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Experiment evolution for Downdraft Gasifier

With using various biomass wood, bagasse and coconut shell

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Abstract - *The Gasification is a thermo-chemical process for converting solid biomass into mixture of combustible gases. The mixture of gases produce by partial combustion is carbon monoxide, carbon dioxide, methane, oxygen, nitrogen and hydrogen. In this project down draft gasifier will be developed, in which wood, coconut shell and bagasse is used as a biomass to evaluate the performance of gasifier. The effect of air flow rate on producer gas temperature. Producer gas production rate, calorific value of producer gas and content of gases produce by this three biomass will be evaluated.*

Keywords: biomass, calorific value, down-draft, gas composition, gas production rate.

I. INTRODUCTION

Nowadays scarcity of fuel, social and economical problem related to energy, price and pollution are the challenging issues in front of the world and in such senior alternative fuel technology which may be economical and eco-friendly is need and demand of time and one such option is gasification of solid fuel in which due to partial combustion of fuel solid as well as gaseous fuel is available. Electricity has today become a basic necessity for world, but also for the developing and underdeveloped countries. At that time, the fuel used for power generation have been primarily fossil fuel and non-renewable in nature. These fuels be exhausted and they also give rise to harmful pollution. Due to this climate change and global warming problem are generate. For this nature control greener and more renewable sources for power production required. Use Biomass based power production is one such option. It is important for India to start using renewable energy sources like biomass. More than 5500 villages without electricity in India. For mobile application in India mostly non-renewable fuel. The biogas is use in internal combustion engine. The pollution and scarcity of fuel is control by using biogas. The process of producing energy using the gasification method has been in use for more than 180 years. In the early time coal and peat were used to power these plants. Initially developed to produce town gas for lighting and cooking in the 1800s, this was replaced by electricity and natural gas, it was also used in blast furnaces but the bigger role was played in the production of synthetic chemicals where it has been in use since the 1920s[5]. During both world wars, especially the World War II, the need for fuel produced by gasification reemerged due to the shortage of petroleum. Wood gas generators, called Gasogene, were used to power motor vehicles in Europe. By 1945 there were trucks, buses and agricultural machines that were powered by gasification. It is estimated that there were close to 900000 vehicles running on producer gas all over the world. [5]

1.1 Biomass Gasification

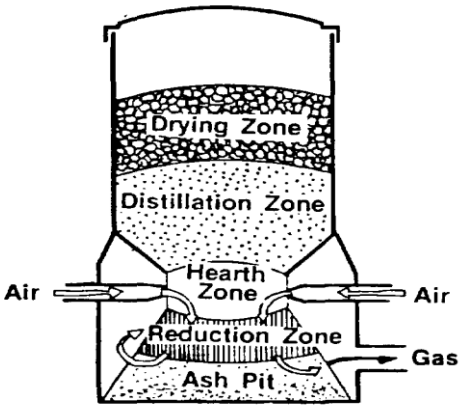

Figure 1. Gasification Zones [6]

The biomass Gasification is a thermo-chemical process for converting solid biomass fuel into mixture of combustible gases. The mixture of gases generate by partial combustion is carbon monoxide, carbon dioxide, methane, oxygen,

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nitrogen and hydrogen. Methane is used for in internal combustion engines. The reactor is called a gasifier. [1]Throw this process also generate non useful products like tar and dust. For main process in gasification drying of fuel, pyrolysis, combustion, reduction. .throw out this process temperature rise up to 12000C. The gasification process done by gasifier. In the downdraft gasifier air intake above the oxidation zone in the gasifier. The producer gas is removed at the bottom of the gasifier, so that the fuel and gas move in the same direction. [5]

1.2 Chemical process in Downdraft Gasifier

(1) Pyrolysis zone

Up to the temperature of 200^0C only water is driven off and between 200 to 280^0C carbon dioxide, acetic acid and water are given off. The real pyrolysis, which takes place between 280 to 500^0C, produces large quantities of tar and gases containing carbon dioxide. Also beside light tars, some methyl alcohol is also introduce. Between 500 to 700^0C the gas production is small and contains hydrogen. [2]

(2) Reaction zone

The products of partial combustion water, carbon dioxide and un-combusted partially cracked pyrolysis products are pass through a red-hot charcoal bed where the following reduction reactions take place. [2]

$C + CO_2 = 2CO$

$C + H_2O = CO + H_2$

$C + 2H_2 = CH_4$

$CO_2 + H_2 = CO + H_2O$

The temperatures in the reduction zone are normally 800-1000^0C.

