J. App. Em. Sc
Vol 4, Issue 2, December 2013

Thermogravimetric Analysis (TGA) of Lignite Coal, Tree Leaves and Their blend

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Abstract

Coal and biomass blend taking part of renewable energy sources and best option to satisfy the environment regarding pollution. In this paper TGA analysis of lignite coal, tree leaves and their blends were under study. The main purpose is to see thermal characteristic of coal and tree leaves using Thermogravimetric Test. The proposed TGA method utilizes 90c ambient temperature. The samples were dewatered at the temperature ranges up to 102-109^{o}C.the maximum volatile matter achieve when we increase the amount of tree leaves and for as fixed carbon (char burning)is concerned the maximum amount for char burning is LC90+TL10 . The blending ratio of coal and biomass has many favorable conditions regarding dewatering, devoltization and char burning.

Keywords: Lignite Coal; Tree Leaves; Thermogravimetric Analysis (TGA) Test; Blending Ratio; Dewatering

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INTRODUCTION

As Pakistan gifted with huge reservoirs of coal, there is need to identify new technology regarding coal utilization coal and biomass co-combustion had getting very much interest regarding power generation and pollution .In co-combustion of coal and biomass Particle size ranges (53–75, 106–150 and 150–212 mm) were found to have a limited effect on weight loss profile at these conditions (Sahu et al., 2010). Thermogravimetric analysis revealed that the great amount of volatile matter in the biomass the rapid emission of this volatile matter under low temperature, which contribute to the accelerated ignition at a lower temperature, increased the particle surface temperature and enhanced the reactivity on the surface of a low-rank coal (Cepeliogullar et al., 2013, Cuiping et al., 2009).Thermal analysis has been generally used to characterize the thermal decomposition of biomass, coal, more recently and sewage sludge. Thermogravimetric analysis is the easiest and the most effective technique to observe the combustion profile of a fuel. The advantage of this analysis is its rapid assessment of the fuel value, the temperatures at which combustion starts ends and other characteristics, such as maximum reactivity temperature, ash amount and total combustion time. The materials were characterized in terms of their proximate and ultimate analysis and calorific value.(Gil et al., 2010). The combustion behavior of biomass and biomass–coal blends under typical heating conditions was investigated. Thermogravimetric analyses were performed on bituminize coal, aspen straw dust and wheat straw used alone and blended with different coal weight ratios (Cepeliogullar et al., 2013, Muthuraman , 2013).The research work carried out on TGA analysis of lignite coal ,tree leaves and their blends .

MATERIALS AND METHODS

The whole work done in the department of Chemical and Mining Engineering MUET Jamshoro Pakistan. Materials required for

research were lignite coal, tree leaves and their blends.

Lignite coal

In Pakistan huge reserves of coal are present, the coal that are present in Pakistan is mostly lignite coal .Lignite coal has moisture about 44.3%, fixed carbon 19.2%, carbon 51.18% and ash 6.83%.(Choudry et al., 2010)

Tree leaves

Different varieties of tree leaves available at every where to utilize in a safe manner co-combustion has an option to utilize it without disturbing the environment**.** Tree leaves that are used in this research taken from different places of Jamshoro and Hyderabad.

Lignite coal and tree leaves blend

Blending of coal and biomass were done using laboratory blender to mix in a proper way. Different percent of lignite coal and tree leaves were blended to know the characteristics of their blend.

Methodology

The method that was applied for TGA analysis described in below block diagram. In below block diagram first step is sample preparation, in the sample for T.GA analysis like crushing, grinding and weighing. After that we mix the different ratio of lignite coal and tree leaves for TGA analysis (Vuthaluru, 2003). In TGA analyzer we analyse the thermal behavior of lignite coal and tree leaves.

Figure 1: Methodology for lignite and tree leaves for TGA analysis.

RESULTS AND DISCUSSION

TGA analysis of lignite coal,tree leaves and their blends were under study to know the characteristics of coal and biomass before co-combustion various percentage of tree leaves were used with lignite coal to see the effect of blending ratio on combustion (Yan et al., 2014).

Table 1: TGA results of coal,tree leaves and their blends

S:No	Sample name	Dewatering (°C)	Ignition (°C)	Devolatization and burning (°C)	Transition period (°C)	Char burning (°C)	Burnout residue %
1	LC90%+TL10 %	106.06	946	200-500	500-945.68	945.68-949.62	13.20
2	LC80%+TL20 %	108.38	947	220-510	510-948	948-948	15.67
3	LC70%+TL30 %	103.19	949	300-550	550-949.59	949.59-949.59	13.98
4	LC60%+TL40 %	104.78	948	250-750	700-948	948-949.59	15.90
5	LC	108.15	956	200-520	600-949.3	949.3-950	15.21
6	TL	108.15	955	200-510	590-949.3	949.3-950-3	11.49

Figure 1 shows the effect of blending ratio of lignite coal and tree leaves on removal of moisture (Dewatering). Dewatering is process in which moisture is removed after attaining the required temperature for the type of sample used. Different samples were analyzed using TGA analyzer for getting pre processed condition .,because when co-combustion of coal and biomass when we use LC70+TL30% the minimum temperature required to remove moisture from sample about 103°C.

