Journal of Advanced Research in Alternative Energy, Environment and Ecology
Volume 5, Issue 1&2 - 2018, Pg. No. 25-28
Peer Reviewed Journal

Research Article

A Down Draft Gasifier of Biomass Gasification

Pawan Kumar Khatri[1]

[1]Assistant Professor, MED, NIET College, Alwar, (Raj).

Abstract

Great environmental concern is expressed over the release of CO_2 from the burning of fossil fuels. When fossil fuels are burnt, carbon from fuels reacts with oxygen from air and produce CO_2. This is the reason for steady increasing CO_2 content of atmosphere. Carbon dioxide contributes to 50% of green house effect. There is a need to balance the increasing demands for the electricity while simultaneously avoiding the adverse impacts on the environment. Nowadays, other field of research is the production of hydrogen as a fuel from the gasification process of different types of biomass.it is the simplest and economical process to produce thermal energy.

Keywords: Renewable energy, Pyrolysis, Equivalence ratio, Turn-down ratio, Updraft gas producer

Introduction

Energy is the single most critical component that expedites the pace of growth and development and facilitates improvement in the quality of life for the rural masses. Industrialization and urbanization of the society in the present world has also increased the levels of pollution in all the three sectors, land, air and water due to the wastes generated. Carbon dioxide contributes to 50% of greenhouse effect. Industrialization and urbanization of the society in the present world has also increased the levels of pollution in all the three sectors, land, air and water due to the wastes generated. The production and disposal of large quantities of organic and bio-degradable waste without proper treatment resulted in widespread environmental pollution. Great environmental concern is expressed over the release of CO_2 from the burning of fossil fuels. When fossil fuels are burnt, carbon from fuels reacts with oxygen from air and produce CO_2. This is the reason for steady increasing CO_2 content of atmosphere. Carbon dioxide contributes to 50% of greenhouse effect.

Nowadays, other field of research is the production of hydrogen as a fuel from the gasification process of different types of biomass. It is widely acknowledged that hydrogen is an attractive energy source to replace conventional fossil fuels, both from the environmental and economic standpoint. It is often cited as a potential source of unlimited clean power. When hydrogen is used as a fuel it generates no pollutants, but produces water which can be recycled to make more hydrogen. Apart from its use as a clean energy resource, hydrogen can be used for various other purposes in chemical process industries.

Due to this, now-a-days the world concentrates on both important basic need of human being, power and environmental security. Energy or power in its various forms permeates the modern society; urban and rural alike. Proper treatment and disposal of the industrial waste in order to prevent the damage to the natural resources and the environment is being recognized and pursued at various degrees of seriousness around the world.

However, while the uses that energy can be put to are endless, the conventional sources of energy are finite. There is a need to explore other sources of energy that are more sustainable, should not harmful for environment and would complement or even supplement the existing sources. One of the non-conventional sources of energy is bio-residue or biomass that is available mainly as a by-product of crop production, agro processing or the wood industry. Today, energy generated from biomass sources accounts for 12% of the energy consumed at a global level1, 3-5 % among the industrialized countries, and 18-49% in developing countries.

In India, it is estimated that biomass meets about 32% of the total energy needs. Besides being the most commonly used fuel in the household sector, it is also extensively consumed in rural industries, such as brick and limekilns and roadside restaurants in rural areas as well as towns. Biomass utilization in India is characterized by a low efficiency of

E-mail Id: pawankumarkhatri245@gmail.com
Orcid Id: https://orcid.org/0000-0003-1143-9564
How to cite this article: Khatri PK. A Down Draft Gasifier of Biomass Gasification. *J Adv Res Alt Energ Env Eco* 2018; 5(1&2): 25-28.

utilization, drudgery associated with its collection and use, and negative environmental effects. India generates over 500 million tonnes of biomass every year. It has been estimated that in addition to the present usage as fuel in the domestic sector, India has a potential of about 16000 MW of power generation capacity from biomass sources, excluding through cogeneration.

Potential of biomass gasification for meeting the growing needs of electricity in our country is enormous. Since the early 1990's the Government of India through the Ministry for Non-conventional and Renewable Energy (MNRE) has been supporting research and development of biomass gasification technology in the country. It has supported Action Research Centers (ARCs) to catalyze and coordinate R&D in various areas [11].

Biomass

Green plants capture solar energy and store it as chemical energy in the form of cell walls in the plants' stalks, stems and leaves and as oils or starch in the seed, fruits or roots. Both plants and the waste materials derived from them (such as sawdust, wood wastes, and agricultural wastes) are referred to as biomass. It chiefly contains cellulose, hemi-cellulose and lignin, with an average composition of $C_6H_{10}O_5$, with slight variations depending on the nature of the biomass. Unlike fossil fuels biomass does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon while growing. It is the cheapest, eco-friendly and renewable source of energy.

