Human waste biogas production: Processes and Utilization

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Abstract. Human waste biogas production is not fashionable at the moment due to its quality compared to other animal waste. However, human waste is more abundant than animal waste. More so, the possibility of having scarcity of human waste in the coming years is almost not possible. This research seeks ways of optimizing the quality of biogas from human waste. The results show that the processed human wastes have improved biogas quality. It is recommended that standalone energy users in urban and rural centres to adopt this technique to utilize biogas usage from human waste.

Keywords: energy, biogas, human waste, renewable energy, biofuel

1. Introduction

Biogas is a gas that has a synthesis of around 50-70% Methane (CH₄), 30-half Carbon dioxide (CO₂) with the rest of the gases being: H₂, O₂, H₂S, N₂ and water vapour, produced from the anaerobic processing of natural waste. Biogas comprises mostly of CH₄ and CO₂, with low dimensions of H₂S and different gases. The biogas yield in animal waste and biomass is presented in Figure 1. It is a known fact that biogas from human waste is quite low [1-2]. However, it is abundant and may not go extinct as the waste or biomass presented in Figure 1.

Figure 1: Biogas production from selected animal waste and biomass
The results in Figure 1 are due to the rate of anaerobic biodegradation in the waste or biomass. Anaerobic creation of biogas does not deliver any hostile smell, causing reduction of pollution, hence making it environmentally friendly, cost efficient, cheap and readily available, and reduces greenhouse effect [3-5]. Biogas resulting from biomass or waste is targeted to replace fossil fuel usage to mitigate air pollution [6-7]. The richest forms of biogas or biofuel materials are cow waste (i.e. cow dung) due to the already digested state from the multiple stomachs of the host [8-9]. Cow dung is easily gotten in large quantity from rural areas. There is the possibility that the continuous usage of animal waste may go extinct due to its other application as manure for rural farmers. In other words, the only other alternative is human waste, and this is richly available in the sewage sludge. Unlike the cow dung sewage sludge is not processed and still has to be refined for it to be a good source of biogas. This therefore poses a problem for future biogas users.

2. Experimental Design, Materials and Methods
Pipes are connected to open sewage slurry, the fumes from the slurry is collected into a cylinder. The biogas naturally travels through the pipe by diffusion. This process takes close to an hour. However, if automatic pumps are used to suck the biogas in the sewage slurry, the process is faster i.e. 5 minutes. The component of the biogas in the cylinder was tested for methane (\( \text{CH}_3 \)), hydrogen sulphide (H₂S), carbon (II) oxide (CO₂), and moisture before passing it through a connecting pipe to the purification cylinder containing silica gel. The silica gel is a drying agent that would suck-up the moisture content of the human waste biogas. After about thirty minutes, the biogas is harvest and tested the second time.

3. Results and Discussion
According to Figure 2, the pre-processed methane levels started at a steady concentration of 167 ppm and maintained this levels up until 500 seconds (8 minutes) into the readings from the first cylinder, where it fell to 150 ppm. Methane readings eventually after 1000 seconds recorded 180 ppm. This reveals that the methane production in the sewage slurry is dynamic with time. According to figure 3, the CO₂ contained in the sewage fumes was constantly fluctuating. It started off at 124ppm and constantly fluctuated till it dropped drastically after 500 seconds of reading. It peaked again at 600 seconds and dropped at 800 seconds, after which it was on a constant increase with just minor fluctuations.
Figure 2: The graph of pre-process for Methane.

Figure 3: The graph of pre-process for CO2

The significance of this is that the CO₂ content in the pre-processed fumes was unstable and this could have been as a result of a number of reasons that may not be captured in this report because the history of the sewage sludge is not known by the authors. According to figure 4, the undehydrated hydrogen-sulphide reading recorded steady levels throughout the 1000 seconds of the experiment except for some minor fluctuations. This implies that the H₂S levels contained in the pre-processed fumes were steady and in rich supply. According to figure 5, looking at the range of value between which the concentration of humidity, it can be inferred that the humidity maybe almost uniform in larger part of the experiment.
When the captured biogas was processed. The results is presented in Figures 6-9.
Figure 6: The graph of post-process for methane.

Figure 7: The graph of post-process for CO2.

Figure 8: The graph of post-process for H2S.
According to the post-process graphs, it shows methane has improved in its level of concentration, from 180ppm to 230ppm maximum value in the pre-process and post-process respectfully. CO levels, drastically reduced in the post process from 124ppm to 91ppm maximum value in the pre-process and post-process respectfully. Hydrogen-sulphide levels also improved a little but maintained its recorded reading without much fluctuation from 36ppm to 46ppm maximum value in the pre-process and post-process respectfully.

4. Conclusion
Biogas from human waste can be treated and utilized as shown in this research. Hence, the quality of biogas from human waste can be further optimized for better quality. This research considers only the biogas quality and not its quantity. However, it is recommended that the quantity of the biogas from human waste can be improved if the fluid in toilet system is changed from water to pressurized air.

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5. References
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