

Effect of Pakistani Low Rank Coal and Banana Tree Waste on Gaseous Emissions through Co-combustion- An Environmental Approach

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Abstract

With increasing problem of air pollution due to emission of different gases, biomass plays an important role to overcome this environmental issue. This research work gives an option regarding environmental problem as well as replaces the energy requirement. Coal and banana tree waste co-combustion done on laboratory scale muffle furnace with the help of stack gas analyzer. Gas emissions were measured at optimized temperature 300°C. The higher calorific value of blending ratio of 80/20 gives higher calorific value regarding other blending ratio. As for emission were analyzed that for NO_x and SO₂ blending ratio 80/20 give minimum emission for CO 90/10 and CO₂ minimum emissions were observed at 100/100 banana tree waste.

Key words: Lignite coal; Banana tree waste; Co-combustion; Blending ratio

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INTRODUCTION

Development of new technology against air pollution to decrease the emission of NO_x, SO_x and CO₂ emissions, co-combustion is one of the important technology which gives opportunity to decrease the emission by using suitable quantity of biomass. The energy sector in the global scenario faces a major challenge of providing energy at an affordable cost and simultaneously protecting the environment (Sahu et al., 2014). The decomposition processes of agricultural biomass included evaporation, release of volatile matter and combustion as well as char oxidation. The thermal reactivity of coal could be improved through the addition of agricultural biomass in suitable proportion and subsequent appropriate heating rate during combustion (Chuncai Zhou et al., 2014) Co-combustion of biomass and coal is a sustainable and cost effective option to involve the renewable energy sources in short term and it has low risk and low cost. Moreover, it provides reductions mainly in CO₂, and partly in SO_x and NO_x emissions (Baxter, 2005). Therefore, usage of bio-waste materials in co-combustors is of great interest. For instance, many coal-firing power stations in UK have also been utilized biomass and some of which blend biomass with coal in the ratios of 2-4 wt. % (Backreedy et al., 2005). Biomass energy is one of the renewable energy resources. When the huge biomass potential of the world is considered, biomass is a candidate fuel to play a supplementary but active role for meeting part of the world's energy demand (Oberberger, 2005). On the other hand, biomass species often create problems during co-processing if the blending ratio exceeds a certain level. For this reason, the blending ratios of 10-30 wt. % of biomass are generally preferable with respect to the gaseous pollutant emissions of CO, CO₂, NO_x, and SO₂. But an increase in the moisture content of biomass not only decreases the combustion temperature but also increases CO emission (Zhong et al., 2006). The main purpose of this work is to use low rank coal of Pakistan with banana tree waste.

MATERIALS AND METHOD

Coal is one of the fossil fuel used today for power generation and different other chemical productions. Coal was collected from Lakhra coal field. Banana tree waste was collected from different places of Hyderabad

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district of Sindh Pakistan. Sample of coal and banana tree waste were collected and crushed in laboratory scale jaw crusher. Sieve was used to take a homogeneous particle size of sample for co-combustion. Coal and banana tree waste were blended using laboratory scale blender.



Figure 1: Methodology for coal and banana tree waste co-combustion

RESULTS AND DISCUSSION

Co-combustion get attention due to low value waste get part in energy sector simultaneously satisfies the environmental condition. Different blending ratios were used to investigate the low emission ratio regarding environmental pollution. Table 1 is for heating value of lignite coal and banana tree waste and their blending ratios. Heating value of 80/20 ratio for coal and banana tree waste is maximum as compared to other blending ratios which are about 844454.6Btu/lb.

Table 1: Heating value of different coal and banana tree waste blends

Sample	Heating value (Btu/lb)
Lignite coal	730539.9
Banana tree waste	809612
LC90%+BTW10%	797342.6
LC80%+BTW20%	844454.6
LC70%+BTW30%	817016.2
LC60%+BTW40%	632423.2

Table 2: Emission analysis of coal and banana tree waste blends

Sample	CO (ppm)	CO ₂ (ppm)	NO _x (ppm)	SO ₂ (ppm)
Lignite Coal	901.83	2190	30.63	325
Banana Tree Waste	1510	1633	64.66	66.67
LC90%+BTW10%	1136.16	3105	45.83	9.83
LC80%+BTW20%	12475	2515	42.66	-305
LC70%+BTW30%	1449.2	3255	44	-18
LC60%+BTW40%	1644	2970	55.5	-47.66

