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Effect of Moisture Content on Gasification Efficiency in Down Draft Gasifier

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Abstract :- Biomass gasification is used to generate producer gas for the sustainable development. Now a days down draft gasifier is most widely used due to its characteristics like non production of tar production. Presently in India, few biomass based power plants are in use because of lack of knowledge and promotional policies of Government. Proper knowledge is essential for the smooth operation of biomass based power plant in full capacity. The main objective of the present study is to focus on the effect of moisture content on the gasification efficiency out of several influencing parameters of gasification technology.

Keywords:- Gasification, biomass, moisture content, downdraft gasifier etc.

I. Introduction

Biomass gasification technology is an oldest and efficient technology by which the agriculture and forest waste is used to generate producer gas. Most of the part of India is covered with forest and agriculture land. However huge agricultural productivity and consequently the escalation of green revolution has made feasible only by huge amount of energy inputs, particularly those from fossil fuel [1]. Due to recent price hike of fossil fuels and depletion of these fuels attracts the attention of many researchers towards the use of unconventional energy sources[2]. The great problem associated with the use of unconventional energy sources is uncertainty[3]. Biomass gasification is basically partial combustion of biomass ensuring the production of mixture of combustible gases like carbon monoxide(CO), hydrogen(H_2) and methane(CH_4). The mixture is known as producer gas. This gas is enough capable to run internal combustion engines (can be used in both SI and CI engines)[4]. For various direct heat applications producer gas is used in place of furnace oil. However the present conditions are considered, the economic factor seems to provide the strong arguments to accept gasification as the alternative source of power generation. In many countries like India, where the price of fossil fuels is high and also unreliable supply, the biomass gasification can make available an inexpensively feasible system[5,6].

II. Gasification Technology

Gasification is unswerving clean technology that can turn biomass into producer gas. First of all, the available biomass is prepared for the combustion process. Then the biomass goes through a thermo chemical process using oxygen of atmospheric air. Thus generated producer gas can then be used in a internal combustion engine for the production of power. A noteworthy benefit of biomass is that the system is squashed, which enables a plant to be built in small communities where the main grid connectivity is not available.

III. Experimental Procedure

For the investigation of effect of moisture content on gasification efficiency, wood chips and mustard oil cake is used as biomass. Wood chips are first converted into the powder form then it is blended with the mustard oil cake to form inhomogeneous mixture. This mixture is now being passed through the briquetting machine to generate cylindrical briquettes. These briquettes are fed at the top in the reactor. In the upper zone, a drying process occurs. After this pyrolysis process is taking place. Following this, the briquette passes through a reduction zone. This is the place where the actual gasification takes place. In the bottom the oxidation process is carried out. To supply the oxygen for combustion process and steam for gasification process, the atmospheric air is supplied at the bottom of the reactor. Combustible gas at a low temperature is discharged at top of the reactor, and inert ash from the heat generating combustion process is extracted from the reactor bottom through a water lock.

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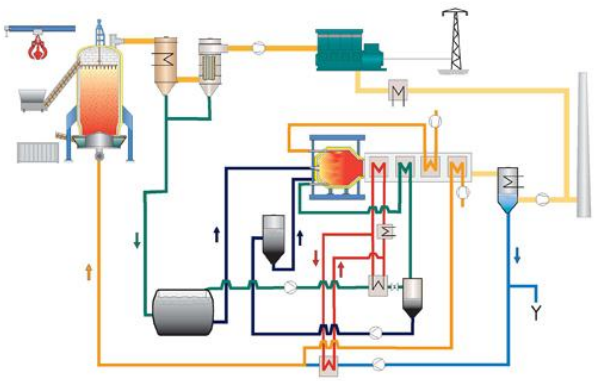

Figure 1 Biomass Gasifier Plant

IV. Biomass for gasification

Wood chips and mustard oil cake, is used as a feed stock for gasification. It is a renewable source of energy and easily accessible at great extent. Wood chips can be collected from furniture shop, and it is one kind of waste for shop keeper and they used to through it as it is. Mustard oil cake can be produced by extracting mustard oil from the mustard seeds by transesterification method. Generally it is used to provide as food for the cattle because of its higher nutrition content. In the present study wood chips and mustard oil cake is used for feed to gasifier. Every biomass type has carbon, hydrogen, and oxygen as major chemical constitutive elements. These element fractions can be quantified with the ultimate analysis. Ultimate analyses are reported using the CxHyOz formula where x, y, and z represents the elemental fractions of C, H, and O, respectively. To fully describe biomass characteristics, it is customary to provide the proximate analysis. Proximate analysis gives the composition of the biomass in terms of gross components such as moisture, volatile matter, ash, and fixed carbon. It is a comparatively simple and reasonably priced procedure. Ultimate analysis is comparatively complicated and expensive compared to proximate analysis. The ultimate analysis of the properties of wood chips and mustard oil cake are shown in Table 1

