ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 5, Issue 4, July 2016

POWER GENERATION POTENTIAL OF NON-WOODY BIOMASS AND COAL-BIOMASS MIXED BLOCKS A REVIEW

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Abstract— For power generation, fossil fuels are being currently used but they are limited & cause pollution. There are various type of renewable energy sources such as solar, wind, hydropower, biomass energy etc. out of these biomass is more economical. Biomass is a carbonaceous material and provides both the thermal energy and reduction for oxides, but other renewable energy sources can meet our thermal need only. Amongst all the solid fuel, biomass is the purest fuel consisting of very lesser amount of ash materials. The power generation 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. However, the country is locking in exploitation of biomass in power generation. Till date, India has been capable to generate only 2000 MW (approx.) of electricity per year in spite of declaration of several incentives by the govt. of India [22]. Hence, there is an argent need to increase the utilization of biomass in power generation. The present project work is a positive step towards energy and environmental problems facing the world.

Index Terms— **coal, non-woody biomass.**

I. INTRODUCTION

India is a developing nation, but sustainable development is more important. In developing nations, energy is being consumed at a very faster rate and it is a initial requirement for economic development. Every sector of Indian economy – agriculture, industry, transport, commercial and domestic – needs inputs of energy [1]. This growing consumption of energy has also resulted in the country becoming increasingly dependent on fossil fuels such as coal and oil and gas. Rising prices of oil and gas and potential shortages in future lead to concerns about the security of energy supply needed to sustain our economic growth [2]. Increased use of fossil fuels also causes environmental problems both locally and globally. Biomass has always been an important energy source for the country considering the benefits it offers. It is renewable, widely available, and carbon-neutral and has the potential to provide significant employment in the rural 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 [3]. 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 programmed for promotion of efficient technologies for its use in various sectors of the economy to ensure derivation of maximum benefits Biomass power generation in India is an industry that attracts investments of over extracted from fossil fuels but they are developing at a very faster rate which is a matter of concern Rs.800 crores every year, generating more than 10000 million units of electricity and yearly employment of more than 20 million man-days in the rural areas [4]. For efficient utilization of biomass, baggage based cogeneration in sugar mills and biomass power generation have been taken up under biomass power and cogeneration programmes [5].

II. LITERATURE REVIEW

In the preceding, we have explored the current status of coal and biomass co-conversion in thermo chemical systems. It was observed that this process allows for compensating the shortcomings of one fuel by another since both fuels seems to be complementary in their drawbacks and advantages. Among all renewable energies, biomass is the only source of concentrated carbon and as such, is the only renewable energy source for replacement of transportation fuels, and therefore, will certainly play an important role in meeting the future energy need of the world.

Tomohiro Tabataa et al. [2011] has studied the business impact of GHG reduction from semi-carbonized fuel produced by co-firing woody biomass with coal in thermal power plants. In this study, a new business whose operations would co-fire the woody biomass with coal is considered. A life cycle inventory (LCI) analysis and a life

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cycle impact assessment are conducted to evaluate the GHG emissions, taking into account processes such as cutting timber, manufacturing semi-carbonized fuel, and co-firing with coal [6].

Jaya Shankar Tumuluru et al. [2011] there is a significant interest in using biomass for power generation as we seen power generation from coal continues to raise environmental concerns. Using just biomass for power generation can bring a lot of environmental benefits. However the constraints of using biomass alone can include high investments costs for biomass feed systems and also uncertainty in the security of the feedstock supply due to seasonal variations, and in most countries, limited infrastructure for biomass supply. Alternatively, co-firing biomass along with coal offers advantages like reducing the issues related to biomass quality and buffers the system when there is insufficient feedstock quantity and costs of adapting the existing coal power plants will be lower than building new systems dedicated only to biomass. Some of these limitations can be overcome by using preprocessing methods. The authors have discussed the impact of feedstock preprocessing methods like sizing, baling, pelletizing, and briquetting, washing/leaching, to refraction, to refraction and pelletization and steam explosion in attainment of optimum feedstock characteristics to successfully co-fire biomass with coal [7].

Y. Haseli et al.[2011] have assumed pyrolosis of biomass to take place through three competing reactions yielding char, light gas and tar. The model is validated using different sets of experiments reported in the literature. Special emphasis is placed on examination of the effects of pyrolysis kinetic constants and gas phase reactions on the combustion process which have not been thoroughly discussed in previous works. It is shown that depending on the process condition and reactor temperature, correct selection of the pyrolysis kinetic data is a necessary step for simulation of biomass particle conversion. The computer program developed for the purpose of this study enables one to get a deeper insight into the bio-mass particle combustion process [8].

