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Non-Woody Biomass: A Clean Source of Energy

Salvi
M. Tech Student,
Electronics and Communication Department
Takshshila Institute of Engineering & Technology, Jabalpur (M.P.) [INDIA]
Salvi049@gmail.com

Abstract— Energy is the basic requirement for a developing country like India. Due to continuous development the energy demand is increasing more tremendously than the increase in population. To meet this energy demand the fossil fuels reserves are continuously depleting. The fossil fuels like coal, petroleum, gas etc. are used for power generation. Any other solution for power generation is required to save reserves and environment. The renewable energy sources are the best solution for this problem. This paper reveals the main renewable energy for power generation and its availability in different states. We discuss the various technologies that can be used to use dry or wet biomass for power generation. In view of high energy potential in agricultural potential, proximate analysis, gross calorific value and ultimate analysis is done for different crop samples collected.

Keywords:– Biomass, Potential, Power, Renewable Energy, Technologies**.**

1. INTRODUCTION

The overall energy demand of world is increasing at faster rate than the increase in population. The overall generation in the country has increased from 971.551 during 2010-11 to 1011.143 during the year 2011-12. To meet the increasing demand renewable energy sources are the best method for power generation. Many areas of our country are still without any access to any form of electricity.

Electrification of these areas can be done by distributed generation using renewable energy sources. Renewable form of energy mean a lot for India due to two reasons, Firstly, it is available in abundance, secondly it enhance energy security and reduce environmental impacts. The main renewable sources available in our country are biomass, solar, wind and hydro power. As hydro power generation is possible only if the area has plenty of water, wind energy is usually restricted to coastal areas and solar energy has high initial capital investment cost. So these renewable energy sources are restricted to particular region. As in India most of the people has agriculture as their occupation, the agri-waste residue is the major source for power generation. Biomass available in plenty in most of the parts of India can be utilized for energy generation. The total biomass available in India with energy potential estimation is shown in the Table 1.1

Table 1.1: Total Potential Estimation of Biomass

S.No	Item	Estimated Potential
1	Bio-power (Agri-residue and Planta-tion)	16881 MW
2	Cogeneration (bagasse)	5000 MW
3	Waste to Energy (urban and Industrail)	2700 MW
	Total	24581 MW

In view of high energy potential in agricultural waste an attempt has been made to calculate the proximate analysis and energy content (GCV) of different types of biomass, so that proper utilization can be made for power generation using agricultural waste.

2. BIOMASS AND BIOENERGY

Biomass is an organic matter and the energy released from biomass when it is burnt is called biomass energy. In India biomass is predominate for generation due to its properties like: renewable, widely available and carbon neutral. Biomass contains stored energy from Sun. Plants absorbs CO_2 from the atmosphere while photosynthesis and releases the same CO_2 while burning. Biomass has one more advantage that it can be used for power generation with the same equipments which are used for fossil fuel generation. Biomass used as energy feedstock is environment friendly because biomass recycles the carbon in the environment and does not add CO_2 in atmosphere. [4] Biomass basically is classified in two categories: woody and non woody. Woody biomass consist of high bulk density, less void age, low ash content, low moisture content, high calorific value like forest based residue and agro industrial residue. Non woody biomass characterized as lower bulk density, higher void age, higher ash content, higher moisture content and lower calorific value like agriculture residue, animal waste, urban and industrial solid waste.

2.1 Non- woody Biomass

The various agricultural crop residues resulting after harvest, organic fraction of municipal solid wastes, manure from confined livestock and poultry operations constitute non-woody biomass. Non-woody biomass is characterized by lower bulk density, higher void age, higher ash content, higher moisture content and lower calorific value. Because of the various associated drawbacks, their costs are lesser and sometimes even negative.

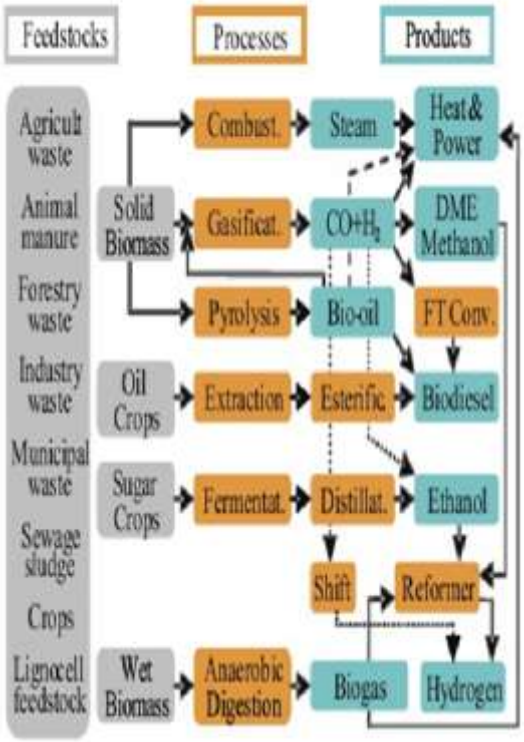

Figure 1 : Biomass Conversion Paths

2.2 Generated Potential from Biomass

Biomass resources are potentially the world's largest and most sustainable energy sources for power generation in the 21st century (Hall & Rao, 1999). The current availability of biomass in India is estimated at about 500 million metric

