

A Review on Gasification Process & Gasifier

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Abstract— Every day human being consume lot of energy more than half of this energy comes from fossil and non-renewable energy sources. This fuels are extracted from the earth's crust for more than 150 years, now 135 billion tons of crude oil has been used till today. Biomass energy is becoming an alternative for fossil fuels as it has immense potential to replace fossil fuels and also reduces greenhouse gas emission. This paper briefly reviews the process of gasification, gasifier and its efficiency for different fuels.

Keywords: Gasifier, Gasification Process

I. INTRODUCTION

In 2020 with increasing population and increase energy needs availability of fossil fuels in upcoming years will become a significant issue.

On that note renewable energy is the energy that comes from resources which are continuously replenished such as biomass, sunlight, wind and tides.

Biomass gasification is a proven technology which can replace use of traditional energy sources to a good extend. Gasification can convert 62% to 90% of energy in biomass into energy in gas. Gasifier is device to generate gas from agricultural waste.

Gasification is a technological process that can convert any carbon based raw material such as coal into fuel gas also known as synthesis gas. Gasification occurs in a gasifier generally a high temperature/ pressure vessel where oxygen and steam directly contacted with the coal or other feed material causing a series of chemical reaction to occurs that converts the feed to synthesis gas and mineral residues. Gasification offers an alternative to more established ways of converting feed-stocks like a biomass and some farm waste into electricity and other useful products.

II. HISTORY

The Process of Gasification is not new o world, it is being used in blast furnaces for over 180 years. Charcoal and peat like feed materials were used for gasification, for purpose of using gas obtained from gasification for power generation. With changing time petroleum based fuels got popularity but during crisis like world wars, especially in Second World War shortage of petroleum based fuels and resources again introduced Gasification to lives.

III. GASIFICATION

It is the process that converts organic fossil fuel based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide. This is achieved by reacting material at high temperatures without combustion with controlled amount of oxygen and steam.

In this process biomass converts into combustible gases that contain all energy present in biomass. It is partial combustion of solid fuels at temperature about 1000 degrees. Nitrogen, water vapor, carbon dioxide and Sulphur of oxygen are the products of gasification process.

A. Gasification Process

Production of Generator gas (Producer Gas) called gasification, it is partial combustion of solid fuel above 1000 c in a reactor called Gasifier.

When the biomass is burned under restricted air supply for production of generator gas the resultant Generator Gas (Producer Gas) is obtained. Generator Gas is mixture of gases which involves:-

18% - 22 % Carbon monoxide (co)

8% - 12% Hydrogen (H₂)

8% - 12% Carbon dioxide (CO₂)

2% - 4% Methane (CH₄)

40% - 50% Nitrogen

B. Reactions

During the process of Gasification following reactions take place.

1) Drying:

Biomass contains about 10% - 35% moisture when the temperature reaches beyond 100 cc the moisture in biomass fuels is converted into steam leaving completely dry fuel behind.

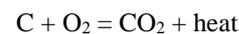
2) Pyrolysis:

As further heating of fuel continues, biomass undergoes pyrolysis process. Pyrolysis is nothing but burning of biomass completely without supply of Oxygen. In result the biomass fuel decomposes into solid, liquid and gaseous form.

Eg. Wood charcoal is solid remains, tar is liquid and the flue gases are gaseous part after pyrolysis.

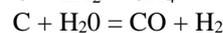
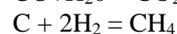
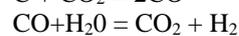
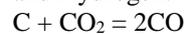
3) Oxidation:

After pyrolysis as the decomposition is done, air is supplied to gasifier. During the process, above 700 to 1400cc solid carbonized fuel reacts with oxygen to produce carbon dioxide and heat



4) Reduction:

At very high temperatures when there is not enough oxygen available following reactions take place which results in formation of Carbon dioxide, Methane, Carbon Monoxide and Hydrogen.



IV. DESIGN

Gasifiers are classified according to way of air or oxygen introduced in it. There are different designs of gasifiers as per the requirements. There are three main types of gasifier mention as below.

1) Updraft gasifier

2) Downdraft gasifier

3) Cross draft gasifier

A. Updraft Gasifier

This is oldest and simplest type of gasifier in construction. Air comes in at the bottom and produced syngas leaves from top of gasifier. This gasifier is also known as Counter Current gasifier.

The combustion occurs at bottom of gasifier near grate and the reduction reaction occurs above that. In extreme upper part of gasifier heating and pyrolysis of feed stock occurs, Syngas leaves from the upper part of gasifier with tar mixed in it, which is later removed by filters like candle filter.

The resulting producer gas is rich in hydrocarbons and hence this gasifier is known for higher calorific value of gas produced, because of this property these gasifiers are used where more heat is needed. These gasifiers has high equipment efficiency.

