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# STUDY OF GASIFICATION ON THE DIFFERENT FUELS AND FUEL FEED RATE IN FLUIDIZED BED GASIFIER

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## ABSTRACT

An Optimum Fuel feed rate is Established in a Fluidized bed Gasifier for generating producer gas at a steady state Screw feeder system is installed that was used to feed fuel particles of different size. Steady state gasification was achieved at higher gas velocities are the fuel particles in fluidized state. A fluidized bed Gasifier is developed that incorporates a variable fuel feed mechanism for generation different quantity of producer gas. A study of gasification on the different fuels and Gasification rate for various fuel feed rate were be made. In this paper also design and fabrication of compact fluidized bed Gasifier with increased gas – solid interaction is proposed for automotive vehicle. The aim of the design is generate a Producer Gas a low tar content. Feeder system is installed for the controlling fuel feed rate and better Gasification rate is provided to the fluidized particle. The Design and fabrication of Fluidized bed Gasifier is Automobile Application .The Different particles and different size of particles were analyzed for fluidized bed. The time of generation of producer gas is significantly reduced as compared to conventional packed bed Gasifier .The size of the Gasifier is reduced hence can be conveniently used for Automobile Application. Experimental results showed that achieved low ignition time as compare to packed bed Gasifier.

**KEYWORDS**: Fluidized bed Gasifier,Gasification,Feeder system, different fuels

## INTRODUCTION

Biomass can be utilized as energy feedstock's through thermo chemical or biological conversion pathways to generate various energy products such as heat, electricity, liquid fuels, hydrogen and synthetic gases. Biomass is defined as materials of recent biological origin from plants such as trees, grasses and agricultural crops, as well as animal manures and sewage bio-solids. Via gasification of biomass, a hydrogen and carbon monoxide rich gas, called syngas (synthesis gas), can be produced. This syngas can be used for various applications like the production of biofuels via Fischer-Tropsch synthesis, electricity production via turbines and the production of various chemicals. This report focuses on the influence of various parameters in the gasification process forth purpose of producing biofuels from woody biomass. Biomass is the third largest primary energy resource in the world, after coal and oil. Biomass materials with high energy potential include agricultural residues such as straw, bagasse, groundnut shell, coffee husks and rice husks as well as residues from forest-related activities such as wood chips, sawdust and bark. Thermo chemical conversion of biomass offers an efficient and economically process to provide gaseous, liquid and solid fuels and prepare chemicals derived from biomass. The use of biomass gasification for conversion of hydrocarbons to permanent fuel gas mainly composed of $H_2$, CO, $CO_2$ and $CH_4$.main purpose of our research is the Gasification is done by fully air supply (1m/s) at variable fuel feed rate and different types of fuels are used in Fluidized bed Gasifier. The our Gasifier is satisfactory work on full supply of air velocity (1m/s) and gasification is achieved.

## GASIFICATION

Biomass is basically composed of carbon, hydrogen and oxygen represented approximately by $CH_{1.4}O_{0.6}$. A proximate analysis of biomass indicates the volatile matter to be between 60% - 80% and 20% – 25% carbon and

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rest, ash. Gasification is a two-stage reaction consisting of oxidation and reduction processes. These processes occur under sub-stoichiometric conditions of air with biomass. The first part of substoichiometric oxidation leads to the loss of volatiles from biomass and is exothermic; it results in peak temperatures of 700 to 1200 K and generation of gaseous products like carbon monoxide, hydrogen in some proportions and carbon dioxide and water vapor which in turn are reduced in part to carbon monoxide and hydrogen by the hot bed of charcoal generated during the process of gasification. Reduction reaction is an endothermic reaction to generate combustible products like CO, $H_2$ and $CH_4$ as indicated below.

**Exothermic reactions**

$C + O_2 \leftrightarrow CO_2$ (Oxidation)

$2C + O_2 \leftrightarrow 2CO$ (Partial oxidation)

$C + 2H_2 \leftrightarrow CH_4$ (Hydro-gasification)

$CO + 3H_2 \leftrightarrow CH_4 + H_2O$ (CO meth nation)

**Endothermic reactions**

$CO + H_2O \leftrightarrow CO_2 + H_2$ (water-gas shift)

$C + H_2O \leftrightarrow CO + H_2$ (water gas reaction)

$C + CO_2 \leftrightarrow 2CO$ (Boudourd reaction)

Since char is generated during the gasification process the entire operation is self sustaining. The temperature of gas exiting the reactor is about 600-900°K Typical composition of the gas after cooling to ambient temperature is about 18-20% H2, 18-20% CO, 2-3% CH4, 12% CO2, 2.5% H2O and rest, N2. The lower calorific value of the gas ranges is about 5.3 + 0.3 MJ/Nm3, with a stoichiometry requirement of 1.2 to 1.4 kg of air for every kg of producer gas.

