VOL. 10, NO 22, DECEMBER, 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

PERFORMANCE ANALYSIS OF BIOGAS STOVES WITH VARIATIONS OF FLAME BURNER FOR THE CAPACITY OF BIOGAS 1 M3 / DAY

Syamsuri[1], Suheni[1] and Yustia W. M.[2]
[1]Depatrment of Mechanical Engineering, Institut Teknologi Adhi Tama Surabaya, Indonesia
[2]Depatrment of Chemical Engineering, Institut Teknologi Adhi Tama Surabaya, Indonesia
E-Mail: syam_sby2003@yahoo.com

ABSTRACT

Natural Resources on earth are very abundant one of Natural Resources is Fuel. But the last few years the energy is a crucial issue in the world. One alternative is biogas energy. Biogas is a viable energy used technically, socially, and economically mainly to solve the energy problems in rural areas. In the present study, aims to identify and analyze the performance of the biogas stove. In this study, will be tested various forms burner i.e. regular shaped burner, Cyclone 1, and Cyclone 2. The results showed that the power of a cyclone burner biogas stove shape is higher than that using a biogas stove burner usual form. As for the efficiency of biogas stoves shape cyclone burner 2 is higher than the efficiency of biogas stoves that use a form of ordinary burner. From another aspect, namely the mass of the steam generated by the cyclone burner type 2 is greater than the other burne.

Keywords: performance stove, variation, burner, biogas.

INTRODUCTION

Natural resources on earth are very abundant; one of Natural resources is a fuel. Over time the number of people on earth is increasing, the amount of fuel oil consumed by mankind to meet the needs of everyday life must also be fulfilled, so the supply of natural resources called fuel on this earth more days will be dwindling.

The energy crisis triggered by soaring oil prices (once reached $70/barrel) also choke people's lives in different parts of Indonesia. It is aware of the various parties that dependence on fuel (fuel oil) is slowly needs to be reduced. The bad effect of fuel combustion on the environment is also a driving factor for the search and development of new alternative energy (Indartono, 2005).

In this situation the search, development, and deployment of new alternative energy technologies are cheap, environmentally friendly and renewable as well as solar energy, wind Energy, water energy and alternative energy sources becomes more important. Mainly aimed at the poor as the group most affected when there is an increase, the price of fuel and LPG. Those problems can be overcome if it is not dependent on fossil fuels and LPG in a way using the new alternative energy sources that are environmentally friendly, inexpensive, easy to obtain and can be renewed. One is a biogas which is a viable energy used technically, socially, and economically. Especially for addressing energy problems in rural areas (Udiharto, 1982)

Biogas is a gas produced from organic material such as biomass, agricultural waste and animal waste also which through the process of anaerobic fermentation. Gas produced from the fermentation process contains a high calorific value and can be used for cooking and lighting for households in rural areas. The rest of the fermentation can also be used as a very useful fertilizer for plants. Besides, also its management can improve environmental hygiene. This is because agricultural waste and animal waste that had been dumped in the open now utilized. But now the use of alternative energy sources that are environmentally friendly is still a few who use it particularly in rural areas (Wibowo *et al.*, 1985).

Research on biogas have been carried out by previous researchers among others by Meynell (1976), Sihombing (1980), Indartono (2005), Widodo *et al.*, (2006), and Sofian (2008). Research on the performance of the stove, fuel briquettes also been done by Syamsuri and Suheni (2014), Syamsuri (2013), and Syamsuri and Aris Budianto (2014). Similarly, research on biogas stoves performance has been done by Syamsuri (2014). However, research on biogas stoves performance with variations flame of the burner has not been done by previous researchers yet.

THEORY

Power stoves

To determine the amount of power of the stove/furnace used the following equation (Bhattacharya *et al.*, 2003):

$$P = \frac{m_f.E}{\Delta t}\,(\mathrm{KW}). \tag{1}$$

where: P is the stove power (kW), m_f is the fuel consumption during time t (kg), E is the Low Heating Value (LHV) fuel, kJ / kg. fuel and t is testing time (s).

ARPN Journal of Engineering and Applied Sciences

Efficiency

Efficiency is the percentage of useful heat compared to heat given by the fuel during the test, the equation used is as follows [Bhattacharya *et al.,* 2003]:

$$\eta_{overall} = \frac{(m_w.cp + m_{pa}.cp_a)(T_2 - T_1) + m_s.H_{fg}}{m_f.E} \times 100\% \quad (2)$$

where: η is the overall efficiency of the stove, Mw is the mass of heated water, kg, Mpa is used pan mass, kg, Cp is the specific heat of water, kJ / kg, Cpa is the specific heat of pan, kJ / kg, T_2 is the temperature of boiling water, ^oC, T_1 is the initial temperature of the water, ^oC, Ms is the mass of evaporated water, kg, Mf is the mass of material used, kg, Hfg is the latent heat of vaporization water, and E is LHV.

