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Vol.2 No.2; Mar-Apr 2021 HYDROGEN SULFIDE (H<sub>2</sub>S) GAS ABSORBSION IN BIOGAS USING FERRY OXIDE (Fe<sub>2</sub>O<sub>3</sub>)  
Rudy Sutanto<sup>1</sup> and Sujita<sup>2</sup> <sup>1,2</sup>Department of Mechanical Engineering, Engineering Faculty, Mataram University,  
Mataram, Indonesia. ABSTRACT [The long-term objective of this research is to obtain biogas with renewable natural gas quality and can be used as fuel for electric generators to support the availability of electricity in](#) small island areas. [The specific target to be achieved is to obtain methods / techniques to reduce impurity levels contained in biogas, especially hydrogen sulfide gas, comprehensive technology information and active ingredients to absorb](#)

[hydrogen sulfide gas as materials](#) for [writing textbooks and articles for national journals](#). This research will be tested to reduce levels of H<sub>2</sub>S (hydrogen sulfide) in biogas using ferric oxide (Fe<sub>2</sub>O<sub>3</sub>) absorbent. In this study, the variables studied were the effect of the biogas flow rate on absorbed hydrogen sulfide (H<sub>2</sub>S) and the resulting CH<sub>4</sub>. H<sub>2</sub>S absorption was carried out by feeding biogas into the ferric oxide absorbent continuously at a certain biogas flow rate (1, 3, 5, 7 and 9 l / min). Then the research was continued by determining the levels of H<sub>2</sub>S absorbed and CH<sub>4</sub> produced using the biogas tester set type atex directive. The increasing of the biogas flow rate that passes through the absorber tube containing Fe<sub>2</sub>O<sub>3</sub>, the smaller the H<sub>2</sub>S gas that can be absorbed by Fe<sub>2</sub>O<sub>3</sub>, this is because the time to react between H<sub>2</sub>S and Fe<sub>2</sub>O<sub>3</sub> is getting smaller or less, so that the reaction that occurs is still not perfect, the biogas has left the tube. absorber. In this study, biogas with a flow rate of 1 liter / minute, obtained the best absorber ability to absorb H<sub>2</sub>S, namely H<sub>2</sub>S lagging an average of only 14.43 ppm from 1314 ppm contained in biogas, or nearly 98.9% which can be absorbed. Meanwhile, the level of methane gas (CH<sub>4</sub>) did not change during the purification process. KEYWORDS: biogas, ferric oxide, hydrogen sulfide, absorbent INTRODUCTION The process of making biogas is the process of decomposing organic matter by including small substances in anaerobic conditions, namely conditions without oxygen (anaerobic digestion), so the equipment used requires a high air tightness. The process occurs at low temperatures up to 65oC, biogas can be a cheap and environmentally friendly alternative to fuel oil. Where the composition of the biogas is CH<sub>4</sub>, CO<sub>2</sub>, N<sub>2</sub>, H<sub>2</sub>, O<sub>2</sub>, and H<sub>2</sub>S. Methane gas or CH<sub>4</sub> in biogas is the main element in biogas which is a component in combustion and also has a large percentage, so that it can produce high heat. In addition to methane gas (CH<sub>4</sub>), which is very necessary, there are other ingredients that can disturb or damage it. For example carbon dioxide (CO<sub>2</sub>), this CO<sub>2</sub> level in biogas ranks second after CH<sub>4</sub> with a percentage of approximately 40% followed by H<sub>2</sub>S levels with a percentage of 3%. Vol.2 No.2; Mar-Apr 2021 [CO<sub>2</sub> gas in biogas needs to be removed because this gas can reduce the heating value of biogas combustion](#). In addition, [the content of carbon dioxide gas \(CO<sub>2</sub>\) in biogas](#) is quite large, namely around 30-45%, so that the heating value of biogas combustion will be significantly reduced. The heating value of burning pure methane gas at a pressure of 1 atm and a temperature of 15.5oC is 9100 Kcal/m<sup>3</sup> (12,740 Kcal/kg). While the heating value of biogas combustion is around 4,800 - 6,900 Kcal/m<sup>3</sup> (6,720 - 9660 Kcal/kg) [1]. The gas separation technology that has been developed is the use of membranes. In this case zeolite Mixed Matrix Membranes is used for the separation of CO<sub>2</sub> / CH<sub>4</sub>. The choice of membrane as a gas separation technology is not new. Two criteria for a separation technology will be chosen if technical and economic considerations are easy [2]. [3] has carried out the process of refining and pressurized packaging of biogas and its application in the process of generating electrical energy and substituting fossil fuels. It shows that the biogas purification results are close to 100% CH<sub>4</sub> with an efficiency level of electricity and combustion in car engines reaching 97%. Bajracharya (2009) has carried out biogas purification and increased pressure in its storage system, showing that the heating efficiency rate has increased by up to 97%. This shows the success of biogas purification using CaO, Ca (OH)<sub>2</sub> and NH<sub>4</sub>OH as CO<sub>2</sub> absorber and H<sub>2</sub>S gas absorber. The results of the research on horse manure utilization are very good for use as a basic material for making biogas. Horses have a special digestive system that uses microorganisms in their digestive system to digest cellulose and lignin from grass or high-fiber forages. Therefore, horse manure has a high cellulose content. Based on the results of the research, it shows that biogas with raw material of horse manure has a gas composition including methane (CH<sub>4</sub>) 69.7%, carbon dioxide (CO<sub>2</sub>) 25.4%, nitrogen (N<sub>2</sub>) 2.3%, hydrogen sulfide (H<sub>2</sub>S) 0.3% and oxygen (O<sub>2</sub>) 0.1 % [4]. The CO<sub>2</sub> content in biogas is still quite large. This causes the efficiency of the heat [produced is still low so that the quality of the biogas flame is still not optimal. Therefore](#), it is necessary to purify the CO<sub>2</sub> content in biogas, one way is to use ammonium hydroxide (NH<sub>4</sub>OH). The purification process carried out is to create a CO<sub>2</sub> absorption system, where the NH<sub>4</sub>OH solution will bind CO<sub>2</sub> in the biogas. This study used an experimental method with three treatments, namely

