aims to determine efficiency of CO_2 reduction by the CO_2 absorption using NaOH, $Ca(OH)_2$ and KOH solvent on the 15 % consentration .

II. EXPERIMENTAL

A. RawMaterial

Raw materials used in this study were (a)Biogas from alcohol fermentation waste water (b) 15 % NaOH solution (c) 15 % KOH solution (d) 15 % Ca(OH)2 solution.

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B. Method Experiment

Biogas were produced by anaerobic fermention alkohol industrial waste water for 49 day. Once day production of biogas was measured through the water manometer and those were passed in the alkaline absorbent 500 mL solution and 15% concentration. Biogas were analyzed CO_2 content and CH_4 content before entering the absorber solution and after exit absorbent solution once every 7 days. The CH_4 and CO_2 concentration was analyzed using Gas Chromatography Shimadzu GC 14B, with SUS Packed Column Porapak Q, FID detector. The schematic diagram of experimental set up is shown in Fig. 1.

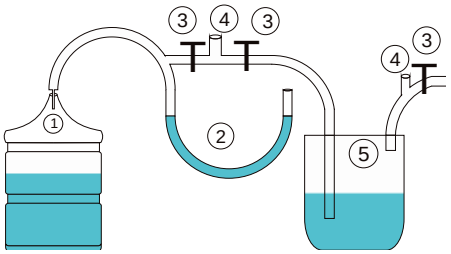

Fig 1. Schematic of absorbtion CO_2 of biogas

III. Results and Discussions

Production rate of biogas

Microorganisme was adapted in another growth medium at the beginning of production biogas. So they did not grow very well. At the tenth day microorganism can be degradation anerobic an organic material and produced biogas. Degradation anaerobic has four phase are hidrolysis, acidogenesis, acetogenesis and metanogenesis. Biogas production was processed during fermentation as well as the aviability of nutrition or substrate.

Production rate of biogas was showed at table 1.

Table 1. Production rate of biogas during the anaerobic fermentation

day	Production rate of biogas (mL)			day	Production rate of biogas (mL)		
	NaOH	KOH	Lime Water		NaOH	KOH	Lime water
1	0	0	2,573	26	75.026	156.386	149,26
2	0	0	0	27	139.164	85.715	93,436
3	0	0	0	28	176.973	115.409	122,931
4	3,959	9,898	11,086	29	44.738	43.748	100,562
5	127,484	66,316	36,424	30	134.413	142.529	127,286
6	53,052	18,45	9,106	31	100.562	25.338	102,74
7	17,42	18,806	4,949	32	22.171	117.19	115,211
8	10,67	61.367	52,854	33	96.603	97.791	211,418
9	11.877	21.379	37,018	34	99.572	121.15	120,16
10	124.911	72.056	24,349	35	144.904	138.768	156,584
11	98.187	38.008	30,089	36	100,364	103,136	94,821
12	130.652	199.936	155,99	37	165,69	157,178	155
13	32.663	71.264	59,189	38	138,966	123,525	63,544
14	35.038	109.866	104,917	39	6,335	7,126	8,116
15	14.847	98.978	76,807	40	38,8	70,077	74,036
16	7.918	30.881	15,837	41	137,976	138,966	10,492
17	8.71	53.25	15,837	42	25,338	20,192	103,729
18	8.512	61.565	27,318	43	125,505	193,998	220,92
19	9.502	115.211	119,17	44	115,211	184,496	187,069
20	110.856	110.46	118,18	45	40,185	158,959	172,618
21	226.067	154.802	156,584	46	50,875	188,257	192,414
22	176.578	196.571	165,67	47	39,987	24,745	189,445
23	135.403	134.413	121,546	48	40,501	119,764	184,298
24	41.769	27.714	27,12	49	52,063	179,151	195,383
25	46.322	115.211	35,236				

Gas production of CO_2

Biogas was passed to each absorber (NaOH, KOH and $Ca(OH)_2$ at the once day. Biogas were analyzed CO_2 content and CH_4 content before entering and after exit the alkaline absorbent solution every 7 days. The result can showed at table 2.