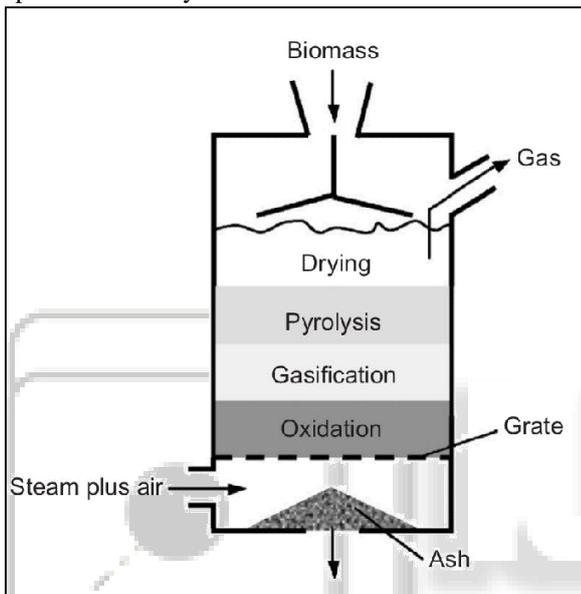


Fig. 1: Updraft Gasifier

B. Downdraft Gasifier

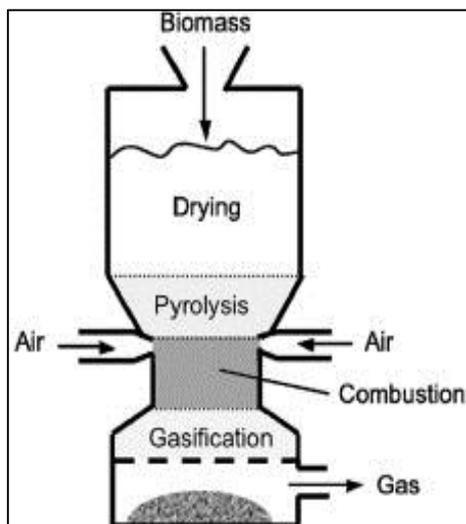


Fig. 2: Updraft Gasifier

As seen in updraft gasifiers the tar mixed with syngas is a problem. To provide solution to this primary gasification air is supplied or introduced above oxidation zone. The produced gas is taken out from bottom therefore fuel and gas move in same direction, hence this gasifier is also known as co current

gasifier. In this process the complete breakdown of tar is achieved as the tarry products have to pass through heated glowing charcoals. The tar gets completely burned and gets converted to permanent gases – Hydrogen, carbon dioxide, Carbon Monoxide and methane. This entire process depends on temperature of hot zone and time residence of tar.

The reason why downdraft gasifier is preferred that it can produce tar free clean gas which can be also used for engine operation. In practice very rarely tar free gas is produced but the percentage of tar present in generator / product gas is very low as compared to gas produced in updraft gasifiers.

C. Cross Draft Gasifier

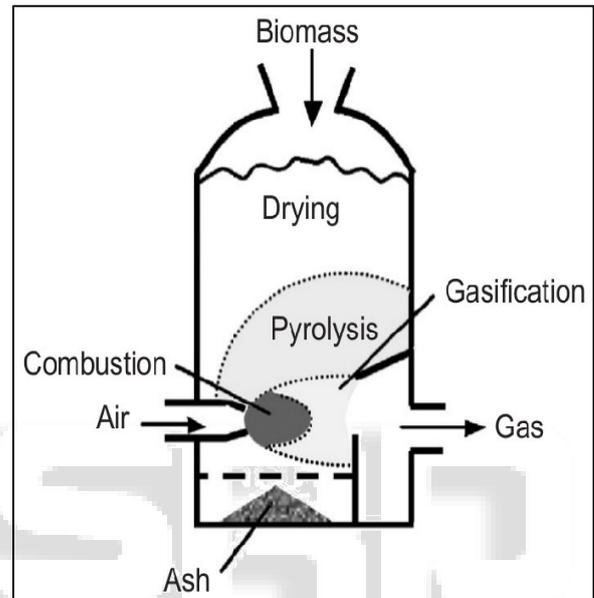


Fig. 3: Cross draft Gasifier

In these type of gasifiers the air enters from one side in reactor and leaves from another side. These gasifiers have compact construction and low cleaning requirements but the compact design characteristics limit type of fuel usage i.e. only low ash fuels can be used. eg wood, charcoal and coke.

These gasifiers have high exit gas temperature and poor CO₂ reductions hence it is not an ideal gasifier, still its low starting time (5-10 min) and well operation under dry air blast and fuel make it unique.

