Investigation on Co-Combustion of Coal And Biomass

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Abstract- *Higher heating value is a parameter to generating electricity in coal fired power plants. In this paper the ultimate analysis is carried out on coal and biomass to determine the weight percent of carbon as well as hydrogen, sulfur, nitrogen, and oxygen using specialized laboratory equipment, such as carbon, hydrogen, nitrogen, sulfur(CHNS) analysis. The demonstration test on co-firing mixture of coal and biomass in different ratios is carried out to identify the highest heat rate produced.*

Keywords- Coal, Biomass, Co-firing, Ultimate analysis.

I. INTRODUCTION

The demand for power is ever increasing. Energy technologist are now facing the formidable challenge. to meet this demand in an efficient and cost effective way.To overcome this, the reduction in emissions from fossil fuel use may be ahived by the substitution of fossil fuels with a high carbon content (coal) towards a low carbon (natural gas)or from fossil fuels(biomass).Presently, coal is most widely available and used fuel worldwide. But the cost and impact to environment are huge. In order to reduce this with small capital interest biomass co-firing with coal is the best possible option. Several existing coal-based power plants have been retrofitted to biomass cofiring for pilot plant test data generation and analysis tofind feasibility of biomass cofiring.Results from these pilot plants have confirmed that biomass cofiring with coal as an easy and effective technology.Cofiring biomass with coal, in comparison with single coal firing, helps reduce the total emissions per unit energy produced. Coal and biomass fuels are quite different in composition. Cofiring biomass with coal has the capability to reduce both NOx andSox levels from existing pulverized coal fired power plants.

Cofiring may also reduce fuel costs, minimize waste and reduce soil and water pollution, depending upon the chemical composition of the biomass used.Through cofiring, biomass utilization may become increasingly important, with utilities making a more significant contribution to biomass energy utilization.Compared with dedicated biomass or waste-fired plants, the addition of biomass or waste to high-efficiency coal-fired power plants can greatly increase the efficiency of utilizing these fuels. Besides, the cost of retrofitting an existing coal-fired power plant to acocombustion plant can be considerably lower than building a new dedicated biomass or waste-fired plant. Though many technical issues are yet to be resolved, cocombustion is possibly the best energy option for the power producers. As compared with coal, biomass fuels contain higher-volatile matter with higher oxygen content, and as such, possibility of easy release of volatile matter in a combustor is more. All these characteristics of biomass have been found to have large influence on the burnout time of blends of coal and biomass.

II. BIOMASS AS RENEWABLE ENERGY

Electricty has today become a basic necessity for not only the developed world but also the developing and underdeveloped countries. At the same time, the feed stocks used for power generation have been primarily fossil fuel-based and nonrenewable in nature. Not only will these fuels be exhausted, but they also give rise to harmful pollution, especially in the form of GHG that leads to climate change and global warming. This makes it very important for all countries concerned to consider greener and more renewable sources for power production. Biomass-based power production is one such. While there are multiple pathways to produce power using biomass, all these utilize a variety of biomass in order to either derive power directly or indirectly. With serious concern globally and in India on the use of fossil fuels, it is important to start using renewable energy sources. It is equally important to explore sources that can bring power in a distributed manner and on small scales so that villages that have no access to power can benefit from electricity. That is why biomass power and especially biomass combustion/gasification-based power will Biomass combustion/gasification, with its capability to work in small scales and its ability to utilize a wide and diverse range of biomass feedstock, is ideally suited for the power needs of many segments. This would serve rural areas where access to power is minimal, but an easy access to significant amount of cheap(and many times no-cost) biomass is prevalent. The following points illustrate why biomass–coal co-combustion is a promising energy option for greener power generation. Use of different types of biomass (viz., sawdust, rice husk, corncob, coconut coir, straw, wood chips, coconut shell, and bagasse) in power generation is very much important particularly in the rural areas where plenty of availability of such material sexists. Cocombustion of biomass with coal may also be an option to promote decentralized power generation policy for economic growth of rural sector. Moreover, this is a fact that noncoking coals, which are mined now in India, do have high-ash and low- to medium-volatile matters. Therefore, apart from the saving of precious fossil fuel, gainful utilization of those coals is also possible in case those are cofired with biomass in Indian context. Biomass combustion-/gasification-based power production is relevant today because of its potential to provide distributed power at rural level, especially for small remote villages that have good access to biomass but no access to grid power and that require only small-scale power production.

III. BURNING PERFOMANCE OF COAL-BIOMASS BLENDS

There are several reasons to blend biomass with coal or with other types of fuel prior to burning. Sometimes, biofuel products are mixed with coal to get better control of the burning process. In cocombustion processes, a volatile matter content >35% is sought in order to provide a stable flame, which could be attained by using biomass. Furthermore, existing coal-fired power plants may continue tobe used with very few modifications, and the coutilization of biomass or waste in existing coal-fired plants is likely to result in a number of environmental, technical, and econmical benefits. Several researchers (Sami et al., 2001; Sahu et al., 2014)investigated cocombustion behavior of coal/biomass blends in different scales to evaluate resultant combustion characteristics, heat release pattern, kinetics, etc.Basic cocombustion studies were carried out mainly with the help of thermogravimetric analyzer (TGA); bench-scale studies were carried out with the help of furnaces like drop-tube furnace and fixed-bed combustor. Pilot-scale combustion test facilities were also utilized for cocombustion studies for possible application of cofiring in actual boiler.

