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A Case Study on Generation of Biomass Energy Using Agriculture Residue

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***Abstract*— Today the power generation is dominated by fossil fuels and the most of power is consumed by urban and industrial sector. The rural area has to be electrified properly, so biomass power generation is the best way as it has renewable source of energy and the raw material for running the plant abundant in nature. In this paper, work has been done on utilizing the agriculture residue to fulfill the needs of rural electric power demand and controlling the pollution caused due to openly firing of agriculture residue. The calorific values of various samples from agriculture residue were tested using bomb calorie meter and efficiency was calculated and compared with the coal plant efficiency. Using the biomass energy will solve two major problems of rural area, first the lack of power for irrigation and second the proper disposal of the agriculture residue which is burnt openly causes air pollution. Punjab and Haryana are agriculture dominant states where the biomass plants can be run efficiently. In the study cluster of 6 villages is formed which is capable of providing the raw material to 12 MW plant for the year and can fulfill power need of the cluster electric demands.**

Keywords—Calorific Value, Agriculture Residue, Bomb Calorimeter, Efficiency, Fossil Fuels.

I. INTRODUCTION

Nature is being used by technology to utilize its resources to supply the human needs. Fossil fuels are the major sources of generating the electric power which leads to large emission of the greenhouse gases which is depleting ozone layer and causing the uneven climatic changes. So to overcome this problems attention should be payed toward renewable sources for generating the power which are ecofreindly and abundant in nature – sun, wind, seas and biomass in particular. These sources have no shortage but the problem was how to use them.

Today world is more concerned about the environment and steps are being taken to control the emission of gases. The aim can be fulfilled by proper use of the renewable sources instead of conventional sources. Today, focus is on long term energy supply and environment safeguarding. The clean electrification in rural areas can be done by the proper utilization of the sources like biomass. Planning is to be done for harnessing the biomass which is available abundantly and is being not utilized due to lack of awareness.

Fossil fuels are dominating the power generation worldwide. 84% of energy produced is by fossil fuels where India uses produces its 90% energy by use of fossil fuels. As we know Today world depends largely on the Electrical energy which is basic input of our daily life used for all minor to major works. The countries economy is viewed by its stand in energy generation. Electrical energy is at the top position in the energy hierarchy. It is used in variously in household, industry, agriculture and commercial work. The use of electrical power has made the work easy and comfortable. The efficiency of work had been increased very much as machines had placed the manpower and speed to do work has been multiplied. But the increasing population and therefore demand of power is creating few problems as the demand is not being matched. To fulfill the demand the use of the non renewable energy sources is being done on large scale which is resulting into depletion of resources and production of green house gases. So to overcome this problem the demand is to skip the conventional sources to renewable sources which are very good alternatives and ecofreindly sources. Biomass is one of alternative which is very largely available in our country.

India has a tremendous supply of renewable energy resources. Crop residue and animal waste in rural area are major available sources which can be used to generate the power to meet the demand. Using these resources in improve the standards of the electrification in rural areas and will strengthen agriculture sector and will reduce the burden on existing grids. Renewable energy sources can provide for indefinite period and is free from from the pollutant gases. Therefore, these sources are able to control the global warming and balance the conditions which today are being unbalanced.

In India the use of biomass is very applicable as we have plenty of agriculture resources for production of residue. India is the agriculture based country where 70% population is dependent on agriculture sector. The GDP of our nation also depends largely on the agri production. But the agriculture sector receives minimum electrical power for irrigation as power is given to industry and urban areas, which makes rural area unelectified. There are thousands of villages in India which are not still electrified.

Biomass is non conventional energy source in form of sawdust, cotton stick, straw, wood, cow dung, etc. these sources are used in the various sectors as to generate electrical energy, to generate steam by directly burning to generate steam. It is easy to generate power from these sources but the problem is to collect them and store them. These plants can be very useful to rural areas where raw material can be available very easily.

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II. STATE REVIEW

Punjab is known to be "Grain bowl of India". The main occupation of state is agriculture and 70-80% population depends upon agriculture. Punjab has only 1.6% of total countries geographical area. From the total geographical land available in state, 85% of land is available for cultivation, 0.2% is cultivated waste land, and 14.8% land is not under cultivation. There are very good facilities for the irrigation in the state, which leads to such great development in agriculture sector.

There is great development in the techniques and production in state. As 23% of total country wheat is produced by the state, 11% of rice produced in country is produced by Punjab. Punjab has 26 lakh hectares of land under paddy cultivation. The straw produced is 180 lakh tones per year. 70% of straw produced is burnt under open air, which produces very large number of emission in the environment.

A. Types of agriculture residue

The biomass plant requires the residue to generate the electrical power. The residues which are available in the state are rice husk, straw, saw-dust, baggage, cotton-stick, municipal waste. Baggage is the material left after the juice is extracted from sugarcane.