residue and wastes. The block diagram of direct firing is shown in Fig. 4.1

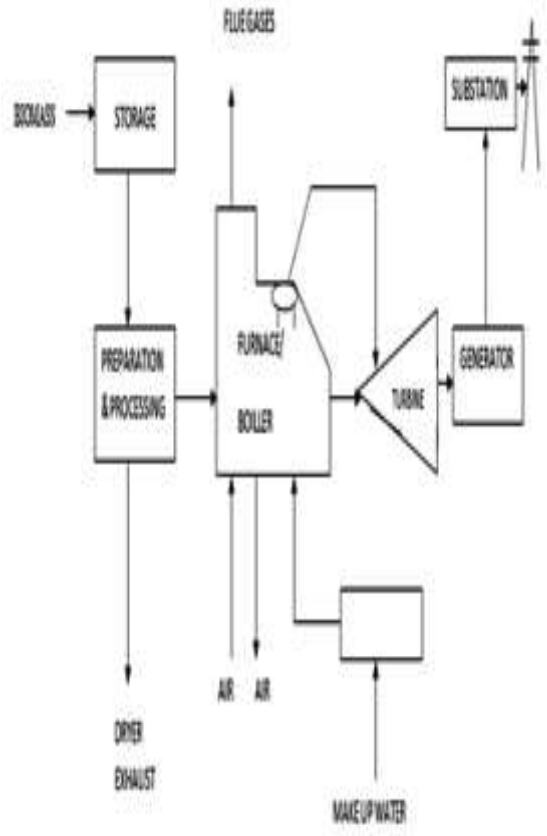

Figure 2: Block diagram of direct firing

4.2 Co-firing

Co-firing is mixing of a percentage of biomass with the coal in coal fired stations. Co-firing can also be used to improve the combustion of fuels with low energy content. The different options for co-firing: -

4.2.1 Biomass blending with coal or Direct firing:

It is simple and least cost approach. Biomass fuels are blended with coal and blend is sent to the firing system.

4.2.2 Separate Injection or Indirect firing:

In this approach the biomass is separately injected into the boiler without impacting the coal delivery process. This method involves more equipment than the first approach.

4.2.3 Gasification based Co-firing:

In this approach, biomass is first fed to gasifier to generate producer gas and then it is fired in boiler.

4.3 Gasification

Gasification is a technique in which thermo chemical conversion of solid biomass into highly combustible gas for burning is obtained by partial oxidation under high temperature. [3] The gas obtained from the gasification process is a mixture of CO, H_2 and CH_4 with CO_2 and N_2. The gas can be used in internal combustion engine or in gas turbine. 4.4 Pyrolysis Pyrolysis is biomass conversion technique, through which biomass is converted to liquid, solid and gaseous fractions by heating the biomass in the absence of air or oxygen. In this volatile component of the waste are vaporized by heating, leaving residue consist of char and ash. 4.5 Anaerobic Digestion In anaerobic digestion, organic material is broken down by bacteria in the absence of oxygen, to produce methane rich biogas. The solid waste left can be used as compost in fields. There are four biological and chemical stages of anaerobic digestion shown in Fig 3.

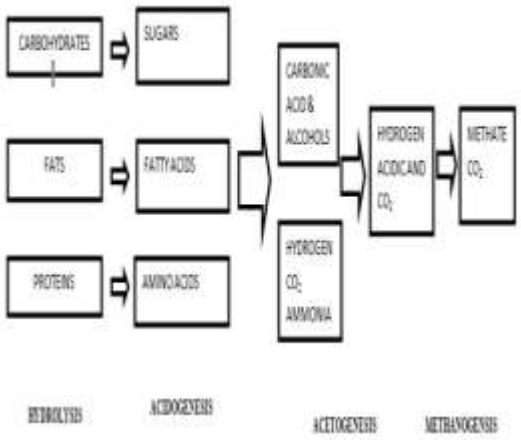

Figure 3: Four stages of anaerobic digestion

4.6 Fermentation

Fermentation is a technique in which a mixture of 60% methane and 40% CO_2 produced through anaerobic fermentation of material like plants vegetable waste and

tonnes per year. Studies sponsored by the Ministry has estimated surplus biomass availability at about 120 - 150 million metric tonnes per annum covering agricultural and forestry residues corresponding to a potential of about 17,000 MW. This apart, about 5000 MW additional power could be generated through bagasse based cogeneration in the country's 550 Sugar mills, if these sugar mills were to adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them.