Beena Patel et al. [2012] surveyed at the power industry for confronting challenges with seemingly conflicting goals. They provide the economy of scale needed to minimize the cost of production. Consumers, including industry, rely on affordable, dependable electrical energy. It’s an important part of our economy and our daily lifestyle. However, reducing emission levels and conserving our finite resources are key components for achieving a sustainable environment. Biomass is a resource that can be substituted for coal, in varying degrees for existing pulverized coal plants. New, large power plants are being designed to utilize biomass as the primary fuel. Biomass is available now and biomass based new products and sources are being developed. However, fuel properties and characteristics are important to boiler design and operation. Different boilers have unique design and fuel requirements. Heating value, percent volatiles, total ash and moisture content, ash constituents and particle size are all key parameters considered by the boiler designer. Some biomass products have unique utilization issues. The chemical fraction behavior of biomass materials is quite different from that of typical coals. For co-firing applications, the properties of biomass and coal can be blended as a designer fuel. The objective is to best meet boiler, combustion, emission and economic requirements. Fuel degradation and spontaneous combustion are more important concerns for biomass fuel products. This is a moisture-dependent issue. Dry biomass can be stored for longer periods. High moisture levels become a concern for degradation and spontaneous combustion. Therefore, the paper deals with the biomass characterization in terms of its physico-chemical properties which can be useful to understand biomass combustion related issues [9].

Gulab Chand Sahu et al. [2013] have discussed 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 types 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 investigated 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 [10].

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Michael E. Goerndt et al. [2013] have presented investigation establishing measures of co-firing potential at varying spatial scales to assess opportunities for renewable energy generation from woody biomass. The study estimated physical availability, within ecological and public policy constraints, and asso- ciated harvesting and delivery costs of woody biomass for co-firing in selected power plants of the Northern U.S. Procurement regimes were assessed for direct sources of woody biomass from timberland including logging residues (slash, by-products), small-diameter trees, and integrated harvest (logging residues and small-diameter trees). Concentric woody biomass procurement areas were estimated for each power plant using county-level estimates and varying procurement radii. Delivered fuel cost estimates were calculated for each power plant and procurement regime based on incremental maximum transport distances. Procurement regimes focused on small-diameter trees can potentially produce the most electric power. For most procurement regimes, an average power plant co-firing had the potential to replace greater than 30% of coal electricity generation if there was no competition for the feedstock. However, woody biomass resource competition from adjacent co-firing plants could reduce this generation potential to less than 10% [11].

A.Raju et al. [2014] this work have proximated analyzed different components, such as wood, leaf and nascent branch and energy content of different components of paddy husk hypogeal. Medical wastes from hospitals and items that can be recycled are generally excluded from MSW used to generate electricity. These biomass components were separately mixed with coal dust and MSW in different-different ratio and also their proximate analysis was done and their energy values were determined to find out the best suitable mixture for power generation. Estimation was made for power generation potential of these biomass species and MSW and coal dust mixed for a small thermal power plant on decentralized basis. As it was evident from result that both the biomass species has less ash content and high volatile matter when mixes with MSW in the ratio of 60:40. In the 60:40 ratios the major component of biomass was the paddy husk and remain part of fuel is MSW and coal dust, due to that when it was mixed with coal, the calorific value of mixture got increased as the quantity of paddy husk biomass was increased in the mixture of coal-biomass.(Municipal solid waste) calorific value, energy value [12].

S.J. Gerssen-Gondelach et al. [2014] The increasing production of modern bio-energy carriers and biomaterials intensified the competition for different applications of biomass. To be able to optimize and develop biomass utilization in a sustainable way, this paper, first reviews the status and prospects of biomass value chains for heat, power, fuels and materials, next assesses their current and long-term levelized production costs and avoided emissions, and then compares their greenhouse gas abatement costs. At present, the economically and environmentally preferred options are wood chip and pellet combustion in district heating systems and large- scale cofiring power plants (75–81 US\$2005/tCO2-eqavoided), and large-scale fermentation of low-cost Brazilian sugarcane to ethanol (65 to 53 \$/tCO2-eqavoided) or biomaterials (60 to 50 \$/tCO2- eqavoided for ethylene and 320 to 228 \$/tCO2-eqavoided for PLA; negative costs represent cost-effective options). In the longer term, the cultivation and use of lignocellulosic energy crops can play an important role in reducing the costs and improving the emission balance of biomass value chains. Key conversion technologies for lignocellulosic biomass are large-scale gasification (bioenergy and biomaterials) and fermentation (bio-fuels and biomaterials). However, both routes require improvement of their techno-logical and economic performance. Further improvements can be attained by bio refineries that integrate different conversion technologies to maximize the use of all biomass components [13].