Fig 1.1 shows the different agriculture residues used as fuels in the biomass plant

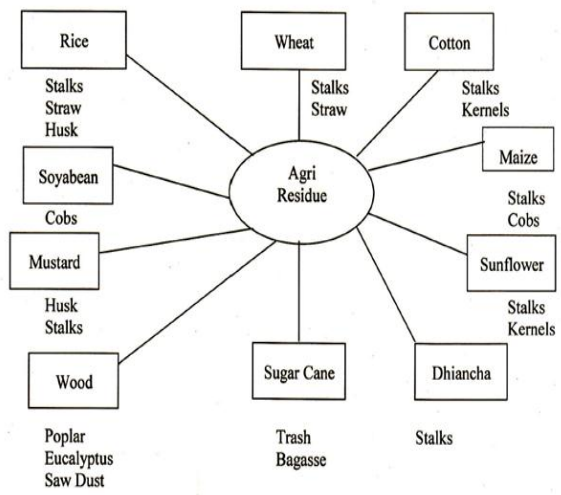

Fig.1.1

B. Punjab biomass plant

The Punjab biomass plant is 12 MW plant situated near ganour, district Patiala near bhagora on the bank of bhakhara.

The plant generate the power at 11KV, 50HZ, 3 phase and steps it up at 66KV and transmits to substation at ghanour which is 5km away from the plant. It operates on DCS system. The steam pressure is maintained between 125-150 degree centigrade's. The rating of transformer is 15 MVA. The various residue used in plant are;-

1. Rice straw
2. Cotton stick
3. Cow dung
4. Saw dust
5. Leaves
6. Wood chips
7. Sun flower stalk
8. Mustard cobs
9. Soya bean husk

III. CLUSTER OF VILLAGES

Punjab is rich in its agriculture sector and enough residue production to meet the electric needs of the state. The work was focused on the cluster of village to develop the small 12 MW biomass plant. There are two groups of crops in state, rabbi and kharif.

A. Introduction to cluster

The cluster of six villages was formed.

Cluster: - Hariou, Daska, Fatehgarh, Gidrani, Sangatpura, Falera.

The table no.3.A.1 showing profile of cluster.

Table no.3.A.1

Sr.no	Terms	Names
1	District & Tehsil	Sangrur, lehragaga
2	Number of villages	6
3	Nearest Towns	Budhlada, lehragaga
4	Nearest Railway Station	Lehragaga, 12 Km away
5	Nearest Airport	Chandigarh, 160 Km away
6	Main Crops	Rabi-Wheat, Barseen, Sarsoon Kharif- Paddy, Cotton, Maize, Sugarcane

B. Survey of cluster

The data was collected from the patwari about the total land of the villages. The data about the crops sown in the area per acre was also collected from the patwari. The production of crops per quintal per acre was collected from the farmers. The calculation of the agriculture residue was done by using residue production ratio (RPR).

Residue production (tones/year) = Grain production (tones/year) × RPR (residue production ratio). (1)

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The table no.3.B.1 representing the data collected is below:-

Table No.3.B.1

Sr. No.	Crop	Agri-Residue Component	Residue Production Ratio(RPR)*	Grain Production (Quintal/acre)*	Agri-Residue production (Quintal/acre)
1.	Cotton	Stalks	4.1	12	49.2
2.	Paddy	Straw	1.6	32	51.2
3.	Wheat	Husk	1.52	25	38
4.	Maize	Stalks Cob	2.6	18	46.8
5.	Sugarcane	Tops Leaves	0.3	400	120
6.	Sarson	Straw	2.65	20	53

On doing the calculation it was found that cluster of villages produces 761912.4 MT of straw, 764902 MT of the husk and 199112.4 MT of the cotton sticks.

IV. BOMB CALORIMETER

Bomb calorimeter is the device used to measure the calorific value of the given material. The four samples were taken and the experiment was done at the lab of GNDEC Ludhiana. The samples taken were saw dust, straw, cow dung and cotton sticks. The calorific value was calculated by the formula:-

$$\text{Calorific value} = (W+w)^* (t_2-t_1)/x \quad (2)$$

Where W = Water quantity in bucket
w = water equivalent
x = weight of sample
t_2= higher temperature
t_1= lower temperature

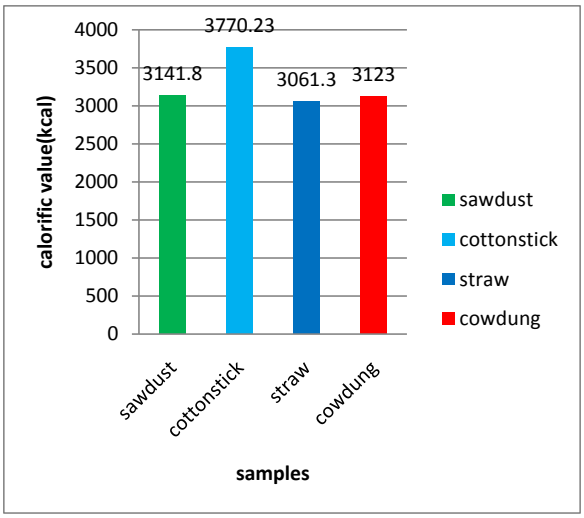
The table no. 4.1 shows the calorific values of the samples tested on bomb calorimeter.