Table 1.2- Statewise Estimated Potential of Biomass

States	Biomass power in MW
Andhra Pradesh	578
Assam	212
Bihar	619
Chhattisgrah	236
Gujrat	1221
Haryana	1333
Himachal Pradesh	142
Karnataka	1131
Kerala	1044
Madhya Pradesh	1364
Maharashtra	1887
Odisha	246
Punjab	3172
Tamil nadu	1070
Uttar Pradesh	1617
West Bengal	396
	Total 16268

3. BIOMASS AVAILABILITY

Different types of biomass are available in different areas. The northern states of Punjab and Haryana are rich due to multi cropping practices. The main biomass is wheat and rice straw. Some amount of cotton stalks is also available in the western part of Punjab. Agro industrial residue like rice husk, sugarcane bagasse, ground nut and soya shells are also available in commercial market and almost the entire quantity of generated waste is efficiently used. In Rajasthan main source of biomass is mustard residue. In Maharashtra cotton stalks are available in large amount and Madhya Pradesh has soya residue.

4. BIO-ENERGY TECHNOLOGIES FOR DECENTRALIZED POWER GENERATION

Biomass power can be generated by using two technologies one is thermo-chemical and other is bio-chemical. In thermo-chemical: direct firing, co-firing, gasification and pyrolysis techniques can be used for woody biomass, while in bio-chemical anaerobic digestion and fermentation techniques can be used for non woody biomass.

The advances in bio-energy technologies (BETs) over the last few decades have enabled a significant increase in the utilization of biomass for power generation. Key technologies available for promoting power generation from biomass in India are **gasification, combustion, co-firing and bio-methanation.**

4.1 Direct Combustion

Direct combustion is similar to thermal power generation, in which biomass is burnt in the boiler and produce steam to run the turbine to produce electricity. It is based on rankine steam cycle. The chemical reaction is:

$$CxHyO + O2 \longrightarrow CO2 + H2O + Heat$$

The capacity range of these plants is ranges from 0.5 MW to 10 MW and the efficiency range of these plants are 15-25%. This technology disposes of large amount of

animal waste etc. This method requires large installation cost, longer reaction time, high amount of water and large area for installation of plant. Production of ethanol and methanol: 4.6.1 Ethanol – Ethanol is produced from the biomass like sugarcane, starches and cellulose i.e. wood and agricultural residues 4.6.2 Methanol – High cellulose content materials such as wood and agricultural residues are suitable for methanol production.

5. BIOMASS-ENVIRONMENTAL AND CLIMATE CHANGE BENEFITS

Over the past few years, people throughout the world have become very much aware of the terms 'global warming' and 'greenhouse gases'. This has to do with what is going into the atmosphere and how it affects our way of life. When fossil fuels are burned they send carbon dioxide (CO_2), sulphur oxides (SOx), NOx emissions and ash production into the atmosphere. It is believed that these emissions stay there for tens of thousands of years and are creating a barrier, which separates the earth from the sun. Reducing this threat to the atmosphere is one of the Environmental Benefits of Biomass. Air/Atmospheric Pollution is a major challenge faced by the world today and impacts all of us in so many different ways. Importantly, our ability to effectively address air pollution is fundamental to our pursuit of promoting sustained economic growth and sustainable development. Our approach in dealing with pollution issues is, therefore, built around the high priority accorded by developing countries to economic growth and poverty eradication. The decisions concerning the fight against air/atmosphere pollution should be guided by the understanding that economic development, social development and environmental protection are interdependent and mutually reinforcing components of sustainable development. Air pollution has serious negative impacts on human health, socio-economic development, ecosystems and cultural heritage. Urgent and effective actions are, therefore, required in regard to both indoor air pollution from traditional biomass cooking and heating and ambient air pollution from all sources. Indoor air pollution, we believe, must be accorded high priority, as it is in its worst form, a poverty-related manifestation.