Stanislav V. Vassilev et al. [2015] An extended overview of the advantages and disadvantages of biomass composition and properties for biofuel application was conducted based on reference peer-reviewed data plus own investigations. Initially, some general considerations and comparisons about composition and properties of biomass and coal as the most popular solid fuel were addressed. Then, some of the major advantages related to the composition and properties of biomass and/or biomass ash (BA) were discussed. They include: (1) high values of volatile matter, H, structural organic components, extractives and reactivity of biomass, water-soluble nutrient elements and alkaline-earth elements in biomass and BA, and pH of BA; and (2) low values of C, fixed C, ash, N, S, Si and initial ignition and combustion temperatures of biomass, and low contents of many trace elements including hazardous ones in biomass and BA. Further, some of the major disadvantages connected with the composition and properties of biomass and/or BA are described. It was found that the disadvantages of biomass for biofuel and biochemical applications prevail over the advantages; however, the major environmental, economic

ISSN: 2319-5967
ISO 9001:2008 Certified
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and social benefits appear to compensate the technological and other barriers caused by the unfavorable composition and properties of biomass [14].

Xiang Liu et al. [2015] There were significant differences between combustion kinetics of bituminous coal and biomass. The blending ratios and the heating rates had certain effect on the mechanisms of switch grass/coal blends at pre-peak. The dominant mechanisms associated with co-combustion kinetics for beetroot/coal at pre-peak and post-peak were described by the Avramierofeev equations. The mechanisms of co-combustion for switch grass/coal samples at pre-peak were described by the Avramierofeev equation, Z–L–T equation or Anti Jander equation; however, at post-peak, their mechanisms were described by the Avramierofeev equation. The general kinetic compensation effect correlations were deduced for all samples within the heating rates of 10–90 C/min [15].

Nathan C. Crawford et al. [2015] Due to its low density and poor flow ability, raw biomass may not be an economically viable feedstock for the production of bio-fuels. However, mechanical densification can be employed to improve its viability. In this study, the flow properties (compressibility, shear, and wall friction) of "pure" feed stocks (corn stover, hybrid poplar, switch grass and Miscanthus), and feedstock blends, were investigated and compared to measured pelleting energy consumption values. As anticipated, the more compressible materials required lower pelletization energies. Conversely, the less flow able feed stocks (i.e., the materials with higher cohesion and yield strength) were less energy intensive to pellet. In addition, the flow ability parameters of the blended materials were predicted by averaging the measured flow parameters of their pure feedstock constituents. Strong correlation was observed between the measured pelleting energy consumption and the predicted pelleting pressure values. This newly developed model allowed for a material's pelleting feasibility [16].

T.T. Al-Shemmeri et al. [2015] In this paper, the authors attempted to investigate the performance of a small-scale biomass combustor for heating, and the impact of burning different biomass fuels on useful output energy from the combustor. The test results of moisture content, calorific value and combustion products of various biomass samples were presented. Results from this study were in general agreement with published data as far as the calorific values and moisture contents are concerned. Six commonly available biomass fuels were tested in a small-scale combustion system, and the factors that affect the performance of the system were analyzed. In addition, the study has extended to examine the magnitude and proportion of useful heat, dissipated by convection and radiation while burning different biomass fuels in the small-scale combustor. It was concluded that some crucial factors have to be carefully considered before selecting biomass fuels for any particular heating application [17].

G.M. Joselin Herbert et al. [2016] Due to Literature survey the world needs an enormous amount of energy to maintain the future economic developments. India has facile ways to overcome the immediate demand on energy supply by renewable energy resources. It has a huge potential of biomass resources to reduce the dependence on fossil fuels and to produce electrical and heat energy. The biomass energy can contribute to social and economic development. It has been identified as an alternative for the future energy demand in India. As part of furthering the development of biomass technology, it is essential to understand the environmental merits and demerits of biomass. It also aimed to increase the use of biomass energy for domestic purposes. The interest behind the review was boosted by the rapid development of biomass conversion techniques and continual increase of biomass energy generation. It has motivated the authors to collect the essential literature of environmental aspects of biomass energy. The objective of the research work is to quantify and focuses the environmental performance of biomass energy. It also deals with the environment monitoring and control, pricing, standard and regulations of the bio-energy for the future development [18].

Ana Isabel Moreno et al. [2016] In this investigation Densification of furniture wood and the co-densification of furniture wood waste with polyurethane foam was studied. On the one hand, the parameters that have an effect on the quality of the furniture waste briquettes was analyzed, i.e., moisture content, compaction pressure, presence of lignin, etc. The maximum weight percentage of polyurethane foam that was added with furniture wood waste to obtain durable briquettes and the optimal moisture was determined. On the other hand, some parameters were analyzed in order to evaluate the possible effect on the combustion. The chemical com-position of waste wood was

ISSN: 2319-5967
ISO 9001:2008 Certified
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Volume 5, Issue 4, July 2016
compared with untreated wood biomass; the higher nitrogen content and the concentration of some metals were the most important differences, with a significant difference of Ti content [19].