(3) Combustion zone

The combustible substance of a solid fuel is usually composed of elements carbon, hydrogen and oxygen. In the complete combustion carbon dioxide is obtained from carbon in fuel and water is obtained from the hydrogen in form of steam. The combustion reaction oxidation temperature is 1200^0C. The main reactions, therefore [2]

$C + O_2 = CO_2$

$2H_2 + O_2 = 2H_2O$

1.3 Types of Biomass Gasifier

(1) up-draft gasifier.

(2) down-draft gasifier.

-Throat less down draft gasifier.

-Throated down draft gasifier.

(3) cross-draft gasifier.

(4) fluidizedbed gasifier.

(1) Updraft gasifier: In the updraft gasifier air intake is at the bottom and the gas leaves at the top. The ash is either removed in the dry condition or as a slag. Good thermal efficiency.

(2) Downdraft gasifier: In the downdraft gasifier air intake above the oxidation zone in the gasifier. The producer Gas is removed at the bottom of the gasifier, so that the fuel and gas move in the same direction. Low tar content.

(3) Cross draft gasifier: In the cross-draft gasifier air intake in left side and produce gas out from the right side. This type of gasifier is used for coal as fuel. Short design height.

(4) Fludized bed gasifier: In fluidized bed gasifiers, the biomass is brought into an inert bed of fluidized material (e.g. sand, char, etc.). Such systems are less sensitive to fuel variations but produce larger amounts of tar and dust. The fuel used in gasifier is low melting point.this gasifier more compact but also more complex, and usually used at larger scales.

Though there is a considerable overlap of the processes, each can be assumed to occupy a separate zone where fundamentally different chemical and thermal reactions take place. Figure 1 shows schematically a downdraft gasifier with different zones and their respective temperatures. In this project work throated downdraft gasifier developed. [3]

II. DEVELOPMENT OF DOWNDRAFT GASIFIER

In the present work, downdraft gasifier is used for producer gas generation, because it produces less tar compared to updraft gasifier. Since the gasifier has to couple with diesel engine for performance and emission and combustion test hence producer gas from gasifier must content as less tar as possible because higher tar content fuel gives rise to corrosion effect which is a major cause of damage to engine components like piston, valve and fuel pipe lines etc. [7] Hence downdraft gasifier is the best for all above application. All the components of downdraft gasifier are designed in SOLID EDGE software for better understanding. Sketch diagram of design a gasifier reactor below shown in figure. Components Variable Speed Blower, Thermocouples with Indicator, Gasifier Unit Other components are in below,

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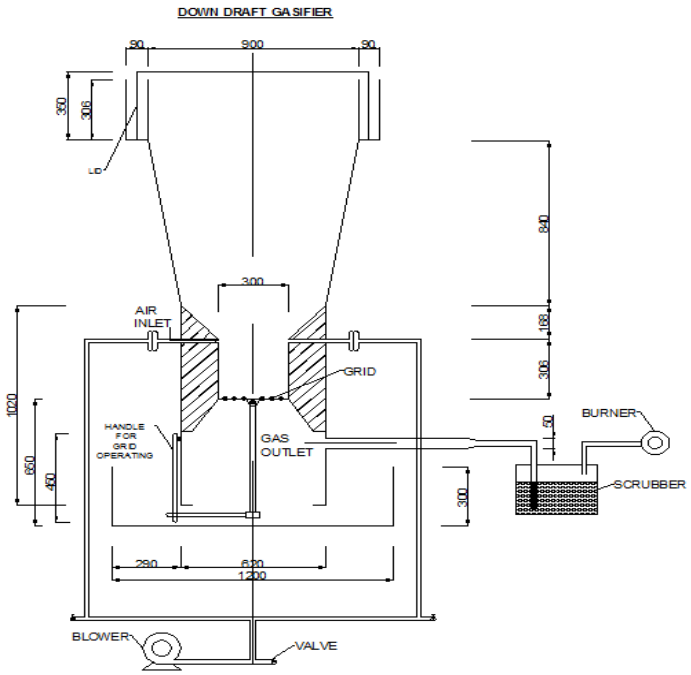

