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Biogas Purification Using Coconut Shell Ash Adsorbent Rudy Sutanto1, Sujita2 1, 2Department of Mechanical Engineering, Faculty of Engineering, Mataram University, Mataram, Indonesia Email address: r.sutanto(at)unram.ac.id Abstract— Global developments cause a lack of energy and the depletion of fossil fuel supplies that require serious attention and find solutions to solve them. The high price of fuel also makes it difficult for people to obtain the fuel needed by vehicles to make it easier to fulfill their needs. One alternative energy that can be used is biogas from cow dung. This study aims to determine the effect of flow rate on the purification process using coconut shell ash as an adsorbent on the chemical composition of methane (CH4) and carbon dioxide (CO2) contained in biogas. The method used in this study is an experimental study, the flow rate in the biogas purification process with variations in the flow rate of 1.16 liters/minute, 2.32 liters/minute, 3.48 liters/minute, 4.64 liters/minute, and 5.80 liters/minute. Biogas produced from the purification process with a flow rate variation of 5.80 liters/minute produces the highest chemical composition compared to other flow rates, namely with a chemical composition of CH4 of 40.95% and CO2 of 34.89%. Keywords— Purification, biogas, adsorbent, ash, coconut shell. I. INTRODUCTION Biogas is a gas produced from the decomposition of organic materials by the activity of microorganisms in the absence of oxygen (anaerobic). Biogas is a mixture of several gases with the main components being methane (CH4) and carbon dioxide (CO2) with small amounts of water vapor, hydrogen sulfide (H2S), carbon monoxide (CO) and nitrogen (N2). The composition of biogas depends on the raw materials used. When using human waste, animal waste, or liquid waste from a slaughterhouse, the methane gas produced can reach 70%. Raw materials from plants such as rice stalks and straw produce about 55% methane gas [1]. A good temperature for the fermentation process is a warm temperature, which is in the range of 30ºC - 55ºC. At this temperature, microorganisms can work optimally to break down organic materials and produce gas. Biogas production usually uses livestock manure, such as cows, buffaloes, horses, chickens, etc., but these materials can be replaced with organic waste. Utilization of organic waste is very good as a basic material for making biogas, considering that organic waste in Indonesia is still not managed properly [2]. The composition of the biogas produced is highly dependent on the type of raw material used. However, the main composition of biogas is methane gas (CH4) and carbon dioxide gas (CO2) with a small amount of hydrogen sulfide (H2S). Meanwhile, other ingredients found in a small concentration range (trace elements) are organic sulfur compounds, hydrogen gas (H2), halogenated hydrocarbons (halogenated hydrocarbons), nitrogen gas (N2), carbon monoxide gas (CO) and oxygen gas (O2). The composition of biogas is dominated by methane gas (50-70%), carbon dioxide gas (30-40%), and other gases (H2S, H2O) in small amounts [3]. The heat of combustion using biogas fuel is very dependent on the percentage of methane gas content and carbon dioxide gas. Biogas with high impurity gas components such as CO2, H2O, and Hydrogen sulfide (H2S), can cause a decrease in calorific value. Adsorption is the concentration of one substance on the surface of another substance. Adsorption system is a system that utilizes the ability of solids to absorb a substance and the absorption only takes place on the surface [4]. The substance that is adsorbed on the surface is defined as the adsorbate and the material in which the adsorbate accumulates is defined as the adsorbent