**Gasification Process**

Gasification occurs in different steps as listed below:

- Evaporation of moisture by drying,
- Pyrolysis resulting in the production of gas, vaporized tars or oils and a solid char residue,
- Gasification or partial oxidation of the solid char, tars and gases.

Subjecting a solid fuel to heated *(35O-5000°C)* in the absence of an oxidizing agent, results in pyrolyses of the fuel to solid

**Combustion Zone**

In this type of the Gasifier below the combustion zone air distribution plate is provided due to the supply of air where initial combustion is performed for Gasifier start-up purposes. Initial combustion takes place with the help of glow plugs, it heating up the bed material and the Gasifier walls until a certain temperature is reached. Fuel feeding will commence once the required temperature is reached and the initial combustion process is halted.

## DIFFERENT TYPES OF FUELS USED IN GASIFICATION PROCES

The different types of fuels are used in gasification and performance evaluation of fluidized bed Gasifier and also observation of the combustion of fuels are given below.

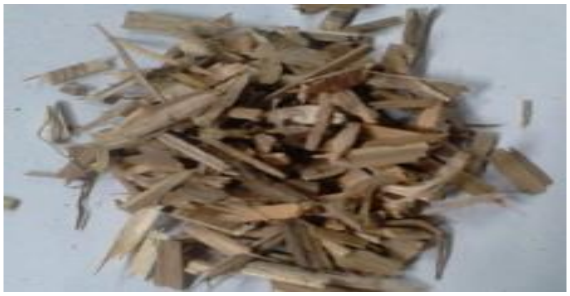
Figure:

Different types of fuel particles With fluidized material

**Wood particle**

After start the Initial Ignition in combustion bed we are feed the fuel of small wood particles by the feeder system so gasification is started a fluidized bed Gasifier after gasification we are feed the fuel sufficient quantity after sometime we are see the upper portion of Gasifier smoke is away from the Gasifier that is the producer gas. Completely combustion after that we are see the wood particles are not burn the properly with full air velocity (1m/s) it is quenched the combustion zone. The density and particle size is 302kg/m3, 30mm length, 4mm width. The our observation with the small wood particles it is not fully combusted and low quantity producer gas are produced. So we are not use regularly of this small wood particles.

Figure:



Wood particles

**Small Wood particles**

We are follow the above given procedure but here fuel are changed. The main problem is the gasification is not done properly in above given fuel so We are reduce the size of wood particles and take the small size wood particles but the gasification process are same. Due to the small size the particles are floated with the fluidized material (sand) and after the gasify producer gas are produced a some quantity. But the main problem is the continuous gasification is not done with full supply of air the air velocity is 1m/s. The density and particle size is 290kg/m3, 42mm length, 2mm width. The our observation of this type of fuel not burning proper manner. So we are not use regularly of this type of fuel.

Figure:

Small Wood particles

**Wood chips**

The gasification and fuel feeding system are same but change the fuel. The wood chips are light weight and quick burn with the air so we are take the wood chips. The density and particle size is 219kg/m3,25mm length, 8mm width. the use this type of fuel is gasification process are continuous comparison of above given fuels. Wood chips are given better

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result and produced the more Quantity of producer gas but we are create a some problem of full supply of air velocity (1m/s) and some wood chips are present in combustion chamber so we may be used of this type of fuel.

