DESIGN AND PERFOMANCE ANALYSIS OF BIO MASS GASSIFIER

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Abstract:

Bio mass was the fuel used for combustion and produce thermal energy. Gasification was a thermos chemical process it converts solid fuel into gaseous fuel. Gasification is the operation used to produce the combustible gas by burning solid biomass, that combustible gas is also named as producer gas. We are using downdraft gasifier to generate producer gas, why because the down draft gasifier produce a lesser amount o tar content and minimum pressure drop. In our country, large amount of solid waste like coconut shell, groundnut shell, carpentry wastage, bagasse this kind of waste is easily combustible biomass. So we can use that combustible waste to run the down draft gasifier to produce the producer gas. We have fabricated the down draft gasifier with 3.5kW power generation. Performance of gasifier has been analysed in-terms of different zone temperatures and pressure drop, wood consumption this things would be experimentally investigated.

Keywords: Combustible solid waste, zone temperature and pressure drop

Introduction

Biomass is the oldest source of energy and currently accounts for almost 10% of total primary energy consumption. Many of the developing countries has growing their concentration in biofuel development and providing greater access to clean liquid fuels while helping to address the subjects such as increase in fuel price, energy security and global warming concerns associated with petroleum fuels. Abundant biomass is existing throughout the world which can be converted into useful energy. Biomass is considered as a better foundation of energy because it offers energy security, rural employability and reduced GHG emission. Biomass is habitually available in the form of solid. Solid biomass include crops residues, forest waste, animal waste, municipal waste, food waste, plant waste and vegetable seeds. This biomass can be converted into heat and power by adopting appropriate method. Direct burning, briquettes, Liquid / gaseous fuels

Biomass Energy in India

Biomass resources are hypothetically the world's largest and most sustainable energy sources for power generation in the 21st century. Over one third of total fuel energy in India is contributed by biomass. The current availability of biomass in India is valued about 500 million metric tonnes per year. Government of New and Renewable Energy has estimated surplus biomass accessibility at about 120 – 150 million metric tonnes per annum covering agricultural and forestry residues corresponding to a prospective of about 17,000 MW. This apart, about 5000 MW Biomass Power By products Fertilizers and fodder Chemicals Fuels additional power could be generated through bagasse based-cogeneration in the country's 550 Sugar mills, if these sugar mills were to approve technically and economically optimal levels of cogeneration for extracting power from the bagasse made by them

(Ministry of New and Renewable Energy). Indicating that the available biomass has a potential to generate all over the place 17,000 MW of electricity. The lading States for biomass power projects are Andhra Pradesh, Chhattisgarh, Maharashtra, Gujarat and Tamil Nadu.

Biofuels are predominantly used in rural households for cooking and water heating, as well as by outdated and artisan industries. Biomass delivers most energy for the domestic use (rural - 90% and urban - 40%) in India (NCAER, 1992). Woody biomass contributes 56 percent of total biomass energy. At present, biogas technology makes available an alternative source of energy in rural India for cooking. A downdraft gasifier at laboratory scale was developed and tested for the composition of producer [1]. The construction of the gasifier was based on the design advocated by Bhattacharya et al. [2].

The various parts of the gasifier like reaction chamber, fuel hopper, gas outlet and air inlet were designed. The gasifier was ignited by a flame torch and the composition of the producer gas was found in close agreement with the desired composition. An experimental study [3] was carried out on a 75kW downdraft biomass gasifier system to acquire temperature profile, gas composition, calorific value and trends for pressure drop across the permeable gasifier bed, cooling-cleaning train and across the system as a whole in both firing as well as non-firing mode. In the reactor, both gas and biomass feedstock move downward as the reaction proceeds.

While biomass flows because of gravity, air was injected with the help of a blower. Experiments were conducted to obtain fluid flow characteristics of the gasifier and also to obtain the temperature profile in the reactive bed, the gas composition and calorific value. For non-firing gasifier, the extinguished bed showed greater pressure drop as compared to a freshly charged

Gasifier bed. The pressure drop across the porous bed was found to be sensitive with change in flow rate. When used in firing mode, the higher temperature in the bed led to better conversion of non-combustibles component in the resulting gas and thus improved the calorific value of the product gas. An experimental study was carried out on producer gas generation [4] from wood waste in a downdraft biomass gasifier. They used sesame wood or rose wood as biomass. They observed that biomass consumption rate decreased with an increase in the moisture content and it increased with an increase in the air flow rate.