Table. 2. CO_2 content for Adsorber Solvent every 7 Day

Day	% volume CO_2					
	NaOH solvent		KOH solvent		Lime water	
	in	out	in	out	in	out
7	22,783	0,000	30,176	0,000	25,149	3,113
14	19,746	0,000	24,323	3,121	24,503	6,825
28	18,578	4,618	26,590	2,128	26,248	24,939
35	42,714	0,000	43,539	0,000	28,201	16,510
49	26,970	0,000	26,056	6,655	32,252	1,385

According to the table 2 it can be seen that CO_2 content of % volume at the time of entry high. This can be caused by microbial activity which is only slightly producing methane gas so that the amount of CO_2 increases, whereas the current decline is because bacteria tend to produce more methane that is supported with a pH optimum of about 6 - 7 The process of methanogenesis can not run optimally, proven the accumulated volume generated by these variables only slightly. Can also be caused due to this variable hydrolysis process (decomposition of organic polymers) goes up and then proceed with the process of acidogenesis and acetogenesis. The process of acidogenesis is the decomposition of organic monomers into acid - an organic acid and alcohol. In this process, the organic monomer is further described by acidogenik bacteria into an organic acid into formic acid, acetic, butyric, propinoat, lactate, ammonia, and also produced CO_2, H_2 and ethanol. Acetogenesis process is the change in the organic acid and the alcohol into acetic acid. In this process, organic acids and ethanol compounds described acetogenic bacteria such as formic acid, acetate, CO_2 and H_2. At each phases of anerobic digestion were produced CO_2 gas , so causing the high of CO_2 content. All adsorbent have decreased of CO_2 content The most excellent adsorbent in the first week of NaOH and KOH, and the absorption of CO_2 by the second week of NaOH, and the most absorption of CO_2 usage lime water in the first week is 87.622%. In the next week on the absorption of CO_2 adsorbent may decline to saturation of the adsorbent and can not absorb CO_2 too much. It can also be caused to the influence of the reaction between CO_2 to produce the adsorbent can decrease CH_4 or other gases .

Gas production of CH_4

Based on table 3 below it can be seen that the levels of CH_4 produced in each bioreactor always increase. At the 28th until the 49th levels of CH_4 are stable. It is also supported by the pH in the bioreactor was 7 so that bacteria capable of producing methane CH_4. At the time of CH_4 into the adsorbent there is an increase and decrease in this case due to the influence of temperature and saturation of the adsorbent. This reaction was represention its below [6].

$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

$2\ KOH + CO_2 \rightarrow K_2CO_3 + H_2O$

Effect of ambient temperature can affect the CH_4 content to decreased levels of adsorbent used in the form of a solution, the solvent used to dissolve the adsorbent can evaporate and it can cause decreasing the CH_4 content.

Table 3. Change of CH_4 content at biogas production

Day	% volume CH_4					
	NaOH solvent		KOH solvent		Lime water solvent	
	in	out	in	out	in	out
7	28,226	47,069	33,639	57,292	35,950	26,856
14	31,137	10,427	28,018	30,577	34,853	11,416
28	54,667	42,312	52,191	39,848	51,737	43,209
35	55,377	82,558	55,002	34,640	56,891	58,840
49	43,120	7,560	51,677	31,813	65,545	4,598

IV. CONCLUSIONS

NaOH and KOH solution was able to reduce CO_2 levels as much as 100% of the biogas produced the 7th day of each were 201 mL and 112 mL. At day 14 NaOH solution able to reduce CO_2 content as much as 100% with a total volume of 444 mL biogas. The biogas was decreased CO_2 consentration as much as 100% by NaOH solvent. Lime water ($Ca(OH)_2$ solution was able to reduce the CO_2 content as much as 87.62%. The Absorption ability of NaOH solven and KOH solvent is almost the same. NaOH absorber solution is able to reduce levels of CO_2 are the best, so raise the CH_4 content from 55,377 to 82.53% volume in the 5th weeks biogas production. Lime water to reduce the CO_2 content is less effective because it produces vapors can reduce the CH_4 content.

V. ACKNOWLEDGMENTS

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