[5]. Adsorption technology in biogas purification can use adsorbents (solids) such as activated carbon or zeolite as CO_2 absorbers. Activated carbon is one of the adsorbents that have been used in the chemical industry. One of the potentials of activated carbon is that it can be used as biogas purification. The surface area of activated carbon ranges from 300 to 2000 m2/g. This is related to the structure of the internal pores which causes activated carbon to act as an adsorbent. Activated carbon can adsorb certain gases and chemical compounds or its adsorption properties are selective depending on the size or volume of the pores and surface area. The absorption of activated carbon is very large, which is 25- 100% by weight of activated carbon. The optimal H_2S adsorption process is indicated by the use of 12 mesh size activated carbon [6]. Research on biogas purification through activated carbon adsorbent column with variations in biogas flow rate of 0.015 l/s, 0.020 l/s 0.025 l/s and obtained an optimal flow rate of 0.025 l/s The results showed the highest effectiveness of the adsorbent column was 96.03% with the use of adsorbent weight of 730 grams [7]. Most adsorbents are highly porous materials, and adsorption takes place on the walls of very small pores, the inner surface area being several orders of magnitude larger than the outer surface. Separation occurs because of differences in molecules or because of differences in polarity which causes some molecules to adhere to the surface more tightly than others. In most cases, the adsorbed component or adsorbate adheres so tightly as to allow complete separation of the component from the fluid without excessive adsorption of the other components. Adsorbent regeneration can be carried out to obtain adsorbate in concentrated or almost pure form [8]. II. RESEARCH METHODS The tools used in this research are: pk compressor, digester, digital balance, 2” pipe, flow meter, gas hose and Gascromatrography. The materials used are: water, coconut shell ash, EM-4, cow feces. This study uses cow feces as the main ingredient in making biogas. The ratio of mixing cow feces with water is 1:1 or 500 liters of water with 500 liters of cow feces. a. Process of making coconut shell ash In this process, the coconut shell is first dried for half a day or about ± 10 hours, after drying the coconut shell is then burned in a container and allowed to extinguish the fire by itself to produce ash. b. Process of making coconut shell ash adsorber The pipe used is a type of PVC pipe with a size of 2 inches and a length of 30 cm then at both ends of the pipe it is installed and a inch gas stop valve which has been fitted with a filter at the bottom and top then filled with coconut shell ash as much as of the volume of the adsorber (Figure 1). The number of adsorbers is 5, namely adsorbers for flow rates of 1.16 liters/minute, 2.32 liters/minute, 3.48 liters/minute, 4.64 liters/minute and 5.80 liters/minute with each adsorber contains 860 grams of coconut shell ash. Fig. 1. The shape of the adsorber c. Biogas purification process This biogas purification process is carried out with various biogas flow rates of 1.16 liters/minute, 2.32 liters/minute, 3.48 liters/minute, 4.64 liters/minute and 5.80 liters/minute. Biogas to be purified is flowed through a flowmeter to the adsorbent (coconut shell ash media) with the help of a mini compressor. Furthermore, the biogas that has passed through the adsorbent becomes purified biogas and is collected back into the next plastic reservoir (figure 2). The research was continued by testing the purified biogas into a gaschromatography tool. Collecting data on the chemical composition of CH_4 and CO_2 contained in purified biogas. Fig. 2. Biogas purification process III. RESULT AND DISCUSSION The results of testing the chemical composition (CH_4 and CO_2) contained in biogas from cow feces using Gas Chromotography can be seen in table I and table II. TABLE I. Carbon dioxide (CO_2) gas content in biogas Flow Rate (liter/minute) 0 1.16 2.32 3.48 4.64 5.80 CO_2 (%) 33.609 33.651 33.902 34.106 34.309 34.894 Fig. 3. Graph of the relationship between flow rate and carbon dioxide (CO_2) content Based on Figure 3, the graph of the results of testing the content of carbon dioxide (CO_2) in biogas has a less significant increase when compared to that without treatment. One of the elements contained in coconut shell ash is silica (SiO_2), where the nature of this silica is able to absorb water vapor. Absorption occurs due to physical contact between biogas and coconut shell ash during the purification process so that the percentage of water vapor (H_2O) content will decrease, as a result of reduced water vapor content in biogas or emptying of biogas composition, causing the composition of carbon dioxide (CO_2)