The performance of the biomass gasifier system was evaluated in terms of producer gas composition, the calorific value of producer gas, gas generation rate, zone temperatures and cold gas efficiency. Thermocouples were placed inside the gasifier at different locations to measure the temperature of various zones of gasifier. They found the producer gas composition using gas chromatograph. Characteristics of hydrogen produced [5] from biomass gasification was studied. They used a self-heated gasifier as the reactor and char as the catalyst. The steady temperatures of the pyrolysis zone, combustion zone and reduction zone were recorded. Equivalence ratio(ER) was defined as the actual oxygen to fuel ratio divided by the stoichiometric oxygen to fuel ratio needed for complete combustion. The temperature of the neck was found to increase with feeding rate for similar ER values. For increasing the production capacity, accelerating the feed rate is essential, but excessively high feeding rate would result in a higher gas yield and a shorter gas residence, thus degrading gas quality. The temperature increased with feeding rate but hydrogen yield decreased with feeding rate.

The thermo-chemical reaction in gasification [6] may vary with varying parameters and the size of biomass. For a particle size below 1mm diameter, thermo-chemical reaction shows a sharp increase in the fuel conversion which could be used in conventional entrained flow gasifier. A reduction in the fuel particle size led to an improvement in the gas quality and thus to a higher producer gas heating value. Maximum fuel conversion was obtained for the smallest particle size tested (0.5mm). The thermo-chemical characterization of the char-ash residue showed that as the

fuels particle size was reduced, the release of volatile matter during pyrolysis stage along with particle carbonization, gradually increased, which suggest that pyrolysis reaction took place to a great extent. For fuel particle size of 1mm, the reaction of char gasification became more relevant which contribute in the improvement of conversion of fuel and the composition of producer gas. It is necessary to cool biomass-based producer gas to ambient temperature, and clean it of tar and particulates before it could be used as a fuel [7]. The unit gave a clean gas with tar dust content below the limit of 150 mg/nm3 as long as the inlet gas tar dust content was below about 600 mg/nm3. The system was being tested to supply gas to a dual-fuel engine, and solve any operating problems in this application. It was developed further to study its maintenance requirements, and increase the number of hours of continuous use of the sand filter with no operator attention. The system was mainly developed for small scale gasifier–engine system applications. It can be scaled up to larger sizes to provide a compact unit. The scale up can be done by increasing the cross-sectional areas of the various beds and the water flow rate in proportion to the producer gas flow rate. For prediction of gasification process in downdraft gasifier, an equilibrium modelling [8] was been used. From journal we have identify that downdraft gasifier is more efficient when compared to the updraft gasifier or cross draft gasifier. We have done the down draft gasifier as per reference dimensions.

Experimental setup

We are constructing four major portions to build a gasifier to generating producer gas. The four different processing zone are drying zone, pyrolysis, and oxidation and reduction zone. Hopper which is designed for store the biomass and feed the fuel into the gasifier. Hopper is closed by lock against pressure in the gasifier .Upper portion is fabricated as per dimension in journals for reference. Throttle is prepared based on calculation we are using roller to make the throttle use the welded joint to connect the throttle and flange. The lower portion which is prepared for collect the ash and producer gas. Finally all the portions are to be assembled respects to the position. The upper plate is connected by the blower to force the air increase velocity of air into the gasifier.

We are using the different solid biomass fuel which is used to generating producer gas. Wood pieces are used as fuel for gasifier to produce the producer gas and measure the different zone temperature and pressure drop. Similarly we are using wooden chip feed in to the gasifier to measure the temperature and pressure drop. Thermocouple and manometer which is placed in the upper portion is used to measure the temperature and pressure drop. Throttle portion is used to increase the pressure drop. The lower portion which is used for receiving the producer gas and collecting the waste ash from the gasifier.

Fig. 1 Photoview of downdraft gasifier

Result and discussion

There are two types of biomass used to run the downdraft gasifier. Gasifier has a fuel as biomass, it was supplied from top end of the downdraft gasifier and air is supply into gasifier using blower.

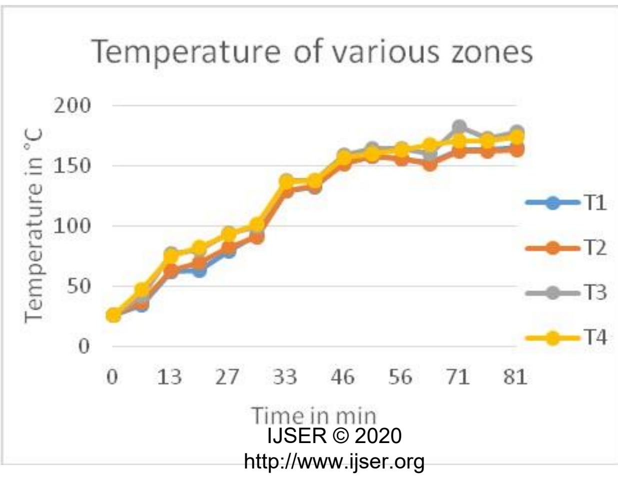

Fig. 2 Temperature of various zone using wooden pieces

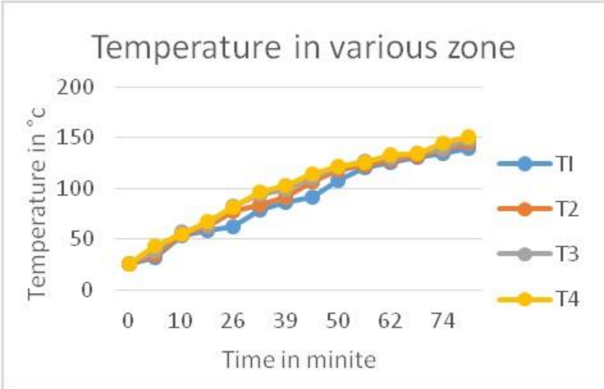

Fig. 3 Temperature in various zone using wooden chips

From the above graphs we have concluded that wooden pieces have higher calorific value compared to wood chips. Calorific value was measured by gas calorimeter.