RESEARCH METHODOLOGY

Areas of research

The burner variations of studied were:

a) Regular-shaped burner
b) Cyclone 1-shaped burner
c) Cyclone 2-shaped burner

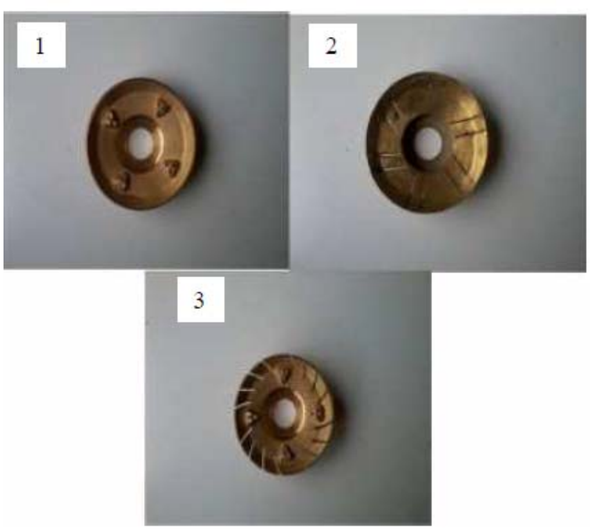

Figure-1. Forms of biogas stove burner.

The surface area of the fuel holes are all the same.

Equipment and measuring instrument

The equipment used in this test for data collection are as follows: gas stove that has been modified. Three burner which has the shape of a flame the assortment namely ordinary burner , burner in the form of cyclone burner 1, burner in the form of cyclone 2, pot of type of pyrex glass, thermometer, gas flow meter, stopwatch, digital scales, water, and digital cameras.

Testing techniques and data collection

In this test conducted with three experiments using three different burners and steps as described below: Ensure biogas in a container (reservoir) the full circumstances, Setting stopwatch, Put the first burner the burner usual on the stove, Weigh the water according to a predetermined size and put into the pot, Measure initial temperature of the water (T_1), Measure initial use of the fuel in the flow meter, Turn on the stove, Retrieval of data for temperature and fuel consumption is done in a time interval 2 minutes until the water boils (T_2), Weigh water remaining in the pan.

In the next experiment, simply replace the burner on the stove with the second burner and the third burner. Next steps are the same as those performed in the first experiment.

RESULT AND DISCUSSIONS

The effect of power against time for various of burner

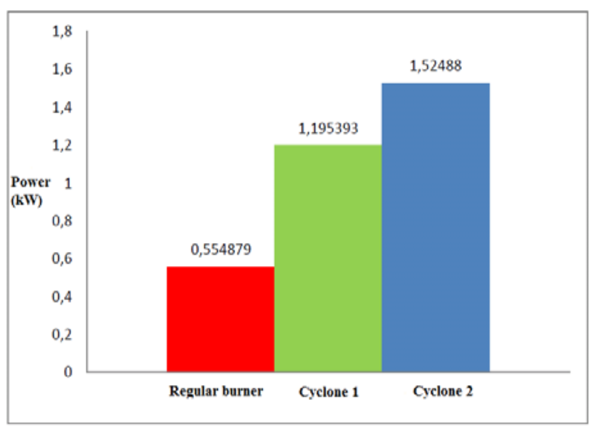

Figure-2. Graph of the influence shape burner to power of the biogas stove.

Figure-2 mentioned above can be concluded that variations of burner greatly affect the value of the power. This is evidenced by more magnitude the value of power of a pot with a cyclone burner 2 compared with ordinary burner shape. This is due to the burner orifice diameter larger than the required fuel consumption is also large, so by equation 1 if the value of the fuel consumption (mf) greater than the value of the power (P) is also great.

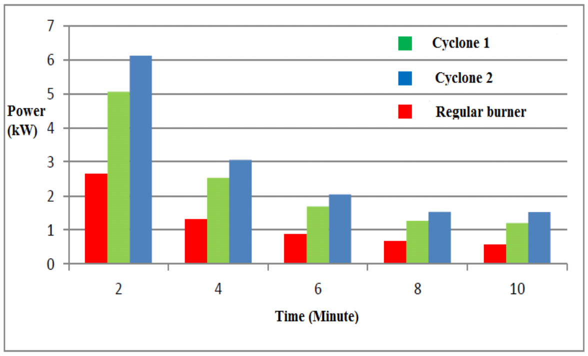

Figure-3. The graph of power versus time.