content to increase insignificantly. The insignificant increase was due to the absorption of the percentage of water vapor content (H2O) in biogas from cow fecesin small quantities. According to the results of the study the percentage of water vapor (H2O) in biogas from cow feces is 4%. So if you look at the difference in the percentage increase in carbon dioxide (CO2) content as shown in table I above, which ranges from 0.12% to 3.82%, it makes sense with the absorption of water vapor (H2O). This means that if there is absorption in one type of biogas chemical composition, the other chemical composition will increase. This shows that coconut shell ash does not react to carbon dioxide (CO2) content but can react to water vapor (H2O) content in biogas. TABLE II. C ontent of methane gas (CH4) in biogas Flow rate liter/minute 0 1.16 2.32 3.48 4.64 5.80 Methane (CH4) (%) 39.907 38.719 39.420 39.789 40.338 40.954 The test results based on Figure 4 show that biogas with flow rates of 1.16, 2.32 and 3.48 liters/minute experienced a decrease in methane (CH4) content when compared to methane content in untreated biogas. However, judging from the composition of the purified biogas, the percentage of methane content at each flow rate level increased less significantly, because the nature of the silica contained in this adsorbent was only able to absorb water vapor. The compositions contained in coconut shell ash are lignin, cellulose, mektosil and silica [9]. Absorption occurs due to physical contact between biogas and adsorbent during the purification process so that the percentage of water vapor (H2O) content is reduced. As a result of the reduced water vapor content in biogas, the composition of methane (CH4) and carbon dioxide (CO2) content increases. The insignificant increase was due to the absorption of the percentage of water vapor (H2O) content in biogas from cow dung in small quantities. Fig. 4. Graph of the relationship between flow rate and methane (CH4) content. Judging from the flow rate in the biogas purification process with the largest flow rate of 10 liters/minute, the methane (CH4) content is greater than the methane content in untreated biogas. This shows that biogas purification by using coconut shell ash as adsorbent is less significant in increasing methane (CH4) content. IV. CONCLUSION The conclusion obtained after conducting research on the biogas purification method using coconut shell ash as an adsorbent is that the purified biogas with a purified type of biogas with a flow rate of 5.80 liters/minute produces the largest chemical composition compared to other types of biogas. Purified biogas with a flow rate of 5.80 liters/minute has a composition of 40.95% methane (CH4) and 34.89% carbon dioxide (CO2). Judging from the difference in chemical composition of purified biogas without treatment is very small, it can be concluded that biogas purification using coconut shell ash as adsorbent is less effective in improving biogas quality. REFERENCES [1]. Hardoyo., Tri Atmodjo., Dadang Rosadi., M. Sigit Cahyono. (2014), ”Panduan Praktis Membuat Biogas Portabel Skala Rumah Tangga & Industri” Yogyakarta. [2]. Jatmiko, Sigit. (2015), “Karakteristik Thermal Biogas Yang Difurifikasi Larutan KOH 4 (Empat) Molaritas Dibandingkan Dengan Biogas Tanpa Purifikasi” Skripsi. Jember : Universitas Jember. [3]. Meynell, P.J. (1976), “Methane: Planning a Digester” Great Britain : Prism Press. [4]. Kriwiyanti A, Enny., Danarto, Y. (2007), “Model Kesetimbangan Adsorpsi Cr Dengan Rumput Laut. Ekuilibrium” Vol. 6 No. 2 [5]. Do, Duang D. (1998), “Adsorption Analysis: Equilibria and Kinetics” London: Imperial Collage Press. [6]. Alwathan., Mustafa., Ramli, Tahir. (2013), “Pengurangan Kadar H2S dari Biogas Limbah Cair Rumah Sakit dengan Metode Adsorpsi” Konversi, Vol. 2 No.1. [7]. Fahruzi, Ilham, M. (2019), “Penyisihan Gas H2s Dari Biogas Dengan Metode Adsorpsi Menggunakan Adsorben Karbon Aktif Tempurung Kelapa” Skripsi. Universitas Jember. [8]. Saleh, A., Permana D.A., Yuliandita, R. (2015), “Pengaruh Komposisi Adsorben Campuran (Zeolit-Semen Putih) dan Waktu Adsorpsi Produk Gas Metana Terhadap Kualitas Biogas Sebagai Bahan Bakar Alternatif. Jurnal Teknik Kimia” Vol. 21 No. 4. [9]. Yayang, A, S., Abdul, L., Winardi, S., Nurtono, T., Widiyastuti., dan Mahmudak, S. (2014), “Pengaruh Pengadukan Pada Proses Pembuatan Sol Silika Dari Sodium Silicate” Fakultas Teknologi Industri, ITB. International Research Journal of Advanced Engineering and Science ISSN (Online): 2455-9024 International Research Journal of Advanced Engineering and Science ISSN (Online): 2455-9024 International Research Journal of Advanced Engineering and Science ISSN (Online): 2455-9024 155 Rudy Sutanto,

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