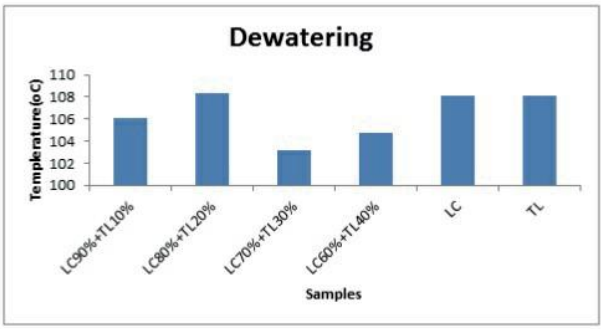

Figure 2: Dewatering of Coal, tree leaves and their blends

Figure 2 shows the effect of blending ratio of lignite coal and tree leaves on removal of volatile matter (Devolatilizing). Different blending ratios were used to see which ratio of coal and biomass has minimum and maximum volatile matter. Using TGA analyzer at different temperature region the removal of volatile matter. (Song et al., 2013). Themaximum amount of volatile matter is for TL and minimum for LC if we increase the amount of tree leaves with coal the volatile matter increasing so blending ratio also effect on burning of coal.

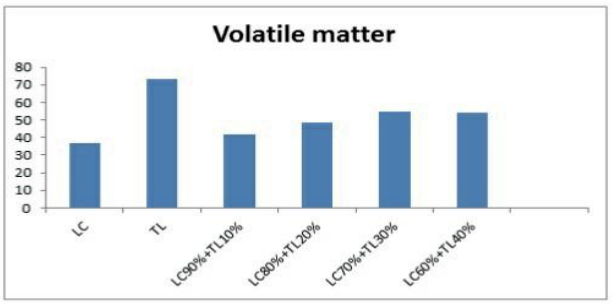

Figure 3: Percentage of volatile matter for coal, biomass and their blends

Figure 3 shows the effect of blending ratio of lignite coal and tree leaves on removal of fixed carbon. Different ratios of coal and biomass blend were under study to pickout the best ratio for co-combustion of coal and biomass (Cheoreon et al., 2013) LC and LC90+TL10 hasmaximum percentage of fixed carbon and as for TL it has minimum percentage of fixed carbon.

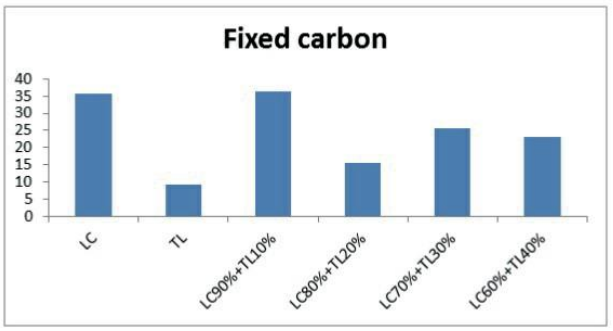

Figure 4: fixed carbon for coal, biomass and their blends

Figure 4 shows the effect of blending ratio of lignite coal and tree leaves on ash content. After the burning of samples residue left behind the maximum amount of residue generated from LC80+TL20 is about 28.38% and minimum amount generated for TL is about 11.49% it means that when we mix tree leaves with coal the maximum residue generated, suitable condition for which burnout residue left behind for TL, because residue generated less as compare to the other coal and biomass, their blends.

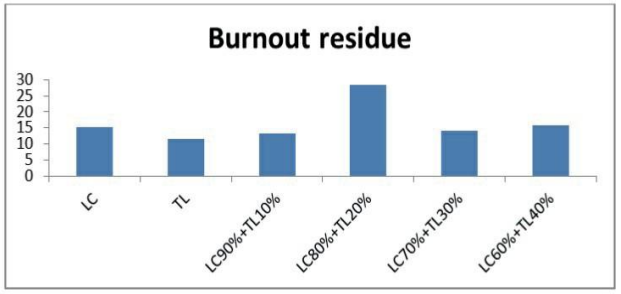

Figure 5: burnout residue for coal, tree leaves and their blends

CONCLUSION

Biomass and coal, their blends has significant effect on co-combustion. When TGA test were performed different things were observed during combustion of coal and biomass . The amount of moisture removed from 103-109^{o}C and minimum temp required for LC70+TL30 about 103^{o}C. The maximum amount of volatile compound present in TL is about 73.01% and for minimum amount is for LC is about 36.85%. The maximum amount of fixed carbon present in LC90+TL10 is about and minimum amount present TL is about. The maximum amount of burnout residue generated for LC80+TL20 and minimum for TL. It is conclude that TL when we used with coal give many benefits for co-combustion of coal.

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