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Estimation of Power Generation of Non-Woody Biomass

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Abstract: ***In view of energy as well as environmental problems associated with the use of fossil fuels (coal, petroleum and gas) in power production, deeply attention is being paid world-over by the scientists and technocrats for the utilization of renewable energy sources in power production, metallurgical industries etc. There are different type of renewable energy sources like solar, wind, hydropower, biomass energy etc. In all of renewable energy sources, biomass is more reasonably feasible for almost all the continents in the world. Biomass is provided both the thermal energy and reduces oxides, where as other renewable energy sources can fulfill our thermal need only. It is a carbonaceous material. Biomass is the purest fuel consisting of very lesser amount of ash materials. The power production potential data for renewable energy sources in India clearly indicates that the biomass has potential to generate more than 17000 MW of electricity per year in India. In the present work, briquettes were prepared by mixing non-coking coal from Orissa mines and the related biomass species in different ratio (coal: biomass = 95:05, 90:10, 85:15, 80:20). The objectives have been to examine their energy values and power production potential.***

Keywords: ash blending temperature, electrical energy production, energy substance, non-woody biomass type.

1. Introduction

The overall energy demand of world is increasing at faster rate than the increase in population. India being a developing nation, sustainable growth is more important. Energy is a basic requirement for economic development. Every sector of Indian financial system– agriculture, industry, transport, commercial and domestic – require inputs of energy [1]. Energy is an important factor for any growing country. Ever increasing consumption of fossil fuels and rapid depletion of known reserves are matters of serious concern in the country dependent on fossil fuels such as coal and oil and gas. Biomass has always an important energy source for the country considering the payback it offers. Biomass offers thermal energy as well as reduction for oxides [2]. It is renewable, widely available and carbon-neutral and has the potential to provide significant employment in the rustic areas. Biomass is also capable of providing firm energy. About 32% of the total primary energy use in the country is still derived from biomass.

2. Literature Review

A majority of the Indian population does not have access to convenient energy services (LPG, electricity) (Pillai et al, 2009). Though India has made significant progress in renewable energy, the share of modern renewable in the energy mix is minor. This paper reviews the condition and potential of different renewable (except biomass) in India. Bio-energy technologies (BETs) are presented as potential carbon abatement opportunities substituting fossil fuel or traditional (less efficient) biomass energy systems (Ravindranath et al, 2006). Cost of energy (produced or saved) of BETs is compared with fossil fuel and traditional biomass energy systems to estimate the incremental cost (IC).

3. Experimental work

3.1 Selection of Materials

In the present project work, two different types of non-woody biomass species Cassia Tora (Local Name: Chakunda) and gulmohar (Local name: Krishnachura) where procured from the local area. These biomass species were cut into different 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.

Figure 1: Sample of biomass omponent

3.2 Determination of Moisture

One gm. (1 gm.) of -72 mess size (air dried) was taken in a shallow silica disc and kept in a muffle furnace maintained at the temperature of 775°C ± 5°C. The materials were heated at this temperature for one hour or till complete burning. The weight of the residue was taken in an electronic balance. Percentage weight of residue. Weight of obtained gives the ash contained in the sample.

% Ash = Weight of excess obtained × 100 / Initial weight of sample.

3.3 Determination of Fixed Carbon

The fixed carbons in the simple were determined by using the following formula.

$$\% FC = 100 - (\% M + \% VM + \% Ash)$$

Where,
FC: Fixed carbon,
M: Moisture,
VM: Volatile Matter

3.4 Ash Fusion Temperature Determination

The ash fusion Temperature, softening Temperature, Hemispherical temperature and Flow temperature) of all the ash samples, obtained from the presently selected non-woody biomass species and coal-biomass (in ratio) mixed sample were determined by using Leitz Heating Microscope.

Figure 2: Leitz Heating Microscope

3.5 Determination of Volatile Matter

One gm. (1 gm.) of -72 mess size (air dried) powder of the above said materials was taken in a volatile matter crucible (cylindrical in shape and made of silica). The crucible is covered from top with the help of silica lid. The crucible were placed in a muffle furnace, maintained at the temperature of 9250 C ± 50 C and kept there for 7 minute. The volatile matter crucibles were then taken out from the furnace and cooled in air. The devitalized samples were weighted in an electronics balance and the percentage loss in weight in each of the sample was calculated. The percentage volatile matter in the sample was determined by using the following formula.
% volatile matter (VM) = % lass in weight - % moisture

4. Calculations

Total Energy Contents and Power Generation Structure from 8 Months old (approx.), Gulmohar Plants.

Table 1: data of various components

Component	Calorific Value (kcal/t, dry basis)	Biomass Production (t/ha, dry basis)	Energy Value (kcal/ha)
Main wood	4532 $\times 10^3$	21	95172 $\times 10^3$
Leaf	3907 $\times 10^3$	7	27349 $\times 10^3$
Nascent branch	3997 $\times 10^3$	9.50	37971.5 $\times 10^3$

Energy Calculation

On even dried basis, total energy from one hectare of land
= (95172+27349+37971.5) ×103
= 160492.5 ×103 kcal
It is assumed that exchange efficiency of timber fuel thermal generators = 26 % and mechanical efficiency of the power plant = 85 %.
Energy value of the total functional biomass obtained from one hectare of land at 26% conversion efficiency of thermal power plant = 160492.5 ×103× 0.26
= 41728.05× 103
= 41728.05×103×4.186/3600
= 48520.45 kWh
Power generation at 85 % mechanical efficiency
= 48520.45 ×0.85
= 41242.38 kWh/ha
Land required supplying electricity for entire year
=73×105/ 41242.38
= 177.00 ha
Total Energy Contents and Power Generation Structure from 4 Months old (approx.), Cassia Tora Plants:

Table 2: data of various components

Component	Calorific Value (kcal/t, dry basis)	Biomass Production (t/ha, dry basis)	Energy Value (kcal/ha)
Main wood	4344 $\times 10^3$	4	17376 $\times 10^3$
Leaf	4013 $\times 10^3$	1.50	6019.5 $\times 10^3$
Nascent branch	3672 $\times 10^3$	2.50	9180 $\times 10^3$

On even dried basis, total energy from one hectare of land

= (17376+6019.5+9180) ×103
= 32575 ×103 kcal

It is assumed that conversion efficiency of wood fuelled thermal generators = 26 % and mechanical efficiency of the power plant = 85 %.

Energy value of the total functional biomass obtained from one hectare of land at 26% conversion efficiency of thermal power plant.

= 32575.50 ×103 × 0.26
= 8469.63×103 kcal
= 8467.29×103 ×4.186÷ 3600
= 9848.30 kWh

Power generation at 85 % mechanical efficiency
= 9848.30×0.85
= 8371.05 kWh/ha

Land required to supply electricity for entire year
=73×105/ 8371.05
= 872.05 ha

5. Conclusions

[1] Both plant species (Gulmohar and Cassia tora) showed almost the similar proximate analysis results for their components, the ash contents being more in their leaves and volatile matter content less in Cassia tora wood and leaf.
[2] Mixed ratio of Both biomass with coal(in four different ratio) also showed the same proximate analysis results, the ash contents being more when 95% coal mixing with 5% biomass and volatile matter is more when 80% coal mixing with 20% biomass.
[3] The non-wood biomass species showed highest energy values for their branch, followed by wood, leaf and nascent branch.
[4] Amongst the both biomass species Gulmohar has the highest energy value compared to Cassia tora.
[5] Energy values of coal mixed Gulmohar biomass component were found to be little bit higher than that of coal mixed Cassia Tora biomass component.

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