KnE Energy

ISSN 2413-5453 Volume 1 (2015) 115-118
Renewable Energy and Energy Conversion Conference and Exhibition
(The 2nd Indo EBTKE-CONEX 2013)

Development of a New Phase Change Biogas for Renewable Energy Storage System

Muhammad Kismurtono[a*)], Satriyo K.W[a], Roni M[a] dan Wahyu A. R[a]

[a] *Technical Implementation Unit for Development of Chemical Engineering Processes, The Indonesian Institute of Sciences, Gunungkidul, 55861. Indonesia.*

ABSTRACT: The aims of this study are to decrease the concentration of organic matter are to cooking and generate electricity from biomass. The methods were the preparation of fixed dome reactor, unit of CO_2 removal, preparation and fermentation of cow dung, water, chicken manure running and sampling periodically every one hour and data analysis. Therefore, CO_2 must be eliminated from the biogas and the corresponding phenomena of mass transfer with chemical reaction of packed column have to be studied. This study assumed steady state and isothermal condition. The system studied consists of packed column (stainless steel 304) 10 cm in diameter filled with 2 mm in diameter bead (zeolite) to the height of 80 cm
and storage system of methane.. The gas flow rate was held constant at F = 800 ml/s, liquid flow rate (L) was 100 ml/s, pressure (P) was varied from: 350 to 700 mm water column (WC), and the concentration of aqueous NaOH 1.5 M inlet absorbent was held constant. The results showed that the percentage of absorbed CO_2 can be enhanced by increasing the pressure.
Using column with packing height of 100 cm. gas flow rate of 800 ml/s, using absorbent containing NaOH1.5 M with flow rate: 100 ml/s and at pressure of 350 mm water column (WC) and temperature of 30^o C , the percentage recovery of CO_2 reacted was 85%. The biogas then will be used to generate electricity.

Keywords: Aqueous NaOH 1.5 M, Biogas purification, CO_2 removal, Storage system

1. Introduction

At present three different techniques for upgrading of biogas are used commercially in Sweden:

- Absorption with water
- PSA (Pressure Swing Adsorption)
- Adsorption with Selexol TM

Biogas is a clean fuel for internal combustion engine (Angenent, Largus T. et al. 2004). Cooper, John investigated the compressed biogas and natural biogas and their application to diesel fuel.
Biogas was compressed up to 9.8 x 10^6 for high pressure application.
The benefit of the research is that the research result can be used as pattern to design and analyses packed column for chemical absorption of gas CO_2 from biogas, and also for other similar system.
The presence of CO_2 in biogas does not give to contribute to the calorific or heating value and are often washed out in purification plant in order to obtain a gas with almost 100% and dangerous effect on environment

2. Methodology

Firstly the biogas introduced at the bottom of the packed column, passing through the aqueous NaOH 1.5 M solution, flowing downwards to the solution separator. In this column the CO_2 is absorbed and transformed into aqueous NaOH 1.5 M solution. Samples of the inlet and outlet biogas were taken during experimental tests using gas sampler. Parameter determined and measured in this experiment were composition of biogas, pressure of biogas, time of burning, CO2 removal percentage, heat and power. The compositions of these samples were determined by gas

Peer-review under responsibility of EBTKE-CONEX 2013
DOI http://dx.doi.org/10.18502/ken.v1i1.342

chromatography. CO_2 removal, expressed as a percentage, was calculated by dividing the difference between the inlet and outlet volume compositions by the inlet.

