ESTIMATION OF POWER GENERATION POTENTIAL BY USING MIXTURE OF NON WOODY BIOMASS SPECIES NAMELY GULMOHAR AND CASSIA TORA SEPARATELY WITH COAL BRIQUETTE IN FOUR DIFFERENT RATIOS – A REVIEW

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Abstract: Now a days the energy and environmental problems associated with the use of fossil fuels (coal, petroleum and gas) in power generation, an increasing attention is being paid world over by the scientists and technocrats for the utilization of renewable energy sources in power generation, metallurgical industries etc. There are various types of renewable energy sources available such as solar, wind, hydropower, biomass energy etc. out of these renewable energy sources; biomass is more economically viable for almost all the continents in the world. Biomass is a carbonaceous material and provides both the thermal energy and reduction for oxides, where as other renewable energy sources can meet our thermal need only. About 32% of the total primary energy use in the country is still derived from biomass. Ministry of New and Renewable Energy has realized the potential and role of biomass energy in the Indian context and hence has initiated a number of programmers for promotion of efficient technologies for its use in various sectors of the economy to ensure derivation of maximum benefit. Biomass power generation in India is an industry that attracts investments of over Rs.600 crores every year, generating more than 5000 million units of electricity and yearly employment of more than 10 million man-days in the rural areas.

Keywords:Proximate analysis, ash fusion temperature, electricity generation, energy content, non-woody biomass species.

I. INTRODUCTION

Biomass is organic material that comes from plants and animals, and it is a renewable source of energy. Biomass contains stored energy from the sun. Plants absorb the sun's energy in a process called photosynthesis. When biomass is burned, the chemical energy in biomass is released as heat. Biomass can be burned directly or converted to liquid biofuels or biogas that can be burned as fuels. Examples of biomass and their uses for energy

- wood and wood processing wastes—burned to heat buildings, to produce process heat in industry, and to generate electricity
- agricultural crops and waste materials—burned as a fuel or converted to liquid biofuels
- food, yard, and wood waste in garbage—burned to generate electricity in power plants or converted to biogas in landfills
- animal manure and human sewage—converted to biogas, which can be burned as a fuel

The term "biomass" refers to organic matter that has stored energy through the process of photosynthesis. It exists in one form as plants and may be transferred through the food chain to animals' bodies and their wastes, all of which can be converted for everyday human use through processes such as Combustion, which releases the carbon dioxide stored in the plant material. Many of the biomass fuels used today come in the form of wood products, dried vegetation, crop residues, and aquatic plants. Biomass has become one of the most commonly used renewable sources of energy in the last two decades, second only to hydropower in the generation of electricity. It is such a widely utilized source of energy, probably due to its low cost and indigenous nature, that it accounts for almost 15% of the world's total energy supply and as much as 35% in developing countries, mostly for cooking and heating.

II. DIFFERENT TYPES OF RENEWABLE ENERGY SOURCES

The various forms of renewable energy sources having a potential to be utilized in power generation are as follows:

- *Wind Energy*

Wind power is the use of air flow through wind turbines to mechanically power generators for electric power. Wind power, as an alternative to burning fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation, consumes no water, and uses little land. The net effects on the environment are far less problematic than those of nonrenewable power sources.

- *Solar Energy*

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy.

- *Hydropower*

Hydropower or water power is power derived from the energy of falling water or fast running water, which may be harnessed for useful purposes. Since ancient times, hydropower from many kinds of watermills has been used as a renewable energy source for irrigation and the operation of various mechanical devices, such as gristmills, sawmills textile mills, trip hammers, dock cranes, domestic lifts, and ore mills. A trompe, which produces compressed air from falling water, is sometimes used to power other machinery at a distance.

- *Geothermal Energy*

Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. The geothermal energy of the Earth's crust originates from the original formation of the planet and from radioactive decay of materials. Geothermal power is cost-effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels.

- *Nuclear Energy*

Nuclear power is the use of nuclear reactions that release nuclear energy to generate heat, which most frequently is then used in steam turbines to produce electricity in a nuclear power plant. The term includes nuclear fission, nuclear decay and nuclear fusion. While every form of nuclear energy has been found in nature, fission energy was frequently viewed as a complete product of human ingenuity, until the discovery of Natural nuclear fission reactors within the earth's geological record. The World Nuclear Association and Environmentalists for Nuclear Energy, contend that nuclear power is a safe, sustainable energy source that reduces carbon emissions.