Figure 2. Experimental Diagram of Reactor [8]

In this work in the first phase after fabrication of the set up the set is filled with the three biomass bagasse ,wood ,coconut shell and then obtain value of calorific value, produce gas composition. And find best biomass from these three. Also study the effect on air flow rate on temperature.

Table 2.1 Material Selection

SR no.	Part Name	Specification		Material
		Length	Diameter	
1	Cover plate	306 mm	990 mm	MS
2	hopper (cone shape)	840 mm	900 mm to 620mm	MS
3	Gasification zone	472 mm	620 mm	MS
4	Grid	-	300 mm	MS
5	Pipe (total length)	3500 mm	50 mm	MS
6	Air leakage box	1200×1200 mm	-	MS
7	Throat	60^0	300mm	MS
8	Fire nozzle	-	20mm	MS

In down draft gasifier primary gasification air is introduced at or above the oxidation zone in the gasifier. The producer gas is removed at the bottom of the gasifier. The fuel and gas move in the same direction, so this gasifier is also known as co current gasifier. The four zones in down draft gasifier from the top of the gasifier are; drying zone, pyrolysis zone, oxidation zone and reduction zone. [3] In this research paper they designed a 4 kW thermal down draft gasifier. The gasifier was manufactured as a single piece having a water seal and cover. The gasifier was tested in natural downdraft and forced downdraft mode.during natural downdraft mode, using wood, cocnut shell and wood as fuel, the produced gas which burned with a blue flame for 15 minutes in the gasifier.

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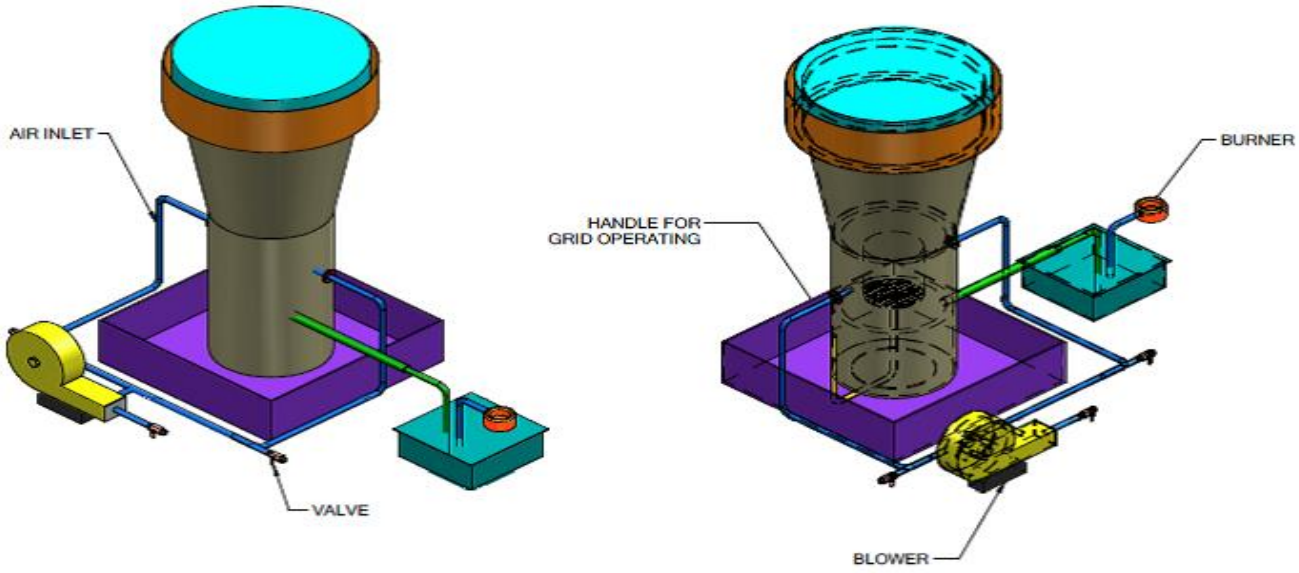