IV. ULTIMATE COAL ANALYSIS

The ultimate analysis indicates the various elemental chemical constituents in coal such as carbon, hydrogen, oxygen, sulfur, nitrogen etc. The ultimate analysis is useful in determining the quantity of air required for combustion and volume and composition of combustion gases. This information is required for calculation of flame temperature and flue gas duct design.

Typical ultimate coal analysis of Indian coal:

Proximate	(wt%)	Ultimate	(wt%)[a]
Moisture	6.0	Carbon	80.7
Ash	12.9	Hydrogen	5.8
Volatile matter	41.5	Nitrogen	1.2
Fixed carbon	39.6	Sulphur	3.6
		Oxygen (by diff.)	8.7
		Total sulphur	5.7
		Sulphate sulphur	1.5
		Pyritic sulphur	0.6
		Organic sulphur	3.6

V. ULTIMATE BIOMASS ANALYSIS

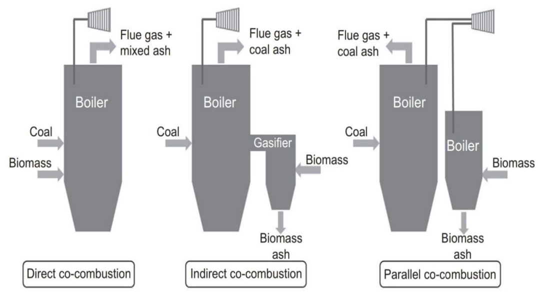
Feedstock	C% by weight	H% by weight	N% by weight	O% by weight
Bamboo	48.39	5.86	2.04	39.21
Gulmohar	44.43	6.16	1.65	41.90
Neem	45.10	6.00	1.70	41.50
Dimaru	44.85	5.98	1.65	41.84
Sisham	45.85	5.80	1.60	40.25

VI. COAL AND BIOMASS CO-FIRING TECHNOLOGIES

Several authors (Agbor et al., 2014; Al-Mansour and Zuwala, 2010;Dai et al., 2008) have listed three technological configurations for cofiring biomass with coal in power plants: direct cofiring, indirect cofiring, and parallel cofiring (Fig. 5.1). The approaches differ in terms of the boiler system design as well as the percentage of biomass to be cofired. In most cases, biomass cofiring in coal power plants takes place by mixing biomass with coal before burning, but biomass can also be gasified and burned in separate burners, after which the gaseous fuel or steam is mixed with the boiler stream of the coal-fired power plant. The last cofiring scheme is usually more suitable for biomass fuels containing problematic compounds or when the ash quality is of importance for subsequent sale or disposal. The most common type of cofiring facility implemented in existing coal-fired power plants is a large, coal-fired power plant, although related coal-burning facilities, such as cement kilns, coal-fired heating plants, and industrial boilers, could also be used.

VII. DIRECT CO-FIRING

Direct cofiring is the simplest, cheapest, and most widespread method of cofiring biomass with coal in a boiler, usually a PC boiler, mainly due to the capital cost required because the needed additional installations in an existing coal fired powerplant are kept to a minimum relatively low.



VIII. FUTURE TRENDS OF BIOMASS CO-FIRING

The main challenges of biomass cofiring could be summarized as follows: (1) biomass cannot compete on an economic point of view with coal (or other fossil energies) due to low thermal efficiency, high cost, and variable impacts on boiler and milling equipment; (2) biomass typically has low bulk energy density, is wet, and is strongly hydrophilic, and therefore, requires a great deal of fuel handling technology compared with its heating contribution; (3) fuel costs may be low, but transportation, preparation, handling, and storage costs for biomass can rapidly exceed total fuel costs for other fossil options; (4) potential for increased corrosion rates in boilers due to higher alkali levels in biomass fuel; (5) biomass fuels can have as much as 50% moisture, which will reduce efficiencies in the boiler; (6) there is higher possibility that the rate and extent of boiler slagging will increase because ash fusion temperatures for most biomass fuels are low (750 C to 1000 oC); and finally, (7) potential emissions and gas cleaning equipment should be considered, as well as ash utilization. Regarding the possibilities of increasing the scale of biomass cofiring, incentives and favorable regulatory and environmental policies will probably be the major factors encouraging the interest in power generation and cogeneration from biomass energy sources in the future. Moreover, the guarantee of a stable and cheap supply of biomass, together with an optimum biomass delivery system, could influence the increase in the number of cofiring power plants.

IX. CONCLUSION

1. Biomass cofiring in coal plants can play an important role in increasing the share of biomass and renewable sources in the global energy mix and reducing emissions of GHGs and, therefore, it is an attractive option of energy generation from both economical and environmental points of view.
2. It is found that the net effect of specific additional cost of electricity per unit emissions of CO2 decreases significantly with increasing plant capacity for small value of it (e.g., for the range 15–50 MW). The effect is less significant for larger plants (e.g., for plants greater than 250 MW).
3. Cofiring may also reduce fuel costs, minimize waste and reduce soil and water pollution, depending upon the chemical composition of the biomass used.
4. The additional specific costs will decrease with higher distribution density of biomass around the plant and remaining life of the plant. However, the effects are not that significant.

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