III. BIOMASSANDBIO-ENERGY

Biomass is renewable organic matter derived from trees, plants, crops or from human, animal,municipal and industrial wastes. Biomass can be classified into two types, woody and non-woody. Woody biomass is derived from forests, plantations and forestry residues. Non-woody biomass comprises agricultural and agro industrial residues and animal, municipaland industrial wastes. Biomass does not add carbon dioxide to the atmosphere as it absorbsthe same amount of carbon in growing as it releases when consumed as a fuel. Its advantage isthat it can be used to generate electricity with the same equipment that is now being usedfor burning fossil fuels. Biomass is an important source of energy and the most importantfuel worldwide after coal, oil and natural gas. Bio-energy, in the form of biogas, which isderived from biomass, is expected to become one of the key energy resources for globalsustainable development. Biomass offers higher energy efficiency through form of Biogasthan by direct burning. Biomass contains stored energy from the sun.The chemical energy in plants gets passed on toanimals and people who eat these plants. Biomass is a renewable energy source because wecan always grow more trees and crops and waste will always exist. Some examples ofbiomass fuels are wood, crops, manure and some garbage. When burned, the chemicalenergy in biomass is released as heat. In a fireplace, the wood that is burnt is a biomass fuel.Wood waste or garbage can be burnt to produce steam for making electricity, or to provideheat to industries and homes. Burning biomass is not the only way to release its energy.Biomass can be converted to other usable forms of energy like methane gas ortransportation fuels like ethanol and biodiesel. Crops like corn and sugar cane can be fermented toproduce the transportation fuel, ethanol. Biodiesel, another transportation fuel, can beproduced from left- over food products like vegetable oils and animal fats. Biomass fuelsprovide about 3 percent of the energy used in the United States. People in USA are trying todevelop ways to burn more biomass and less fossil fuel. Using biomass for energy cancut back on waste and support agricultural products grown in the United States. Biomassfuels also have a number of environmental benefits.

3.1 CLASSIFICATIONANDPROPERTIES

The overall biomass resources can be broadly categorized into two parts based on its availability in the natural form.

1. *Woody biomass*

Woody biomass is characterized by high bulk density, less void age, low ash content, low moisture content, high calorific value. Because of the multitude of advantages of woody biomass its cost is higher, but supply is limited. Woody biomass is a preferred fuel in any biomass-to energy conversion device; however its usage is disturbed by its availability and cost.

2. *Non-woody biomass*

The various agricultural crop residues resulting after harvest, organic fractionof 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.

Biomass properties

An understanding of the structure and properties of biomass materials is necessary in order to evaluate their utility as chemical feed stocks. Chemical analysis, heats of combustion and formation, physical structure, heat capacities and transport properties of biomass feed stocks and chars are more relevant in the gasification of any biomass.Bulk chemical analysis. In evaluating gasification feed stocks, it is generally useful to have proximate and ultimate analyses, heats of combustion and sometimes ash analyses. These provide information on volatility of the feedstock, elemental composition andheat content. The elemental analysis is particularly important in evaluating the feedstock in terms of potential pollution. The low energy density of biomass makes them less preferred by the people when compared to fossil fuels like gas, oil and coal.

Physical properties

The major physical data necessary for predicting the thermal response of biomass materials under pyrolysis, gasification and combustion reactions are shape, size, void age, thermal conductivity, heat capacity, diffusion coefficient and densities viz. bulk density, apparent particle density and true density. The values of these properties are different for different biomass especially in the case of loose biomass.

Biochemical analysis

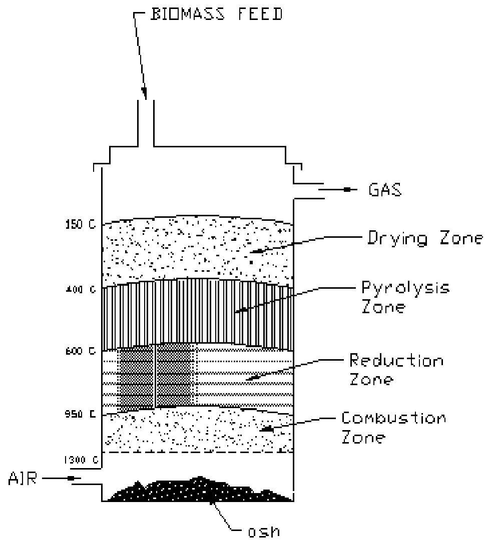
As biomass is a natural material, many highly efficient biochemical processes have developed in nature to break down the molecules of which biomass is composed and many of these biochemical conversion processes can be harnessed. Biochemical conversion makes use of the enzymes of bacteria and other micro-organisms to break down biomass. In most cases micro-organisms are used to perform the conversion process: anaerobic digestion, fermentation and composting.