Figure 2.2 Proposed Experimental Set up of Downdraft Gasifier

Figure 2.3 Fabrication Setup

In this gasifier it is observed that small particle size offers better gas quality in terms of higher gas calorific value and reduced tar content. Due to reduced flow resistance of conical shape, the higher gas generation rates are possible to achieve. The tar content in gasifier is less due to higher temperature level is achieved in down draft gasifier. The hopper is designed as conical shape for reduce bridging and channeling effect in gasifier.

III. RESULTS

In the updraft gasifier air intake is at the bottom and the gas leaves at the top. In the downdraft gasifier air intake above the oxidation zone in the gasifier. The producer gas is removed at the bottom of the gasifier, so that the fuel and gas move in the same direction. The produce gas from updraft gasifier is used for heating application because gas is not tar and dust free. The produce gas from downdraft gasifier is used for internal combustion engine because it is tar and dust free gas. Also this gases used for drying of heating applications. Using various biomass like wood, coconut shells and bagasse produce biogas and collect into gas balloon. This produce gas collect and testing in laboratory. The different gas compositions and percentage of gases in biogas will be found. The gas composition is also a function of gasifier design and thus, the same fuel may give different calorific value as when used in two different gasifiers. [4] The producer gas is affected by various processes as outlined above hence one can expect variations in the gas produced from various biomass sources. The gas generation rate for of wood value ranging from 11 to 18 Nm3 /hr. The gasification zones VS temperature sown in below figure.

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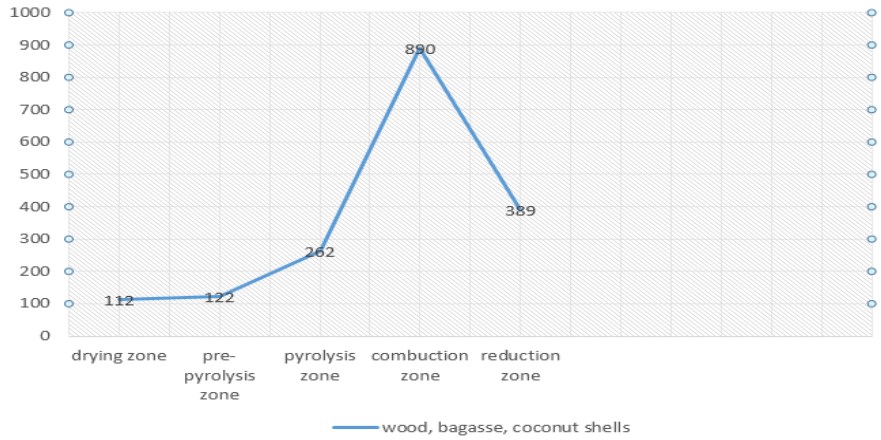

Graph 3.1 Temperature VS Gasification Zones

Table 3.1 Gas Compositions and Calorific Value

Content of gas	Wood Gas (vol. %)	Coconut shells gas (vol. %)	Bagasse gas (vol. %)
Nitrogen	52	-	-
Carbon monoxide	19	23	16
Carbon dioxide	12	12	14
Hydrogen	14	15	17
Methane	3	-	-
Gas caloric value MJ/m³	5.7	7.09	5.19

IV. CONCLUSION

In this project work we are conclude that the coconut shells calorific value are 7.09 MJ/m^3 is high compare to babul Wood and bagasse. The calorific value of babul wood and bagasse is 5.7 MJ/m^3 and 5.35 MJ/m^3. The methane content found only in the wood is 2 to 3%.hence from this the wood is better for IC engines and coconut shells and bagasse is good for thermal applications. The tar content produce from this gasifier is also low compare to others. Simple wet type scrubber is required for gas cleaning.

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