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To Study Biomass in Dual Fuel Engine using Downdraft Gasifier

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Abstract- The current trend of energy consumption, in which fossil fuel is main energy provider, it reached a level where other resources must be unearthed to ensure there is a constant supply for utilization. Sudden rise in fuel prices recently has severely affected economic activity and adversely affected the energy scenario. Generation of electricity is possible in applications like biomass gasification. In all possible gasifiers, the fluidized bed gasifiers are very much upto the task. As the major occupation of people in Punjab is mostly agriculture. So the major source of biomass comes from the fields. The experiments are performed by taking three samples of biomass i.e sugarcane bagasse, cotton stalk, and mustard stalk. Then it is performed for various openings of the valve at different loads; the loads are taken as two kilowatt, four kilowatt and six kilowatt. The openings of the valve are 3 revolutions of gasifier valve, 6 revolutions and maximum possible revolutions of the valve. As expected with the use of producer gas the consumption of fuel (diesel) decreases significantly and subsequently the cost of operation also decreases. From the comparison of the three biomass samples it is clear that the cotton stalk stands out to be the better fuel option. With a wide range of applications the gasifier arrangement has a great potential to reduce the gap between energy requirement and supply of energy.

Keywords: Biomass; Gasification; Dual fuel Engine.

I. INTRODUCTION

As the major occupation of the people of Punjab is agriculture. So the major source of biomass comes from the fields. A major part of biomass is the ligno-cellulose. Ligno-cellulosic material is the non starch, fibrous part of the plant materials. Ligno-cellulosic biomass is not a part of human food chain and thus its use for gasification does not post any threat to the world's food supply. An example of ligno-cellulosic biomass is a straw, woody plant, husk, scrap, slash. So let's classify common sources of biomass, its scenario and some of its important properties while using it for gasification [1].

1.1 Gasifiers and process of gasification

The process of gasification to produce the combustible from organic feeds was used in blast furnaces about over one hundred and eighty years ago. The actual possibility of using this gas for the heating and power generation was soon realized and then emerged in Europe as the producer gas systems, which used the charcoal and peat as the feed material. At turn of the century petroleum was widely used as a fuel, in both the world wars and in World War II, shortage of the petroleum supplies led to widespread re-introduction of gasification. By the year 1945 the gas was being used to power heavy machinery, trucks, buses, agricultural and industrial machinery were being run by the gas. Due to the lack of strategy and the availability of cheaper fossil fuels led to general decline in the producer gas industry, after the World War II. Whereas, Sweden continued with the producer gas technology and the work was accelerated after the crisis of Suez Canal. Then there was a decision to include the gasifiers in the Swedish strategic emergency plans. Research for the suitable designs of the wood gasifiers, especially for transport usage, was done at the National Swedish Institute for Agricultural Machinery Testing [2]. The manufacturing also took off with increased interest shown in gasification technology. At the present there are about 64 gasification equipment manufacturers all over the world [3]. A major breakthrough came in biomass gasification from the Envirotherm atmospheric CFB (circulating fluidized bed) technology, during the 1980's, it was adapted for the combustion of coal. The Lurgi gasifiers use a design of moving bed and operate below the ash melting point of the feed. There was no need for the feed to be finely milled. The major disadvantage of the Lurgi process is its inability to handle fine feed. The feed is fed into the top of the gasifier through lockhoppers. Oxygen is injected at the bottom of the gasifier and reacts with the pre-heated feed by the hot syngas rising through the feed bed [4]. Ash drops off the bottom of the bed and the pressure is released via a lock hopper. Lurgi developed this process in the 1930s in Germany [5]. The production of hydrocarbon liquids is a key disadvantage of the Lurgi process in IGCC applications. BG Technologies USA, Inc., has licensed gasification technology from Ankur Scientific Energy Technologies Pvt, Ltd., of India for the worldwide distribution. Using this technology, Ankur Scientific has installations worldwide for processing of the soy husks, cotton stalks, maize cobs, coconut shells, palm nut shells, wood chips and sawdust. The BG Technologies electric system consists of a biomass gasifier, gas cleaning unit and cooling unit, and a diesel generator set. The diesel generator is operated under dual fuel mode using diesel and producer gas from the gasifier and also reduces diesel consumption by about 70%[6]. The main objective of this system is to transpose some of the fuel requirement for the diesel generator. A gasifier is essentially a chemical reactor where various complex physical and chemical processes take place. Biomass gets dried, heated and pyrolysed, partially oxidized and reduced in the reactor as it flows through it.