**Saw dust**
The saw dust are used the gasification process due to it is easily fluidized with the fluidized material and quick burn the given air velocity. In this gasification process we are also change the fluidized material we are use chalk particles due to not away from the Gasifier with higher velocity and chalk particles are float with the fuel at certain height. The density and particle size is 241kg/m3,786.5µm.The our observation of this type of fuel is Quality and quantity of producer gas are Increases and low tar content of producer gas but the some problem of this fuel is the continuous feed rate are given sometime gasification are closed but we may be use this type of fuel.
Figure:

Saw dust

**Wood husk**
In this type of fuel the burning capacity is high it is quickly burn due to particles are very thin and light weight. The density and particle size is 110kg is the particles are fly and away from the Gasifier but fluidized are very quickly. the our observation of this type of fuel is completely burn particles are not present in combustion zone. So Gasifier efficiency is high and more producer gas are produced so we are use this type of fuel is Regularly due to continuous gasification is done with given feed rate.
The above given Experiments are performed a different types of fuels and we are study a gasification rate of different feed rates. So concluded the we are select the wood chips due to the main reason is Gasification rate is high with full air velocity (1m/s) and more quantity of producer gas are produced low tar content. The below experimental procedure are perform with the wood chips.

## GASIFIER APPARATUS& DIMENSION OF GASIFIER
These are the dimensions of various parts of the gasifier which is used in the design process.

***TABLE I.DIMENSIONS OF COMPONENT OF GASIFIER***

| Component | Length(mm) | Diameter(mm) |
|---|---|---|
| combustion zone | 95 | 78 |
| Gasifier pipe | 914 | 78 |
| feed pipe | 304.8 | 55 |
| perforated plate | 2 | 78 |
| Feeder system | 30 | 20 |

The Fluidized Bed Gasifier assembly consists of

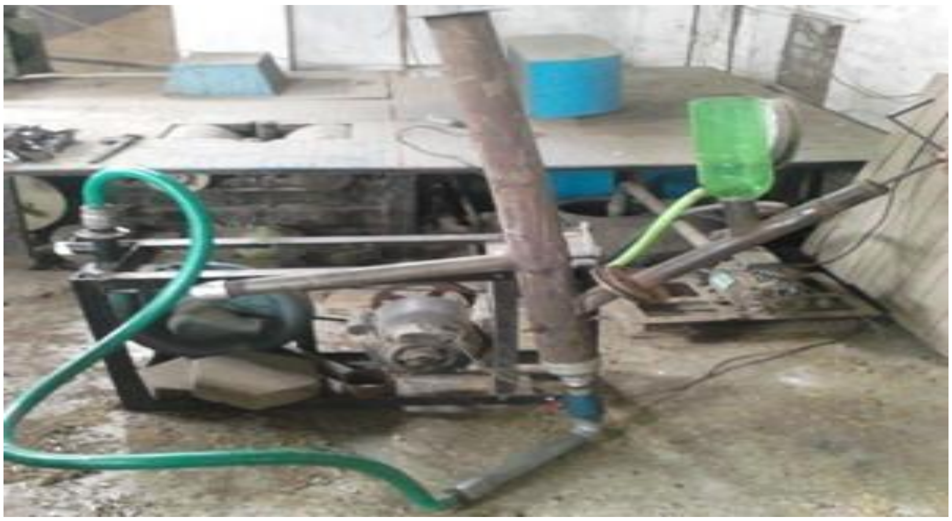
- Blower of 1hp capacity to supply primary air
- Gasifier pipe made of cast iron
- Perforated plate which serves as grate
- Fuel feeding system with outlet above the perforated plate.

- Feeder system consist of screw and handle rotate the handle fuel are fall the combustion zone.

**Secondary Parts of Gasifier**

- Secondary air pipe, this pipe are not in use due to no require of secondary air. The primary air is sufficient ignite the Bed.
- Flow control valve are control the flow of blower primary air.
- Hose pipe are attached due to the Gasifier body are some distance in the Blower assembly and Experiments are perform a maintain some distance.
- 1HP motor are attached a to run the blower

The actual set up of Gasifier with Feeder system is shown.
Figure:



***Actual Figure of Fluidized Bed Gasifier***

## EXPERIMENTAL PROCEDURE

To generate producer gas following steps should be followed.

- To start the process of gasification, first of all we place the fluidizing material over the perforated plateUp to 2" height.
- Thereafter, we feed approximately 200gms wood chips in the combustion chamber and manually ignite it with the help of kerosene.
- The fuel is subjected to full combustion so that the bed materials (sand or chalk) will be heated to Sufficient temperature required for gasification by supplying excess quantity of air through blower.
- Quantity of air can be controlled with the help of flow control valve fitted at the lower end of gasifier pipe.
- This process needs approximately 30 seconds after this the bed particles attain sufficient temperature.
- Now we feed fuel continuously with feed rate of 90gm/min so that incomplete combustion takes place thereby generating producer gas (white in color).
- We manually ignite the white cone of producer gas, to get flames.