the biogas rate of 1.7 m/s, 1.3 m/s, and 0.6 m/s. For data collection, it was done every 5 minutes for 20 minutes. The analysis results showed a decrease in the CO<sub>2</sub> content of the biogas. At a biogas rate of 1.7 m/s the CO<sub>2</sub> content decreased by 9.45%, at a biogas rate of 1.3 m/s decreased by 13.77%, and at a biogas rate of 0.6 m/s the CO<sub>2</sub> content decreased by 15, 72%. The analysis also showed a change in the molarity of the NH<sub>4</sub>OH solution. At the biogas rate Vol.2 No.2; Mar-Apr 2021 of 1.7 m/s there was a decrease in molarity of 0.85 M, at the biogas rate of 1.3 m/s the molarity of the NH<sub>4</sub>OH solution decreased by 1.163 M, and 1.172 M at the biogas rate of 0.6 m/s. The absorption efficiency of CO<sub>2</sub> by the NH<sub>4</sub>OH solution at the biogas rate of 1.7 m/s was higher than at the biogas rate of 1.7 m/s and 0.3 m/s. Meanwhile, the effectiveness of CO<sub>2</sub> absorption by NH<sub>4</sub>OH solution at a biogas rate of 0.6 m/s is more effective than the biogas rate of 1.7 m/s and 1.3 m/s [5]. [6] The use of biogas purification technology depends on the composition of the biogas and its intended use. According to Pabby et al. (2009), the composition of the biogas depends on the source of the raw material. The biogas purification process using membranes is excellent at an operating pressure of 5–7 bar. According to Noverri (2007), the selection of a suitable method for separating CO<sub>2</sub> from the mixture depends on several parameters, namely: CO<sub>2</sub> concentration in the feed stream, the nature of the feed components, pressure and temperature. According to Kapdi et al. (2005), there are several methods of biogas purification (CO<sub>2</sub> removal), including: physical absorption, chemical absorption, adsorption, membrane separation, cryogenic and chemical conversion into other compounds.

1. Research Methods The research method that will be used to achieve the research objective is to carry out several experimental stages: the first step is to analyze the initial composition contained in the biogas to determine the initial concentration of H<sub>2</sub>S gas and the initial concentration of CH<sub>4</sub> gas in the biogas. This stage will be carried out at the New and Renewable Energy Laboratory. While the second stage is to test the ability of the Fe<sub>2</sub>O<sub>3</sub> absorber to bind H<sub>2</sub>S gas in the biogas element so that it will increase the quality of the biogas, this stage is carried out in the energy conversion laboratory and the New and Renewable Energy Laboratory. The main material needed in this study is biomass from household waste and livestock waste, then mix the biomass waste and water with a ratio of 1: 1, stirring until it dissolves. The mixture is put into a storage tank (digester). Then all the ducts and holes are closed so that no air can enter the system. Furthermore, the mixture of manure and water is left to stand for ± 3-4 weeks to form biogas. Furthermore, for the absorber, 270 g of turned iron is used and then put into the absorber tube and then exhaled with pure oxygen for 10 minutes, then the iron growler will react to ferrous oxide (Fe<sub>2</sub>O<sub>3</sub>). While the variables selected include: fixed variables: Biogas composition consisting of a mixture of CH<sub>4</sub> gases, CO<sub>2</sub>, H<sub>2</sub>S, H<sub>2</sub>O and others, Operating temperature (Top): At room temperature (30°C). And for variable changes: biogas flow rate: 1 l/minute, 3 l/minute, 5 l/minute, 7 l/minute and 9 l/minute, absorber: Fe<sub>2</sub>O<sub>3</sub>. The research was continued with the process of absorption of hydrogen sulfide gas contained in biogas Vol.2 No.2; Mar-Apr 2021 with a ferric oxide absorber. H<sub>2</sub>S absorption is carried out by feeding biogas into the ferric oxide absorbent continuously at a certain flow rate (1, 3, 5, 7 and 9 l / min), meanwhile the biogas is flowed to the bottom of the column. Gas and ferric oxide will contact each other and a chemical reaction occurs. Each time interval of 2 minutes, the biogas after absorption is taken for analysis. The amount of H<sub>2</sub>S absorbed was analyzed using the atex directive method. In this study, the variables studied were the effect of the biogas flow rate on the H<sub>2</sub>S absorbed and the resulting CH<sub>4</sub>. The series of biogas purification testing tools are as follows, 1 2 3 4 7 6 5

Figure 1: A series of test equipment. 1. A place to collect biogas, 2. Vacuum pump, 3. Flowmeter, 4. Absorber, 5. Biogas tester (type. ATEX Directive 94/9/EC), 6. Purified biogas tube, 7. Digester

2. Results and Discussion Biogas content in general is methane gas, carbon dioxide gas, hydrogen sulfide and other gases in small amounts. To determine the level of gas contained in the biogas, a biogas tester is used. Hydrogen sulfide contained in biogas is relatively small but is very detrimental because it can cause corrosion, foul odor and is poisonous. The content of hydrogen sulfide in biogas can be reduced by chemical absorption using ferric oxide (Fe<sub>2</sub>O<sub>3</sub>) absorbent. Biogas that