C. Antwi-Boasiako et al. [2016] Due to survey Agricultural and wood residues are principal energy sources for domestic and industrial activities. However, they are often hardly utilized. Conventional wood material for briquetting optimizes combustion and efficient power production. The relationship between strength properties, resistance to humidity and calorific values of sawdust-briquettes from three tropical hardwoods of different densities Enormous briquette Swelling Values for A. toxicaria (60.04%), Mixed type (66.16%) and C. pentandra (70.88%) indicate they would deteriorate fast and require great care to store, handle and transport. However, the large Shatter Indices for the mixed type (98.8%) and C. pentandra (99.16%) denote their high durability to gravitational deterioration. Briquette technology, a "waste-to-energy method", contributes to offset bio-residue management problems and reduce toxic emissions from its incomplete carbonization. Thus, comprehensive understanding of wood-residue briquette characteristics was significant for fuel-energy generation [20].

Haiping Yang et al. [2016]. To introduce application status and illustrate the good utilization potential of biomass paralytic poly generation using retort reactors, the properties of major products and the economic viability of commercial factories were investigated. The capacity of one factory was about 3000 t of biomass per year, which was converted into 1000 t of charcoal, 950,000 Nm3 of biogas, 270 t of woody tar, and 950 t of woody vinegar. Charcoal and fuel gas had LHV of 31 MJ/kg and 12 MJ/m^3 commercial fuels. The woody tar was rich in phenols, while woody vinegar contained large quantities of water and acetic acid. The economic analysis showed that the factory using this technology could be profitable, and the initial investment could be recouped over the factory lifetime. This technology is promising means of converting abundant agricultural biomass into high-value products, respectively, indicating their potential for use as commercial fuel [21].

III. RESULTS AND DISCUSSION

In non-woody biomass components have a large amount of free moisture, which must be removed to decrease the transportation cost and increase the calorific value. In the plant species selected for the present study, the time required to bring their moisture contents into equilibrium with that of atmosphere was found to be in the range of 15 to 20 days during the summer season (temperature :35-45°C and moisture: 6-14%) [10[1]]. the studies of the proximate analysis of fuels /energy sources are important because they give an approximate idea about the energy values and extent of pollutants emissions during combustion. The proximate analysis of different components of plant and these biomass species component blocks with coal are presented. The components of these species are very close to each other and hence it is very difficult to draw a concrete conclusion. However, it appears from these biomass species has somewhat higher ash and lower fixed carbon contents than these of biomass species and the ash contents being more and volatile matter is less when 95% coal mixing with 5% biomass and 90% coal mixing with 10% biomass but when 85% coal mixing with 15% biomass and 80% coal mixing with 20% biomass then ash content is being less and volatile [9[1]] matter is more due to literature review.

IV. CONCLUSION

In the presently review work two non-woody biomass species. Experiments to determine the proximate analysis, calorific values and ash fusion temperature was done on each of the components of the selected species such as main wood; leaf and nascent branch were performed. Estimation was done to analyse how much power can be generated in one hectare of land from each of these species. The following are the different conclusions drawn from the literature survey work:

1. Some species showed almost the similar proximate analysis results for their components, the ash contents being more in their leaves and volatile matter content less in coal.

2. The non-wood biomass species showed highest energy values for their branch.

3. Both biomass species has the highest energy value compared to other.

4.80:20 of coal and biomass ratio gives the highest energy value compared to other.

5. The fusion temperature of all the species are coming above the range of boiler operation, would avoid clinker formation.

6. This study could be positive in the exploitation of non-woody biomass species for power generation.

V. SUGGESTIONS FOR FUTURE WORK

The present study was concentrated on two non-woody biomass species such as leafs and Coal. The following works are suggested to be carried out in future.

1. Similar type of study need to be extended for another non-woody biomass species available in the local area.
2. The biomass species may be mixed with cow dunk, sewage wastes, etc. in different ratios and the electricity generated potentials of the mixtures may be determined.
3. Pilot plant study on laboratory scale may be carried out to generate electricity from biomass species.
4. The powdered samples of these biomass species may be mixed with cow dunk and the electricity generated potential of the resultant mixed briquettes may be studied.
5. New techniques of electricity generation from biomass species may be developed

ACKNOWLEDGMENT

The authors are thankful to acknowledge the financial support from RITS Bhopal (M.P.) India.

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