Biomass Availability

This is an area where all concerned believe they have clear understanding. In reality most are highly opinionated. Some who think that there is no excess biomass in the society with industries using them extensively; others who see mounds of waste biomass in a few places are upfront that so much biomass is available for power generation. Neither of the extremes is right. There are two sources for biomass – agricultural and plantation residues. Estimates made of agricultural residues by several means including detailed (production – utilization) has led to values of 16000 ± 2000 MWe from agricultural residues excluding sugarcane based residues. Two major agricultural residues are sugarcane and rice based – bagasse, cane tops/leaves/trash and rice husk. Bagasse is a captive fuel and used at 50 % moisture content with boilers of relatively low pressure (~ 40 atm) with inevitable performance limitations. One limitation of low pressure boiler is being overcome by encouraging the use of high pressure boilers (~ 62/85/105 atm) through the MNES program of sugar cogeneration with moderate success till date. The other limitation of the use of wet bagasse can be overcome through the development of suitable driers using the exhaust heat going through the chimney. Interestingly, this issue is not new and many brave efforts without adequate thinking have gone on in the country with a negative state of mind at present. More serious demonstration is required before it is considered applicable.

Rice husk is another well know fuel considered abundantly available and also used extensively, till recently at low end use efficiencies and in recent times at reasonable efficiencies in high pressure boilers at power levels of 3 to 6 MWe. Acquisition of the rice husk at huge quantities (at 10000 -12000 tonnes per MWe per year) involving traders with advance payments or payments against delivery with short term contracts or long term ones is beset with hazards along any of the options. In the midst of all this, there are small producers of rice husk who have no difficulty in selling rice husk at 1000 to 1800 Rs. per tonne also talking about putting up small power plants ~ 100 to 200 kWe using rice husk as a fuel. Since the gasifier is specific to rice husk, it cannot be used for any other bio fuel that may be available cheaper than rice husk. Gasifiers that can operate on multi-fuels should be chosen for power generation. And one should avoid rice husk as a fuel of choice since alternate technologies or uses will draw away the fuel. In the case of other agricultural residues, somewhat of a similar strategy in the choice of the technology is vital – a gasification system that can accept a variety of fuels. Plantation residues have not been paid attention they deserve. It is to be recognized that the waste land in the country amounts to 60 to 100 million Hectares as estimated in several studies. One Hectare of land when developed well can generate 15 to 20 tonnes (dry) of solid biomass, and handled poorly will generate 4 to 6 tonnes (dry) of biomass. This amounts to 300 to 1500 million tonnes of solid biomass availability. Simple energy calculations at 8000 tonnes per MWe operating for 8000 hours a year yield an energy potential of 40000 to 180,000 MWe capacities. Even if we achieve 10 % of these values, they amount to very significant values of 4000 to 18000 MWe. Hence, there is urgent need to realize this potential and set up national strategies to use the waste land to grow biomass for electricity generation. There is a further question of what biomass to grow. Biomass grown in plantations fetches market prices of Rs. 800 to 1200 per tonne and hence every hectare will yield revenues of no more than Rs. 5000 to 24000 depending on the output. Getting higher levels of output will mean greater expenditure on the plantation care and nutrients. Hence the net output may range between Rs. 4000 to 15000 per hectare. By a suitable mix of horticulture, non-edible oil bearing trees and other solid bearing stock, it is possible to extract multiple outputs from the land – oil, fruit and wastes (for instance, coconut tree yields 100 nuts and an equivalent of 10 tonnes per hectare per year of wastes in the form of fronds, coconut shells, and fiber bearing outer skin).

Gasification

Biomass gasification is an endothermic thermal conversion technology where a solid fuel is converted into a combustible gas. A limited supply of oxygen, air, steam or a combination serves as the oxidizing agent. The product gas which is known as producer gas or synthesis gas consists of carbon monoxide, carbon dioxide, hydrogen, methane, trace amounts of higher hydrocarbons (ethene, ethane), water, nitrogen (with air as oxidant) and various contaminants, such as small char particles, ash, tars, higher hydrocarbons, alkalies, ammonia, acids, alkalies, and the like. The producer gas so produced has a low calorific value (1000-1200 Kcal/Nm^3), but can be burnt with a high efficiency and a good degree of control without emitting smoke. Each kilogram of air-dry biomass (10% moisture content) yields about 2.5 Nm^3 of producer gas. In energy terms, the conversion efficiency of the gasification process is in the range of 60%-70%.