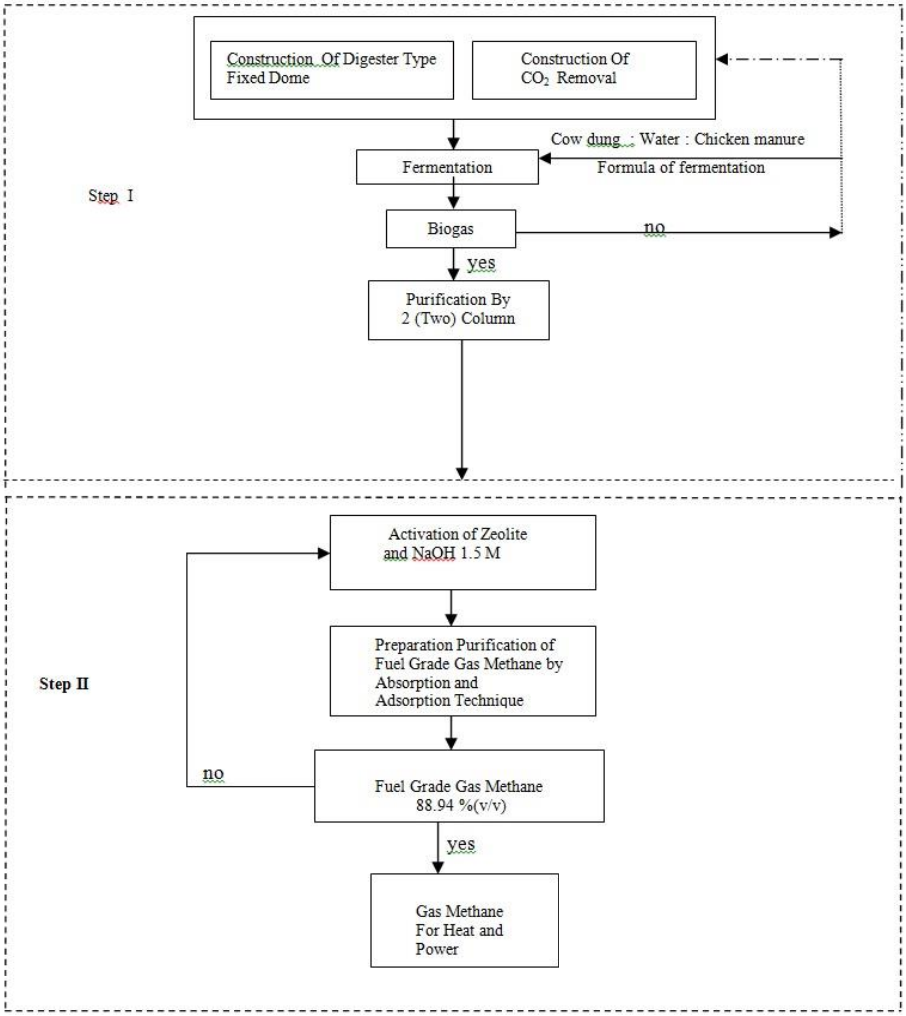

Fig. 1 Research design and methods

Table 1.
Specification of product biogas (before treatment)

No	Component	Percentage	Methods	Composition
1	CH_4	%(v/v)	GC	63.20
2	CO	%(v/v)	GC	11.10
3	CO_2	%(v/v)	GC	25.19
4	H_2	%(v/v)	GC	0.49
5	Impurities	%(v/v)	GC	0.02

Table 2.
Specification of product biogas

No	Component	Percentage	Composition (a)*	Composition (b)*	Composition (c)*
1	CH_4	%(v/v)	55 - 65	55 - 75	40 - 70
2	CO	%(v/v)	-	-	-
3	CO_2	%(v/v)	35 - 45	25 - 45	30 - 60
4	H_2	%(v/v)	0 - 1	1 - 5	0 - 1
5	N_2	%(v/v)	0 - 3	0 – 0.3	-
6	O_2	%(v/v)	-	0.1 – 0.5	-

Note.(a)* Arifin dkk.2008; (b)* www.kolumbus.fi;(c)* Muryanto dkk,2006

3. Results and discussion

This study we assumed steady state and isothermal condition and the system studied in research comprises a packed column 10 cm in diameter
filled with 1 cm ball or 1.6 mm pellet zeolite to height of 80 cm . This research studied the effect of pressure, concentration of aqueous NaOH 1.5 M solution in inlet absorbent and temperature on percentage of CO_2 absorbed. Liquid flow rate was 40 ml. s^{-1} , pressure was varied 350 and 700 mm water column (WC). The gas flow rate was held constant at 600 ml. s^{-1} (Table 3)