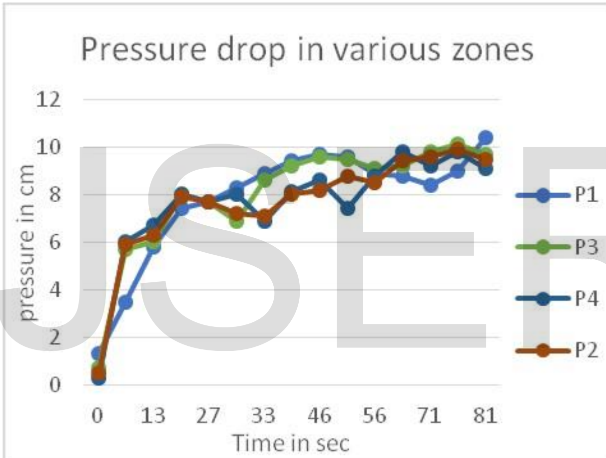

Fig. 4 Pressure drop in various zone using wooden pieces

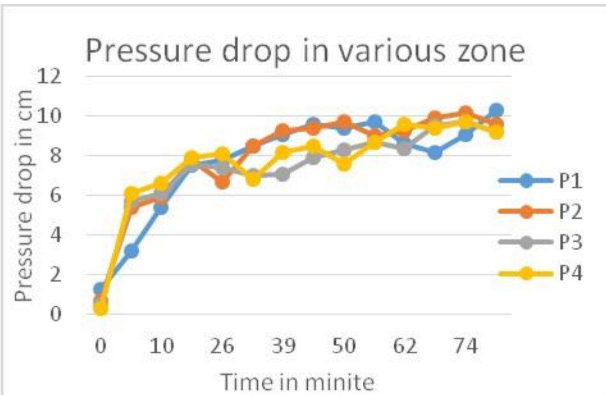

Fig. 5 Pressure drop in various zone using wooden chips

Pressure drops of the different zone which is shown in above Fig. 4 & 5. We concluded that wooden pieces have higher pressure drop compared to the pressure drop of wooden chips.

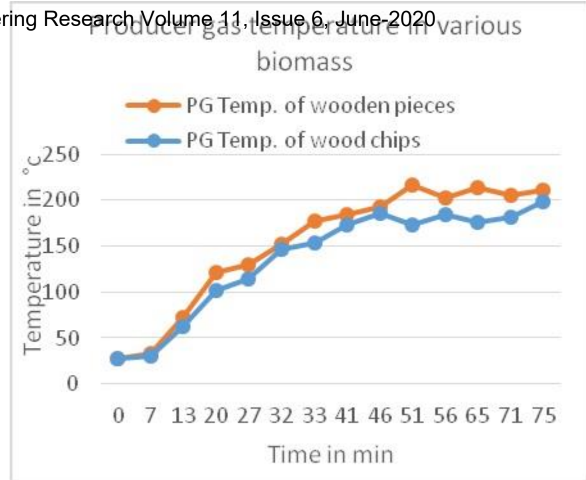

Fig. 6 Producer gas temperature of various biomass

When compared the both trial temperature of the producer gas has increased this leads to increase the calorific value 3500 kJ/kg to 4200 kJ/kg. Due to increase of calorific value higher combustion rate occurs in the combustion zone in the diesel engine for duel fuel operation.

Conclusion

The following conclusions are drawn from the work

1. Wooden piece produces the 4500kJ/kg of calorific value which is much greater than the calorific value of wooden chips which is 3200kJ/kg.
2. The wooden pieces produce more amounts of producer gas and highest calorific value than wood chips.
3. Wooden piece are good for generating the producer gas when compared to wood chips.
4. Variety of alternative fuel has been developed for replacing fossil fuels.
5. Producer gas has been proven a better substitute for diesel fuel for the application in stationary diesel engine.
6. To run the engine which is difficult because of tar content present in the producer gas is huge.
7. We can minimize the tar content level in producer gas by using heat exchanger, dehumidifier and scrubber.
8. Producer gas is used in the engine it’s give more efficiency compared to liquid fuel.
9. The content in the producer gas is optimized and used diesel engine to generate better power generation minimum of 3.5 kW.

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