V. EFFECTIVENESS

Many cities in the world are having the problem to decompose the waste in large quantity in India there is above 5.6 million tons per annum of waste is generated as per 2014 estimate of the erstwhile planning commission urban India generates 62 million tons of municipal solid waste per years of this 42 million tons is collected 11.9 million tons is treated and 31 million tons is dumped load fill gasification is process of devolatilizes solid or liquid hydrocarbons, and converts them into a low or medium BTU gas. There are more than 100 waste gasification facilities operating under construction around the world. About 70% of waste of organic and burning it using extra energy is ridiculous so the gasifier is the best option among all these. It has a high efficiency, it has also used renewable energy sources and it is also environment friendly.

Fuel options: Here are some mainly used fuels in gasifier

- 1) Coal (solid oxide fuel) - In generation of high power in large scale this is used in power plant application. Coal has been majorly used upto 18th century still the oil and natural gas started using from 1922.
- 2) Oil and natural gas - Oil and natural gas makes whole new change in industry as they are comparatively cheap and they are high energy ratio.
- 3) Organic fuel - As we know, biomass gasifier mainly used for less pollution by using biomass product. Their many options for fuel in gasifier are wood, scrap materials, agriculture waste (corn stalks, pelled rice hulls, sunflower & wheat straw, corn cobs, cubed cotton stalks) and many more. As per the requirements we can choose the suitable fuel option.

The main and commonly used source in wood which is easily available everywhere. There is high ratio of wood content in fuel and some other waste or scrap is used with composition.

In India biomass gasifier is way better option for energy generation. As in India we have huge advantage under present condition as we have more urban area where we can collect biomass fuel and make energy at very low cost.

VI. EFFICIENCY

Gasification efficiency is around 75% and wood gas converting mechanical energy with efficiency 25% and total efficiency of wood combustion heat conversion to mechanical could be estimated as 19%. The conversion efficiency of gasification is much higher than that of direct combustion. The conversion efficiency of gasification is 35% to 45% where as that of combustion is 10 to 20%.

The overall efficiency of the system must be computed from the engine efficiency and gasifier efficiency.

A. Advantages

- 1) In biomass gasifier fuel required to produce energy is always available and we can produce it as a renewable energy sources. Biomass crops produces oxygen and use up carbon dioxide.
- 2) As there is a reducing the fuel in world so we are looking for alternative and biomass fuel is good for production of heat, steam and electricity.
- 3) Biomass gasifier uses the waste and scrap material as fuel so it reduces the landfill disposals make more space for everything else.
- 4) One of the major benefit is money saving due t use of oil and coal there is large amount of money spent on it. Biomass gasifier efficiency runs of waste scrap, agriculture waste and wood material which is easily and always available.
- 5) It has low tar and negligible ash percentage in downdraft gasifier at high temperature.

B. Disadvantage

- 1) Agriculture waste is best fuel for biomass gasifier but fuel require for it is in huge amount so the land taken for producing energy crop is also in large amount and maybe in some areas land is in demands for farming, conversion in housing, resorts or agriculture use.

- 2) Animal waste have high ash content percent therefore there is high pollution level and relatively small project are running on animal waste so there are some limitations.
- 3) In some cases major causes behind not using biomass gasifier is pollution. On burning the fuel like agriculture waste and wood, the ash percentage is very less but air pollution is some high.
- 4) Research is indeed needed to reduce the cost of production of biomass based fuel which is renewable and environment friendly.
- 5) It is used in limited scale applications as the high power generation is not possible with biomass gasifier.
- 6) At low temperature more tar is produced so the ash content is increases therefore gasifier should be run on high temperature.

VII. APPLICATIONS

Biomass gasifier has been used in different scales like;

- 1) Large scale- if power generated is above the 500KW
- 2) Medium scale- if power generated between 30-500KW
- 3) Small scale – if power generated between 7-30 KW
- 4) Micro scale- if power generated between 1-7KW.

There are some equipment used in generation of electricity are – gasifier, gas clean up, diesel engine. For cooking gas-gasifier, gas distribution, stove. Generation of heat-gasifier and furnace.

A. Future of Biomass Energy

Biomass gasification is a promising solution to handle agriculture waste. It's been used from centuries during World War 2 when gulf countries banned exporting crude oil this technology got momentum. But after the war efficient petroleum left those cars operated on product of biomass gasification in the pit. It could solve many issues in India in future as we have large amount of agriculture waste. It will help in mitigating effects in climate change. Many of the health related problem rural women and children face today because of use of inefficient Chula can be solve by using purified biogas. Hence there is strongly believe in upcoming years there is huge change in biomass industry.

VIII. CONCLUSION

At this stage we can observe steady tendency towards increasing biomass resources for energy production. There is large amount of agricultural as well as industrial waste in country which is not classified and used properly. In upcoming years there no doubt with some strategy and new innovations and technology biomass gasifier should be used more widely so that many problems could be solved.

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