3.2 DECENTRALIZED POWER GENERATION USING BIO-ENERGY TECHNOLOGIES

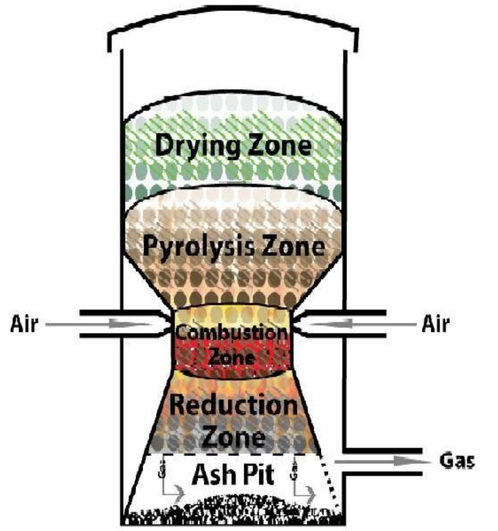
The advances in bio-energy technologies (BETs) over the last few decades have enabled asignificant increase in the utilization of biomass for power generation. Key technologiesavailable for promoting power generation from biomass in India are gasification,combustion, co-firing and bio-methanation

Gasification

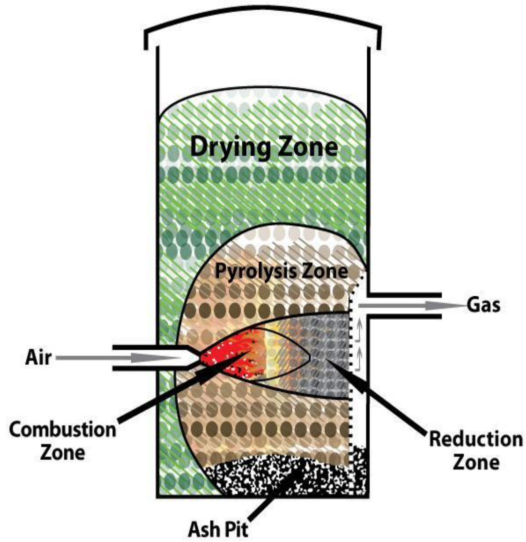
Biomass gasifiers are devices promoting thermo-chemical conversion of biomass into highenergy combustible gas for burning in gas turbine (BIG / GT). Biomass, particularly woodybiomass, can be converted to high-energy combustible gas for use in internal combustionengines for mechanical or electrical applications. Biomass gasifiers are devices performingthermo-chemical conversion of biomass through the process of oxidation and reduction undersub-stoichiometric conditions. Gasifiers are broadly classified into updraft, downdraft andcross draft types depending on the direction of airflow. Gasifier systems with variouscapacities in the range of 1 kg/h to about 500 kg/h are presently in use. These systems areused to meet both power generation using reciprocating engines or for direct usage in heatapplication. The prime movers are diesel engines connected to alternators, where dieselsavings up to 80% are possible. Among the biomass power options, small-scale gasifiers(of 20–500 kW) have the potential to meet all the rural electricity needs and leave a surplusto feed into the national grid. The total installed capacity of biomass gasifier systems as of2011 is nearly 130 MW.



Updraft Gasifier



Downdraft Gasifier



Crossdraft Gasifier

There are four distinct processes to makes gasification are
a) Dryingof fuel
b) Pyrolysis– process in which tar and other volatiles aredriven off
c) Combustion
d) Reduction

- ***Drying offuel***

The first stage of gasification is drying. Usually air-dried biomass contains moisture inthe range of 7-15 %. The moisture content of biomass in the upper most layers is removed byevaporation using the radiation heat from oxidation zone. The temperature in this zoneremains less than 120 °C.

- ***Pyrolysis***

The process by which biomass loses all its volatiles in the presence of air and gets converted to char is called pyrolysis. At temperature above 200°C, biomass starts losing its volatiles. Liberation of volatiles continues as the biomass travels almost until it reaches the oxidation zone. Once the temperature of the biomass reaches 400°C, a self-sustained Exothermic reaction takes place in which the natural structure of the wood breaks down. The products of pyrolysis process are char, water vapour, Methanol, Acetic acid and considerable quantity of heavy hydrocarbon tars.