Figure-3 is a graph of power versus time. From the picture above we can conclude that the use of the form Cyclone burner 2 produces power that is greater than the usual shaped burner. This is because the form of Cyclone burner has a diameter larger, and then the required fuel consumption is also large. On the picture looks power progressively decreases and this is because the power has been used up to heat water with an increasingly long time.

The effect of efficiency against time for various burner

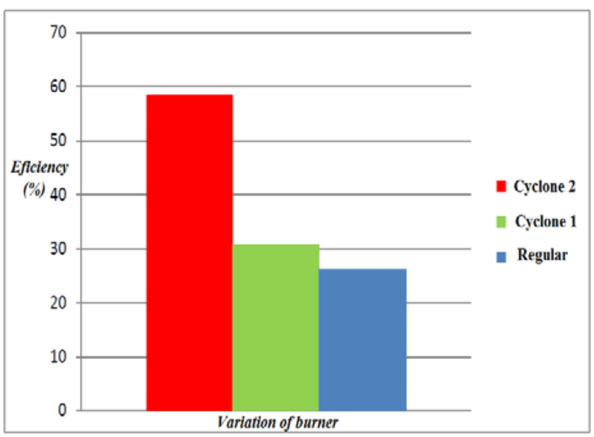

Figure-4. Influence of variations in shape burner to the efficiency of biogas stoves.

Figure-4 shows the greatest efficiency seen in burner stove burner form Cyclone 2. This is because the shape of the cyclone burner causing greater heat transfer area compare to the other burner, so that the resulting temperature is higher or larger ΔT. According to equation 2 that if ΔT values great, then the value of efficiency would also are great. It means that the useful energy was larger. This corresponds with previous studies by Beer (2000), Steven and Philip (2004), and Adi and Yudho (2011), which indicates a high temperature gradient and heat transfer area which is larger.

The effect of temperature against time

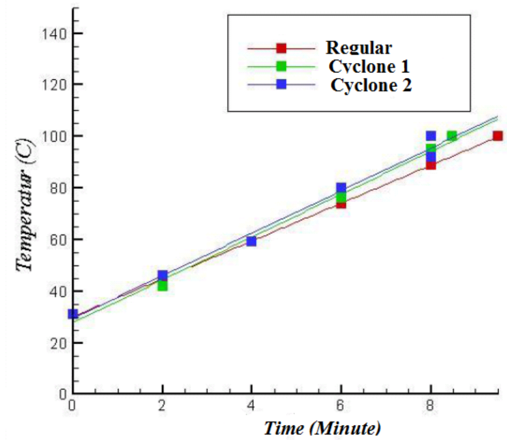

Figure-5. Graph of temperature versus time for various burner biogas stove.

Figure-5 above show that with the increase or increasing the time, the temperature of the water that is cooked will also increase. This is due to heating conducted by the stove causing the temperature in the water. The longer the more go up. The behavior is consistent with warming theory of Newton (Incropera and David, 1996) that:

Qconv = h.A.Δt

If the value of q greater then the value Δt is also great.

The influence of steam mass against time

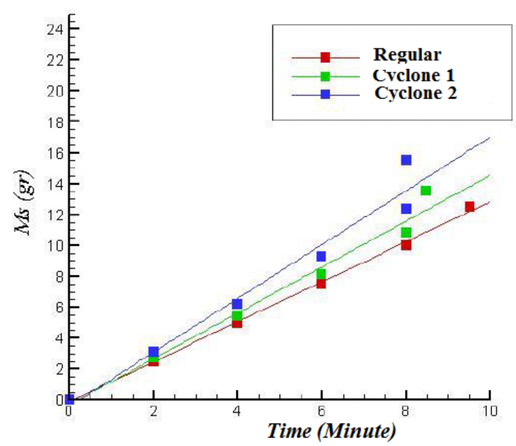

Figure-6. Charts the relationship between the mass of water evaporated over the time for various of burner.

In Figure-6 seen that with the rising time, the mass of water that evaporates will further increase. There is something interesting here that the increase in mass of steam. For the burner cyclone 2, the increase in the mass of water that evaporates more quickly than others. This is because the heat transfer area in the cyclone burner 2 which is great then the heat is supplied is also getting bigger. The temperature will increase and consequently the mass of steam produced is also faster increases. This is in accordance with the equation for the latent heat that is:

$q = Ms.hfg$

At the equation, when the value of q greater than the value of the vapor mass (Ms) is also great.