Table No.4.1

Sr.no.	SAMPLE	CALORIFIC VALUE
1	COW DUNG	3123
2	COTTON STICK	3770.23
3	SAWDUST	3141.86
4	STRAW	3061.30

The samples were tested on bomb calorimeter by finding the water equivalent of benzene, which further was used to find the calorific values of the samples. After testing it was clear that the agriculture residue is well enough good to be used in biomass plant to generate electricity.
The graph no. 4.1 shows the calorific values of the different samples.

Graph No.4.1



A. *Efficiency*

After finding the calorific value the efficiency of each sample was calculated. The efficiency was then compared with the efficiency of coal. It was observed that residue has the higher efficiency then that of coal. The efficiency of the straw was highest to be 47% as coal has lowest efficiency of 22% which is low as compared to all other samples. The efficiency of cow dung saw dust and cotton stick are 46%, 45% and 38% respectively. It was observed that the agriculture residue are well efficient then the coal. As they are efficient as well as environment friendly. The graph 4.A.1 clearly depicts the variation in efficiency of samples to coal to the calorific values.

Table No 4.A.1 shows the calorific values and efficiency of different samples.

Table No.4.A.1

Sr.no	Sample	Calorific value(KCAL)	Efficiency (%)
1	Straw	3061.30	47
2	Cow dung	3123	46
3	Sawdust	3141.86	45
4	Cotton stick	3770.23	38
5	Coal	6500	22

The coal which is widely used source for generation of electricity has very low efficiency in comparison to residue samples.
The graph no 4.A.1 is showing the variation of efficiency to calorific value of different samples comparing with coal.

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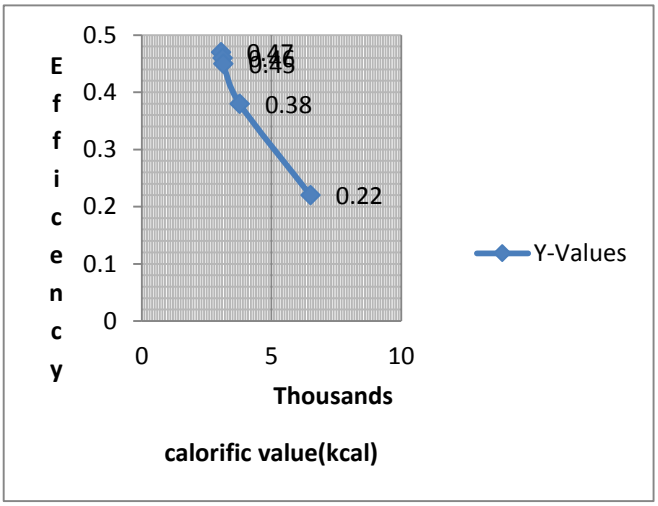
Graph No.4.A.1



B. Power plant

The 12MW plant can be run by the residue production cluster of 6 villages. The load factor is taken to be 0.9. The plant required 127750±10 MT of the residue to run the plant for full year. The residue calculated from the cluster of villages was to be 172542.68±10 MT, which is observed that the cluster of village are sufficient to meet the need of plant by using only 70% of residue and plant is capable of meeting the power requirements of the cluster.

V. RESULTS

The objective of work was to use the agriculture residue to set up the 12 MW biomass plant by observing the efficiency of different samples comparing with coal.

From overall study it was found that fuel requirement of 12 MW biomass plant is met by the residue produced in cluster of six villages which is to be 172542.68 MT. The calorific values of samples were also found by doing experiment on bomb calorimeter, which were found to be 3123 KCAL of cow dung, 3770.23 KCAL of cotton stick, 3141.86 KCAL of sawdust and 3061.30 KCAL was found to be of straw. The efficiency of samples were calculated and found that straw has maximum efficiency of 47% and was compared with coal as it has lowest efficiency then all the samples of 22%. The cow dung has efficiency of 46% whereas sawdust has 45% and cotton stick has low efficiency of 38%. It was observed that the high calorific value has low efficiency. The straw is basic residue which is available in the fields which also have better efficiency then others can be very suitable for the biomass plant. It will allow the rural area to be self sufficient for power and can have safe environment.

VI. CONCLUSION

The thesis work is done on the small biomass plant of 12 MW capacity being set up in the rural area. The data was collected from the cluster of villages from patwari and farmers about the field and the crop sown in the fields. By analysing the data calculations were done and we come to know that their is 172542.68±10 MT of residue all over year which can be used as fuel for biomass plant. Then the samples of residue were taken to test their calorific value, from where it was concluded that the agriculture residue are well enough to be used as fuel for biomass plant. The efficiency of all the samples were calculated and compared with coal. The efficiency of straw was to be highest 47% and coal was having least of only 22% which is lowest then all the samples of agriculture residue.

From all the work it was concluded that cluster of six village has enough fuel to run the plant nonstop. It will solve the problem of disposal of residue and power requirements of rural area. The depilation of fossil fuels can also be longated.

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