Table 1 Properties of Wood chips and Mustard oil cake

	Wood Chips	**Mustard Oil Cake**
PHYSICAL Shape	Irregular	Irregular
PROXIMATE ANALYSIS Moisture Ash content Volatile matter	9.97% 3.83% 86.2%	11.1% 6.9% 82.0%
ULTIMATE ANALYSIS Moisture Carbon Hydrogen Nitrogen Sulphur Oxygen	9.97% 49.0% 5.3% 6.39% 0.02% 39.29%	11.1% 47.78% 5.82% 6.33% 1.54% 38.53%
Gross calorific value	**18.06(MJ/Kg)**	**20.5(MJ/Kg)**

V. Methodology:-

The gasification of the said biomass is carried out in the downdraft gasifier. The biomass, which is under observation, is prepared to achieve three different levels of moisture i.e. 15%, 30% and 45%. These moisture levels are achieved by pouring the water into the biomass in different proportions so that the desired percentage of moisture can be achieved. The briquettes of the said biomass are prepared by the briquetting machine. Then, the prepared sample of briquettes is stored in closed container for allowing no exchange of moisture with the atmospheric air. The operation of a gasifier is affected by the moisture content of the feedstock. The limiting value of moisture mass fraction varies with fuel energy content. The higher the moisture content of the feedstock, the lower the bed temperature due to the energy required to evaporate the water from the feedstock.

VI. Result

In combustion systems any water content in the fuel must be driven off before the first stage of combustion can occur, requiring energy, and thus reducing overall system efficiency and potentially reducing combustion temperature below the optimum. Reduction in combustion temperature below the optimum may result in incomplete combustion of the fuel giving rise to the emission of tars and creosote which may condense in the flue, especially if it is long or includes changes of direction, and particulates.

The water may also recondense in the flue, and all these may lead to corrosion of the flue and the gradual accretion of material leading to the potential for eventual blockages or fire.

Table 2 Experimental values of gasification efficiency and power developed at different moisture content

S.No.	**Moisture Content**	**Gasification Efficiency**	**Power Developed(KW)**
1	15%	65%	8
2	30%	52%	5.2
3	45%	37%	4.1

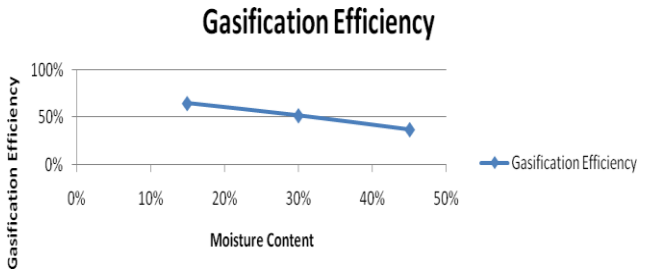

Figure 2 Moisture Content Vs Gasification Efficiency

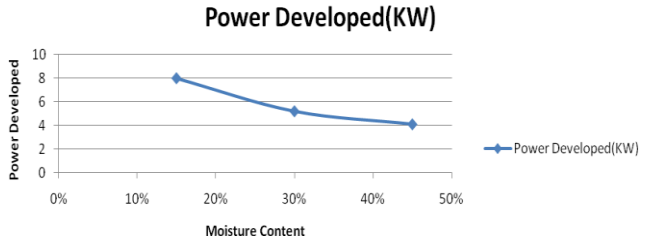

Figure 3 Moisture Content Vs Power Developed

It is clear from the figure that gasification efficiency decreases with increase in moisture content. Power developed also reduces with increase in moisture content.

VII. Conclusion

Most modern, high efficiency combustion systems are designed to operate within a range of parameters to ensure that performance meets emissions and efficiency specifications and a range of acceptable moisture content for the fuel is usually specified. If fuel outside this specification range is used the system may shut down automatically. However low moisture content is required for all biomass combustion system. Not all modern biomass combustion systems require low moisture content fuel, however. Some are designed to handle fuel at much higher moisture content, e.g. as 'green' (freshly harvested) chips. These systems typically make use of some of the heat of combustion to dry the fuel as it approaches the combustion zone. Many biomass gasifiers are designed to operate on very low moisture content feedstock, perhaps 10-20%. Other technologies, such as anaerobic digestion, fermentation, hydrothermal upgrading and supercritical gasification all make use of feedstock in an aqueous medium, and are particularly suitable for very high moisture content biomass, and for which drying is unnecessary.

Following conclusions were mainly found during the work:

1. Material with high moisture took more time for partial combustion.
2. Gasification efficiency reduced greatly.
3. Quality of producer gas is also affected.
4. Moisture content also reduces the overall efficiency of the gasifier.
5. Producer gas heating value is also reduced.

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