The relationship between the mass of fuel against time

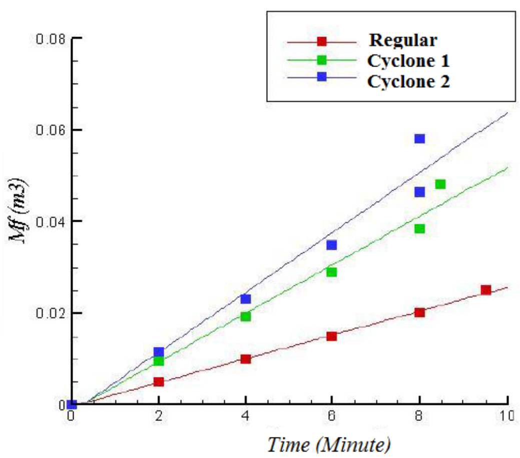

Figure-7. Relationship between the mass of fuel against time for various biogas stove burner.

In the picture above shows that with the increase in time then the fuel is being consumed is also growing. But there are things that are important here, look at the picture that for burner shape of cyclone 2 the use of fuel more than the usual forms and cyclone burner 1. This is because a large area causes debit which is greater for the same speed. This is consistent with the theory of continuity that:

$Q = V.A$

CONCLUSIONS

From the experimental results and calculations performed can be drawn the following conclusion:

a) Apparently the power of biogas stoves which forms cyclone burner is higher than the usual burner of biogas stove form. The biggest power generated is equal to 1.52488 kW for cyclone burner 2.

b) As for the efficiency of biogas stoves shape cyclone burner 2 higher than the efficiency of biogas stove burner usual form. The highest efficiency is equal to 58.42 % for cyclone-shaped burner 2.

c) Mass steam generated by the cyclone burner type 2 is greater than the other burner.

REFERENCES

[1] Adi S. and Yudho D.P. 2011. Investigation of gas swirl burner characteristic on biomass gasification system using combustion unit equipment (cue), Jurnal Mekanikal. (33): 15-31.

[2] Bee´r J.M. 2000. Combustion technology developments in power generation in response to environmental challenges, Progress in Energy and Combustion Science. 26, pp. 301-327.

[3] Bhattacharya S.C., Kumar S., Leon M.A. and Khang A.M. 2003. Design and performance of natural draft gasifier stove for use in institutional and industrial. International Conference. Yogyakarta, Indonesia.

[4] Incropera and David. 1996. Fundamentals of heat and mass transfer. 4th Ed. John Wiley and Sons Inc. New York, USA.

[5] Indartono Y. S. 2005. Biogas reactor for small and medium scale (part one). http://www.beritaiptek.com/statik.php [11 January, 2007].

[6] Meynell D.S. 1986. Methane: Planning a digester. Great Britain: Prism Press.

[7] Sihombing D.T.H. 1980. Prospects use of biogas for rural energy in Indonesia, LPL, No. 11 Tahun XIV, LEMIGAS, Jakarta, Indonesia.

[8] Sofian A. 2008. Improving the quality of biogas as a fuel combustion engine by way of a reduction in the levels of CO_2 in the biogas using slurry of Ca $(OH)_2$, Jurusan Teknik Mesin-Fakultas Teknik, Universitas Muhamadiyah Surakarta.

[9] Stephen M. B. K. and Philip C. M. 2004. Simulation and modeling of wood dust combustion in cyclone burners, Final Technical Report, U. S. Department of Energy.

[10] Syamsuri. 2013. Performance analysis of biomass stove portable with and without fin which briquettes fuel from nutshell, Prosiding Seminar Nasional Rekayasa Energi, Mekatronik, dan Teknik Kendaraan, Komplek LIPI Bandung. pp. 1-8.

[11] Syamsuri. 2014. Performance analysis of biogas stoves by volume container of biogas 1 m^3 / day, Penelitian Mandiri, ITATS, Surabaya, Indonesia.

[12] Syamsuri dan Aris Budianto. 2014. Performance analysis portable biomass furnace with and without fins rice husk -fueled, Seminar dan ekspose hasil penelitian dan pengabdian kepada masyarakat, Kopertis Wilayah VII Surabaya.

[13] Syamsuri dan Suheni. 2014. Experimental study of biomass stove portable with and without fin which briquettes fuel from corncob, ARPN Journal of Engineering and Applied Sciences. 9(9): 1394-1397.

[14] Wibowo D., Rahayu K.,Haryanto B. 1985. Bio gas as one of alternative energy sources, Fafeta UGM, Yogyakarta,Indonesia.

[15] Widodo T. W., Asari Ahmad., Nurhasanah A. and Rahmarestia E. 2006. Engineering and testing biogas reactor for farmer group scale, Balai Besar Pengembangan Mekanisasi Pertanian, Jurnal Enjinering Pertanian. pp. 41-52.