“10 ปี adiCET กับการพัฒนาพลังงานเพื่อท้องถิ่น”

Enhancement of Biogas Production with Solar Energy

Rotjapun Nirunsin, Worajit Settapun, Natthawud Dussadee and Hathaithip Ninsonti.
Asian Development College for Community Economy and Technology, Chaing Mai Rajabhat University, Thailand.

Key Findings

1. Household biogas
2. Solar collector
3. Solar greenhouse

Introduction

This study involves utilization of solar thermal energy to heat the digested slurry inside the biogas digester by using 2 techniques namely solar collector and solar greenhouse. The first technique is solar collector combined with heat exchanger and the second technique is solar greenhouse designed to cover the biogas digester to collect the solar thermal energy. These two techniques were utilized to warm up the digested slurry inside the biogas digester for increasing the anaerobic digestion temperature to the proper range. Finally, the comparisons of efficiency of the biogas production from using these solar heating techniques were presented.

Conceptual Framework

By flowing Figure 1. Solar heating techniques of solar collector and solar greenhouse were applied and compared. For the enhancement of biogas production, solar collector panel was connected to 1,000 L biogas digester system. In the case of biogas production enhancement using solar greenhouse, a solar greenhouse was used to store heat energy from the solar and it was built to cover the entire 1,000 L biogas digester system so that the heat energy get transferred to digested slurry inside the biogas digester.

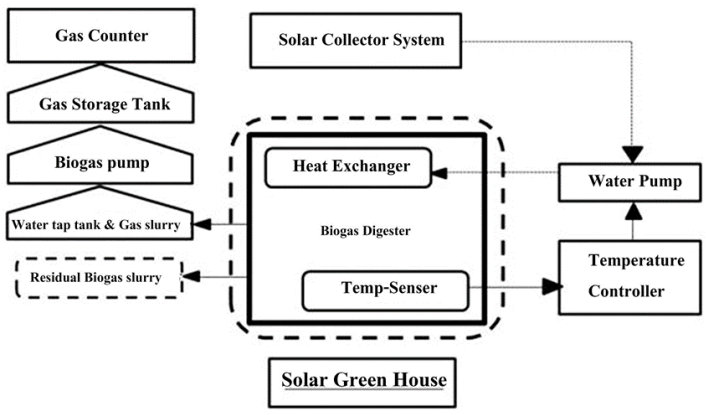

Figure 1. Diagram of biogas production under anaerobic fermentation process.

Research Methodology

In this work, 1,000 L biogas digesters conducted with 3 conditions. The first condition was to produce biogas without solar heating. The second condition, the digested slurry was warmed up by using of a solar collector to store solar heat energy and the third condition was using of a solar greenhouse to store heat from solar energy. The experiments showed as Figure 2.

Figure 2. Three biogas production systems a) 1,000 L biogas production system without solar heating b) Solar collector connected to 1,000 L biogas digester system and c) Solar greenhouse covering the entire 1,000 L biogas digester system.

Preliminary Results

Operational parameters of biogas production were kept under the same condition such as the feeding material with Organic Loading Rate (OLR) 5.6 kg COD/m^3 organic waste; Hydraulic Retention Time (HRT) is 10 days; digested slurry was mixed for 10 min every 3 h; and the experimental data were recorded every hour during 12:00 am till 12:00 pm. The experimental results showed as Figure 3 to Figure 5 that total biogas production quantity when using solar collector, solar greenhouse and without solar heating were 3,754, 2,325 and 965 L, respectively. COD removal when using solar collector and solar greenhouse as compared to using without solar heating were 73.02, 70.64 and 68.70, respectively. The highest methane fraction was 58% when using solar collector while using solar greenhouse and without solar heating were 55% and 51%, respectively.

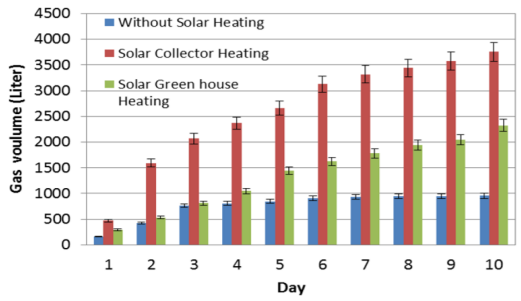

Figure 3. Quantities of accumulated biogas production of three experimental conditions.

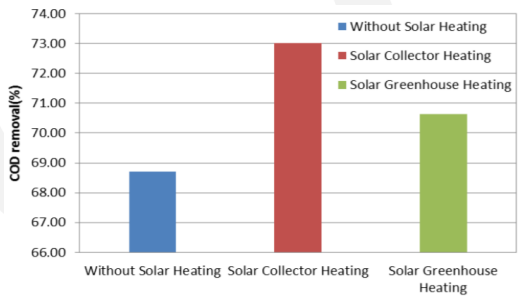

Figure 4. A comparison of COD removal of three experiments.

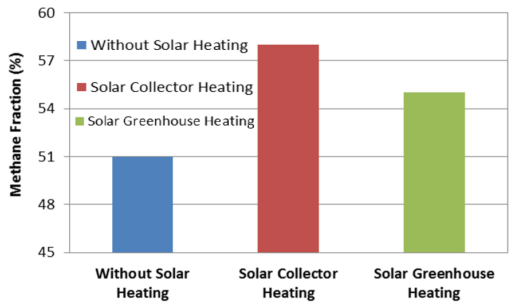

Figure 5. A comparison of highest methane fraction of each conditions.

Conclusion

Three experiments under 3 conditions have been conducted to test efficiency from the use of solar heat for raising temperature of digested slurry inside a 1,000 L biogas digester to achieve higher efficiency of organic waste material fermentation and better biogas production. As the result, solar collector technique was the most effective method to enhance the biogas production from anaerobic fermentation process and it was able to increase and maintain temperature.

Acknowledgements

The researcher would like to thank you for the financial support from Energy Policy and Planning Office, Ministry of Energy and Defense Energy Department for the research equipments. In addition, we would like to thank Asian Development College for Community Economy and Technology (adiCET), Chiang Mai Rajabhat University and School of Renewable Energy, Maejo University for providing analysis tools for this research.