Normally, biomass is first heated (dried) and then it undergoes thermal degradation or pyrolysis. To form the final gasification product, the pyrolysis products (gas, solid and liquid) react among themselves as well as with the gasifying medium. In commercial gasifiers, the thermal energy is necessary for the drying, pyrolysis, and endothermic reactions comes from a certain amount of exothermic combustion reactions allowed in the gasifier.

II. EXPERIMENTAL ANALYSIS

Experimental analysis has been performed on the samples of biomass and proximate analysis has been done. The results are shown as under

In the proximate analysis the various contents of biomass were experimentally calculated. The results collected from the experiment shows that the moisture is maximum in the mustard stalk and also it has maximum amount of volatile matter and also has the maximum amount of fixed carbon.

A) Experimental Set Up

TABLE -1: Proximate analysis

S No.	Type of biomass	Moisture content (%)	Volatile matter (%)	Ash content (%)	Fixed carbon (%){100-(MC+VM +ASH)}
1.	Mustard stalk	12.8	83.27	.04	13.96
2.	Sugarcane stalk	6.8	83.15	4.2	11.8
3.	Cotton stalk	9.9	79.91	5.16	12.84

Figure-1 Dual Fuel Engine with Downdraft Gasifier setup

The experimental set-up shown in the figure 1 is the downdraft gasifier with rated gas flow of 15 Nm^3/hr and can take the biomass with maximum dimension not exceeding 30 mm. It is a batch type gasifier with rated hourly consumption of 10-12 kg. CO, CH_4, H_2, N_2, NO_2 being the producer gases produced. The biomass is fed through the feed door and stored in the hopper. Limited and controlled amount of air for partial combustion enters through two air Nozzles. The throat (or the hearth) ensures relatively clean and good quality gas production. Grate holds charcoal for the reduction of the partial combustion products while allowing the ash to drop off in the ash collector. The gas outlet is connected with the engine via Venturi scrubber, separator box cum fine filter and check filter with an air control valve to facilitate running of the engine in Dual- fuel mode.The rate of flow of water coming through the drain must be maintained at a uniform rate. No parts of the gasifier and downstream sub systemsother than the feed door are to be opened while the gasifier is in operation. Open them only when the gasifier is not in operation and cooled down.

III. EXPERIMENTAL RESULTS

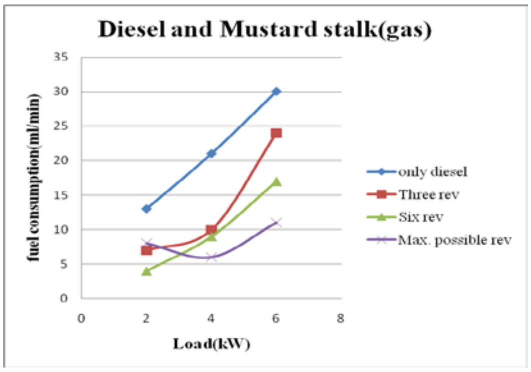

Chart 1- Diesel and Mustard stalk

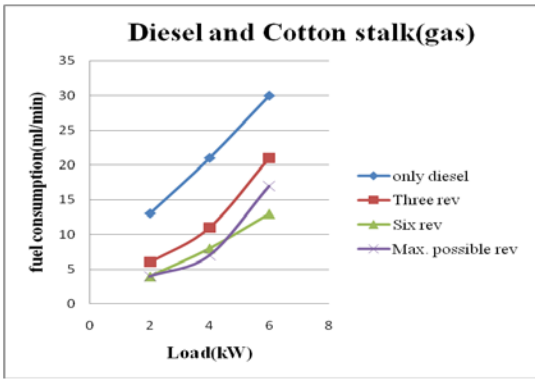

Chart 2- Diesel and Cotton stalk

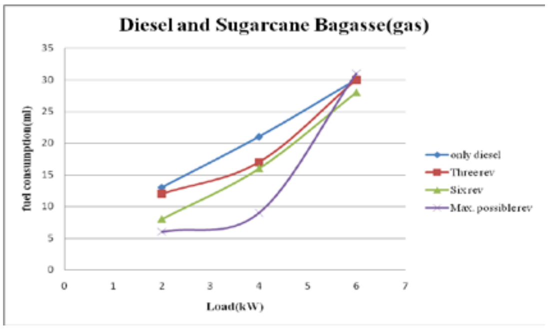

Chart 3- Diesel and Sugarcane bagasse

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IV. CONCLUSIONS

Dual fuel engine is going to be more attractive in coming years to utilize biomass waste. Cotton stalk gives the best performance out of the three biomass samples taken. Cotton stalk have lowest cost of operation and the highest diesel replacement.

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