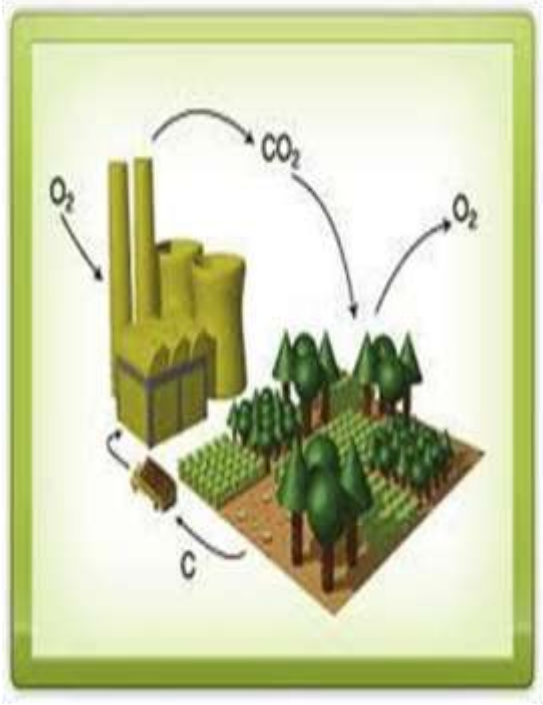

Figure. 4: Carbon Cycle Diagram

6. ADVANTAGES OF DECENTRALIZED BIOMASS POWER GENERATION SYSTEMS

The biomass-based decentralized power generation systems are expected to provide the following multiple social, economic and environmental benefits to the village people:

6.1 Electricity for lighting and development of small-scale industries, thus making the villagers / small industries self-dependent.

6.2 Growth of biomass occurs through photosynthesis reaction. Here, the biomass absorbs Carbon dioxide from the atmosphere and gives out oxygen. Thus the sustainable generation and use of biomass in power plants will definitely help in reducing carbon dioxide concentration in the atmosphere and thus the greenhouse effect.

6.3 Energy content in biomass is more than those of E and F grade coals (mostly exploited coals in Indian power plants).

6.4 Reactivity of biomass towards oxygen and carbon dioxide is much higher than that of coal. This permits the operation of boiler at lower temperatures resulting in greater saving of energy.

7. PROXIMATE AND ULTIMATE ANALYSIS

In this paper proximate and ultimate analysis of some of the samples of biomass is carried out. For this study only crop residue generated by agricultural productions is considered. The crop residue selected for analysis are rice straw, wheat straw, cotton stalk, mustard straw, mungi and groundnut straw etc. Proximate analysis gives the fixed carbon, volatile matter, moisture and ash content of biomass and gross calorific value or higher calorific value is the heat liberated by the combustion of one Kg of fuel at 0°C and under 760mm of mercury. GCV is measures with the aid of the Mahler bomb calorimeter. Ultimate analysis gives the composition of the biomass in weight % of carbon, hydrogen, oxygen, as well as sulphur and nitrogen.

8. CONCLUSION

From all the technologies it is concluded that there are mainly two types of biomass conversion technique: thermo-chemical and bio-chemical conversion. Thermo-chemical conversion techniques are direct firing, co-firing, gasification and pyrolysis. Anaerobic digestion and fermentation are bio-chemical conversion techniques. Biomass to electricity conversion techniques are used in many parts of the world for small to medium scale decentralized or grid connected plants of number of sizes. The values for moisture content, ash content, fixed carbon and GCV are calculated and shown in table 5.1. The value of percentage of composition of different components is shown in table 5.2. We can conclude that biomass has the same potential to generate electricity, so we have to use it for generation purpose, as it is a clean source of energy.

REFERENCES:

[1] Ministry of power, government of India,available: http:// www.powermin.nic.i

[2] Mathias Loeser and Miles Alexander Redfern, Overview of Biomass Conversion and Generation Technologies, *International Universities Power Engineering Conference*, Padova, Italy, Sept 2008, 1–4.

[3] Shouyu Zhang, Dingmao Peng and Fengbao Huang, Effect of Mineral Matter on the Reactivity of the Char from Agricultural Waste, *International Conference on Energy and Environment Technology*, 2009, 286-289.

[4] S. Murali, Rajnish Shrivastava, Mohini Saxena, Quantification of agricultural residues for energy generation –A Case Study *Journal of the IPHE 3*, India, 2007-08.

[5] Gareth J Mayhead, John R Shelly. Utilisation of Boiomass, dec 2010

[6] Amit Jain, Sustainable Energy Plan for an Indian Village *International Conference on Power System Technology*, Hangzhou, 2010, 1-8

[7] Ravindranath N.H. and

Balachandra P., Sustainable bioenergy for India technical, economic and policy analysis, *Energy 34*, 2009, 1003–1013.

[8] M. Kumar and S. K. Patel, Energy Values and Estimation of Power Generation Potentials of Some Non-woody Biomass Species, *Energy Sources, Part A: Recovery, Utilization and Environmental Effects 30(8)*, 2008, 765 – 773.

[9] I. R. Pillai, and R. Banerjee, Renewable energy in India: Status and potential, *Energy 34*, 2009, 970–980.

[10] Dr. Charles Robert Kenneth, International Conference on Advances in Environmental