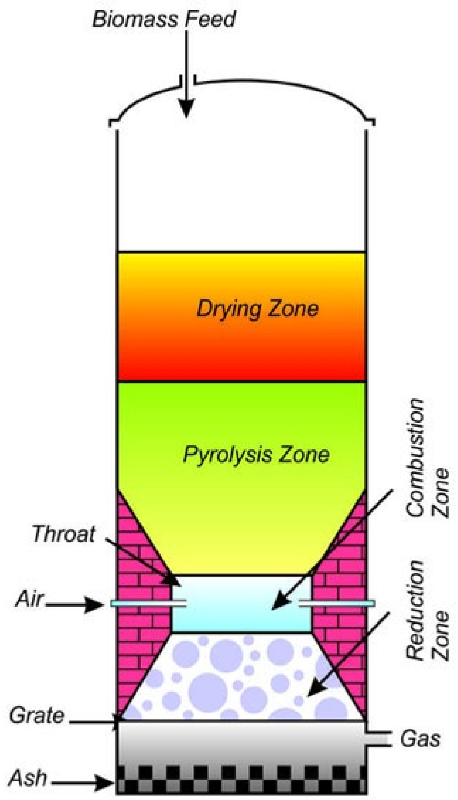

Figure-1.Biomass Gasification Process [4]

Gasification Parameters [15]

- **Superficial velocity and hearth load:** The superficial velocity is one of the most important parameters determining the performance of a gasifier reactor, controlling gas production rate, gas energy content, fuel consumption rate, power output, and tar/char production rate. The superficial velocity is defined as the gas flow rate (m^3/s) divided by the cross sectional area (m^2). A low superficial velocity causes relatively slow pyrolysis conditions and results in high charcoal yields and a gas with high tar content.
- **Equivalence ratio:** This dimensionless parameter shows that curves of several parameters like chemical energy in the gas and the gas composition change significantly at ER = 0.25.
- **Gas heating value:** The gas heating value is usually expressed in MJ/Nm^3. A normal cubic meter is referring to the gas volume at 1 atmosphere and 0 °C.
- **Gas flow rate and gas production:** The gas flow rate can be calculated from the primary air flow if the nitrogen content in the producer gas is known, or measured by orifice plates, venturies, pitot tubes or rotameters.
- **Efficiency:** The efficiency of a gasifier reactor can be expressed on cold or hot gas basis.
- **Fuel consumption***:* The fuel consumption is needed to determine the gasifier and overall efficiency. The fuel consumption can be measured by a balance or automatically by metering bins.
- **Tar and entrained particles:** The amount of tar and entrained particles depends on the gasifier design and operating conditions, in particularly the load level (actual power output to the maximum rated power output).

Down Draft Gasifier

- **Down Draft Gasifier**: Similar to the counter-current type, but the gasification agent gas flows in co-current configuration with the fuel (downwards, hence the name “down draft gasifier”). Heat needs to be added to the upper part of the bed, either by combusting small amounts of the fuel or from external heat sources.
- **Twin-fire gas producer***:* it consists of two defined reaction zones. Drying, low-temperature carbonization, and cracking of gases occur in the upper zone, while permanent gasification of charcoal takes in lower zone. The gas temperature lies between 460 to 520^{o}C. Total process takes place with under pressure of -30 mbar.

Conclusion

Based on the results obtained in the present study, the following conclusions are drawn:

- Wood waste can be successfully converted to generate the combustible gas, known as producer gas, using an Imbert downdraft biomass gasifier.
- With an increase in the moisture content, biomass consumption rate decreases and with an increase in the air flow rate biomass consumption rate increases
- Optimum operating conditions are found by varying

the equivalence ratio, which gives the producer gas having the highest calorific value.

- Molar fraction of N2 and CO2 decrease with an increase in equivalence ratio (Φ) till Φ = 0.205, and they increase subsequently for higher values of Φ.
- The fraction 230 of CO and H2 shows an increasing and decreasing trend exactly opposite to that of N2 and CO2. The fixed bed gasifier is the most practical option for production of a low calorific value gas for use in small-scale power generation schemes or thermal applications.

References

1. D.C. Sau, K.C. Biswal, Computational fluid dynamics and experimental study of the hydrodynamics of a gas–solid tapered fluidized bed, Applied Mathematical Modelling 35 (2011) 2265–2278.
2. C.C. Pain, S. Mansoorzadeh, J.L.M. Gomes, C.R.E. de Oliveira, A numerical investigation of bubbling gas–solid fluidized bed dynamics in 2-D geometries, Powder Technology 128 (2002) 56– 77.
3. S. Gerber, F. Behrendt, M. Oevermann, An Eulerian modelling approach of wood gasification in a bubbling fluidized bed reactor using char as bed material, Fuel 89 (2010) 2903–2917.
4. N. L. Panwar, N. S. Rathore, and A. K. Kurchania, "Experimental investigation of open core downdraft biomass gasifier for food processing industry," Mitig. Adapt. Strateg. Glob. Change, vol. 14, pp. 547–556, 2009.
5. http://gasification.ueuo.com/technologies.

Date of Submission: 2018-04-12

Date of Acceptance: 2018-05-10