Table 3.
Pressure of biogas from digester vsTemperature Maximum from Estimation, °C and Convertion of methan to Co – Generator

No	Pressure of biogas from digester, (mm WC)	Time of burning, (hour)	Input gas to column adsorber (zeolite) % (v/v)	Output gas to column absorber (NaOH,1M) % (v/v)*	Input gas to burner or generator % (v/v)*	Temperatur maximum from estimation, °C
1	350 (n)	1	54.8900 (n)	71.8700* (n)	88.6200* (n)	1.750***
2	600 (n)	2	55.8994* (n)	81.8780* (n)	88.6288* (n)	1.850***
3	350 (n)	1	56.1900** (n)	82.8700** (n)	88.4100** (n)	1.980***
4	700 (n)	2	60.1400* (n)	85.8900** (n)	88.9400** (n)	2.000***

Note .
(n) 3 x
[8] - Petrolab Services
** - Jaringan Kerjasama Kimia Indonesia Services
*** - Trial and error, law of thermodynamic , $H = H_{o\,298} + H_{sensible}$

With the data above, biogas burners or entry-gas generator sets and maximum temperature (1850-2000) °C, then obtained the following results:
In the combustion reaction for pure methane
$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ (1)
If the biogas purification process results in the storage tank 400 L, still entrained CO2 gas, say with a ratio of 2 : 1, the reaction (1) becomes
$(CO_2+2CH_4)+4O_2 \longrightarrow 4H_2O+3CO_2$ (2)
So the reaction (1) and (2) the CO2 gas that is entrained, increasing the volume of exhaust gases or loss of heat energy in the exhaust stack.
In the scrubber column (column absorption and adsorption column), with a burning time of 1 hour, levels of methane gas adsorption column entry (54.89 to 56.19)% and the absorption column exit (from 71.87 to 82.87)% and the concentration of methane gas log burning stove (88.41 to 88.68)%, there is a decline in the quality of methane gas, this is due to the residual CO_2 and gas - inert gas is entrained in the gas methane. When compared to the conditions of the biogas

digester process pressure (6.0 to 7.0) 10^2 and 2 hours of burning time, levels of methane gas adsorption column entry (55.89 to 60.14)% and out absorption column (81.87 to 85.89)% and the concentration of methane gas log burning stove (88.62 to 88.94)% there is an increase in the quality of methane gas, this is due to the pressure of biogas from the digester is increased from 6.0 X 10^2 cm column of H_2O to 7.0 X 10^2 cm column of H_2O.

4. Conclusion

Results obtained in this research are inferential that:
The percentage of removal CO_2 was influenced by absorbent flow rate and pressure of biogas and temperature maximum or heat 2.000 ^oC and Power of Generator-Gas Methana 3.000 watt

Acknowledgements.

The authors wish to acknowledge the donors of Insentif Riset bagi Peneliti dan Perekayasa Tahun 2009 by *DIKTI-LIPI* for the support of this study

References

Angenent, Largus T. *et al.* 2004, "Production of Bioenergy and Biochemicals from Industrial and Agricultural Wastewater", TRENDS in Biotechnology Vol.22 No.9 September 2004
Anonim, "Biogas", www.electrigaz.com
Anonim, "Biogas", www.wikipedia.org
Anonim, 1998, "Biogas Sumber Energi Alternatif yang Ramah Lingkungan", Majalah Kampus Genta, Edisi 117, Thn XXXIII, halaman 35-38, Surabaya
Cooper, John, 2001, "Turning Carbon Directly into Electricity", Science and Technology Review, Lawrence Livermore National Laboratory, US Department of Energy
Raven, et.al, 2005, "Biogas plants in Denmark: successes and setbacks", Eindhoven University of Technology, The Netherlands
Setyo I., Yuli, 2005, "Reaktor Biogas Skala Kecil/Menengah (Bagian Pertama)", ISTECS, Japan, www.beritaiptek.com
United States Patent – 4042332
United States Patent – 5013334
United States Patent – 5174796