- ***Combustion***

The combustible substance of a solid fuel is usually composed of elements carbon, hydrogen and oxygen. In complete combustion carbon dioxide is obtained from carbon in fuel and water is obtained from the hydrogen, usually as steam. The combustion reaction is exothermic and yields a theoretical oxidation temperature of 1400 °C. The main reactions,
Therefore, are:

$C + O_2 = CO_2$ (+393 MJ/kgmole) (1)
$2H_2 + O_2 = 2H_2O$ (-242 MJ/kgmole) (2)

- ***Reduction***

The products of partial combustion (water, carbon dioxide and un-combusted partially cracked pyrolysis products) now pass through a red-hot charcoal bed where the following reduction reactions take place:

$C + CO2 = 2CO$ (-164.9 MJ/kgmole) (3)
$C + H2O = CO + H2$ (-122.6 MJ/kgmole) (4)
$CO + H2O = CO + H2$ (+ 42 MJ/kgmole) (5)
$C + 2H2 = CH4$ (+75 MJ/kgmole) (6)
$CO2 + H2 = CO + H2O$ (-42.3 MJ/kgmole) (7)

Equations (3) and (4) are main reduction reactions and being endothermic have the capabilityof reducing gas temperature.
Consequently the temperatures in the reduction zone arenormally 800-10000C. Lower the reduction zone temperature (~ 700-8000C), lower is thecalorific value of gas.

IV. MERITS 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:

- Electricity for lighting and development of small-scale industries, thus making thevillagers / small industries self-dependent.
- 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.
- In comparison to coal, the ash content in biomass is very less (2-6% approx. as against 20-50% in coal). Thus, the use of biomass in power generation will lead to substantial decrease in the amount of suspended particulate matters in the atmosphere.
- Energy content in biomass is more than those of E and F grade coals (mostly exploited coals in Indian power plants).
- Reactivity of biomass towards oxygen and carbon dioxide is much higher than that ofcoal. This permits the operation of boiler at lower temperatures resulting in greater saving of energy.
- Power generation on decentralized basis will reduce the transmission losses.
- Feasibility of installation of biomass gasifiers in any location or village.
- Easy availability of technology and backup systems.
- Support for the domestic and industrial waste management projects.
- Despite the above advantages, the rate of spread of biomass-based power generationsystems is low due to a number of policy and financial barriers.
- Exploitation of biomass in power generation will lead to better utilization of barrenlands of India (67 million hectares approx.).
- In planning the electricity generation from biomass on decentralized basis, thefollowing points should be taken into account:
- Kind, quality, quantity, feasibility of transportation and storage, sustainability and costof biomass to be used.
- Level of customer demand.
- Method and cost of biomass drying.
- Method of electricity generation and its economic viability.
- Costs and qualities of locally available fossil fuels.

V. TYPES OF NON-WOODY BIOMASS PLANT COMPONENTS

The two different types of non-woody biomass species are taken, one is Cassia Tora (Chakunda) and another is Gulmohar (Krishnachura). These biomass species were cut into small pieces and there different component like leaf, nascent branch and main branch were separation from each other. These biomass materials were air-dried in cross ventilator room for around 20 days. When the moisture contains of these air dried biomass sample came in balance with that of the air, they were crushed inmortar and pestle into powder of -72 mess size. The sample of Coal for making the blend was collected from coal mines. These materials were than processed for the determination their proximate analysis and Energy values. The calorific values of the fuels/energy source are important norms for judging its quality to be used in electricity generation in power plants. It provides an idea about the energy value of the fuel and the amount of electricity generation. Gulmohar biomass species were found to be little bit higher than that of Cassia Tora biomass. Amongst the four different ratios, ratio 80:20 gives the highest energy value in all mixed component and 85:15 also gives higher energy value except leaf component of both biomass in respect to other two ratios (95:05 and 90:10)

VI. CONCLUSION

The potential of both species Gulmohar and Cassia tora are examine and theestimation was done to analyze how much power can be generated in one hectare ofland from each of these species. The following different conclusions are pointed areas follows:

1. In both biomass species, the Gulmohar has the highest energy value than Cassia Tora. The Coal mixed Gulmohar biomass component are found to be little bit higher energy value than Coal mixed cassia tora biomass component
2. The temperature of ash fusion obtaining from all the species are obtaining above theboiler operation range, this would effectively avoid clinker formation in the boiler
3. The ratio of biomass and coal in different ratio is showed in the same proximateanalysis, the ash contents being more when 93% coal mixing with 7 % biomass andvolatile matter is more when 77 % coal mixing with 23% biomass.

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