## OBSERVATION AND CALCULATION FOR FUEL FEED RATE

The observations of the different types of fuels is the Wood particles are not participated in gasification process. The wood chips and saw dust is Gasified in 1m/s air velocity. The Optimum Feed rate is calculated is given below

- Density of producer gas at 80°c is= 1.029kg/m3
- Mass flow rate of air at1m/s=.0019kg/s
- Fuel feed rate obtained=.0015kg/s
  = 5.4kg/hr

- Calorific value of producer gas= 4.75MJ/kg

## APPLICATION

As mentioned earlier the main applications of biomass Gasifier are:

1. Shaft power systems
2. Direct heat applications
3. Chemical production

In the shaft power systems the main agriculture applications are driving of farm machinery like tractors, harvesters etc. There are quite a number of manufacturers catering to the on- farm machinery gasification systems. [3] Small scale electricity generation systems also provide an attractive alternative to utilities.

Another useful application of producer gas units is in irrigation systems. This seems to be the most to be the most important application in developing countries. [4] There is no reason why such systems cannot become popular in developed countries especially when there have been quite a number of solar powered irrigation systems installed.[5] Direct heat systems, because of their simplicity, may prove to have biggest applications in agriculture. Among them are grain drying, green house heating and running of absorption refrigeration and cooling systems. Again these systems can be coupled to other renewable energy systems like solar for thermal applications. Another interesting application for direct heat (external combustion) application is running of Stirling engines.[6] These engines have very high efficiencies and may prove to be a better alternative than internal combustion engine running on producer gas.

Production of chemicals like Methanol and Formic acid from producer gas is a recent phenomenon.[7] However with fossil fuels getting scarcer, production of these chemicals by producer gas may prove to be an economically feasible proposition. Another interesting application may be use ofProducer gas to run a fuel cell plant. The energy density of such a plant would be highly favorable as compared to IC engine systems.

However for all these applications the most important ingredient is the availability of biomass fuel. For on farm applications biomass residues are attractive proposition. However, before any large scale application of gasification is undertaken the fuel availability is to be critically ascertained. As an example it is instructive to look at the land area required, for a Gasifier to run on cotton stalks (biomass residue) as fuel. On an average, quantity of stalks harvested is 1.5 tons/acre/yr.[8] Thus a 100 kW Gasifier running at 8 hours per day for 300 days/year will require about 213 acres of cotton plantation to produce the required cotton stalks. Against such background all the future applications of Gasifiers should be evaluated.

If the biomass residue availability is not adequate then the decision has to be made about running it on wood. However such decisions can only be made at specific sites and for specific applications. Just like in any other alternative energy source it is advisable to use hybrid systems, similarly in biomass Gasification's systems also it will be worthwhile to use them in conjunction with other energy systems. For example, grain drying can have biomass Gasifier/solar coupling.

## CONCLUSION

The Fluidized bed Gasifier has been developed based on the dimensions that are specified and Experiments for fluidization of the particles is carried out. The fluidized bed Gasifier made of cast iron tube with inside diameter of 85mm and height of 914.4mm with a drilled holed distributer plate of 2mm hole diameter was used for air distribution. The present model can gasify different types of fuel we are already performed a experiments which feeded feeder system with the range of 2 to 5kg/hr the optimum value of 5.4kg/hr.from the analysis of the two critical parameters temperature, air to biomass ratio. The temperature plays a significant role in the process. A higher temperature will be more favorable for gas. The Gasifier is designed, manufactured and tested successfully. It generates producer gas with minimum tar formation. For the same power output we obtained significant reduction in dimensions.

The device can be used to power IC engine for vehicle or can be used to generate electricity. The following key points are concluded that in this research are given below.

1. Steady state gasification is was achieved using saw dust and wood chips for the feed rate maintained at 5.4kg/hr.
2. On varying the feed rate from the given value the gasification sized to exist and turned in to quenched process of a complete burning process.

3. The bed particles are chalk particles had little effect on the gasification process.
4. Combustion quality took place during flow air velocity 0.5m/s is needed to inlet the gasification process. A higher velocity the combustion is quenched.

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