Effect of banana tree waste and lignite coal ratio on CO through co-combustion

Coal biomass co-combustion is getting importance due to mode of combustion which utilizes low value waste and converts it to useful energy. For combustion it has also impact on environment, as coal itself concerned emitting various pollutants due to its characteristics. When it combines with biomass for combustion, gives a valuable opportunity to environment for lower emission and also utilizes low cost waste into useful work. Different blending ratios were under study to observe the various pollutants emitting during co-combustion of coal and banana tree waste. During combustion the amount of CO emits due to incomplete combustion. The minimum amount of CO emission occurs using lignite coal because when lignite coal combines with banana tree waste it is effected due to incomplete combustion. Banana tree waste combines with coal and gets moisturized so it is needed to be removed as shown in Table 2 and Figure 1.

Effect of banana tree waste and lignite coal ratio on CO₂ through co-combustion

CO₂ has significant effect on environment with regards to emission analysis. Maximum emission of CO₂ observed at LC and banana tree waste 70% and 30% respectively. Different blending ratios for banana tree

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waste and coal were under study to investigate the minimum amount of CO₂. After combustion, it was observed that by using banana tree waste for combustion gives a minimum amount of CO₂ about 1633 ppm.

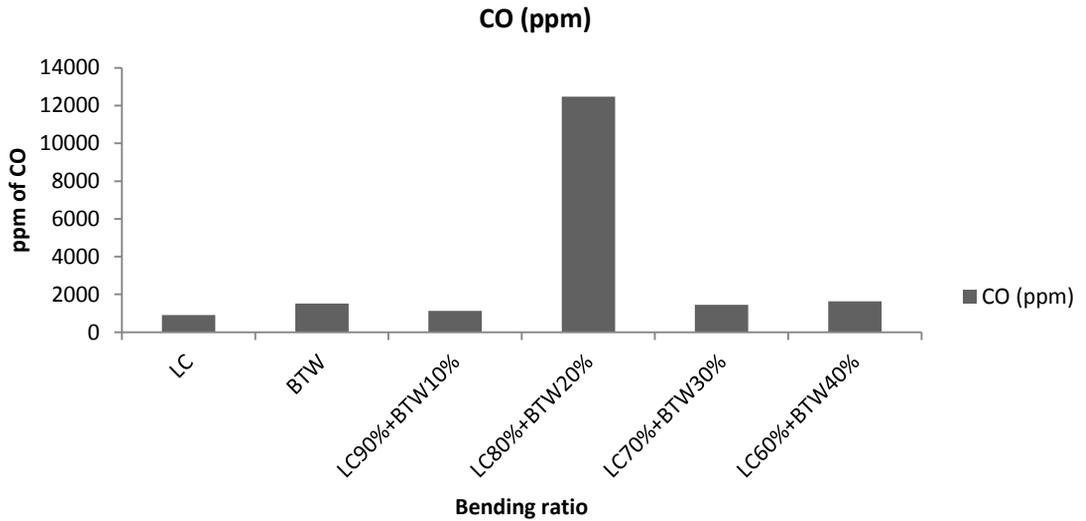


Figure 2: Effect of different blending ratios on CO emission

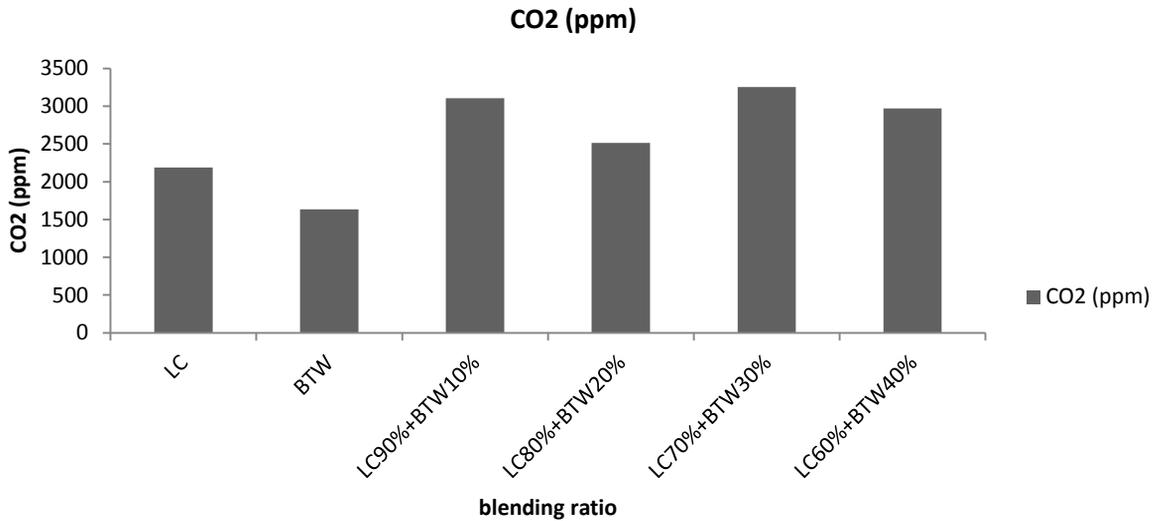


Figure 3: Effect of different blending ratios on CO₂ emission

Effect of banana tree waste and lignite coal ratio on NO_x through co-combustion

Co-combustion of lignite coal with banana tree waste has many advantages regarding environmental pollution and energy production. Different blending ratios for lignite coal and banana tree waste were observed to identify the suitability against environmental pollution and for energy production. NO_x emission was analyzed by changing the percentage of banana tree waste with coal. Fig 4 shows that separate combustion of lignite

coal gives minimum emissions but when simultaneously we deal for energy production 80/20 ratio for coal and banana tree waste, it gives about same amount of emission.

3.4 Effect of banana tree waste and lignite coal ratio on SO₂ through co-combustion

Co-combustion of coal and banana tree has many advantages over SO₂ emission as shown in Fig.5. Separate combustion of lignite coal gives maximum emission, but when banana tree waste 20% mixed with lignite coal, it give minimum amount of sulfur dioxide. Different blending ratios for measurement of SO₂ emission were under study but the ratio 80/20 gave minimum amount of SO₂ emission due to addition of banana tree waste.

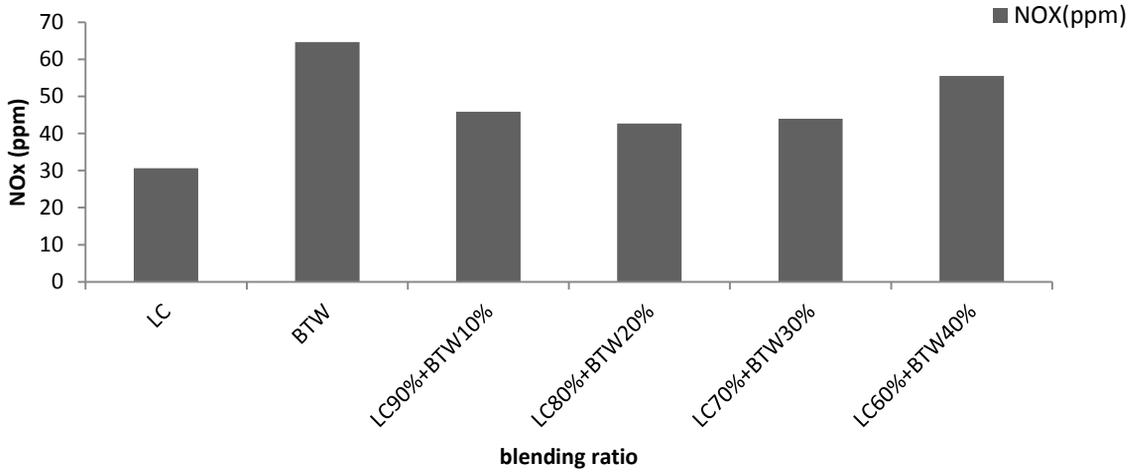


Figure 4: Effect of different blending ratio on NOx emission

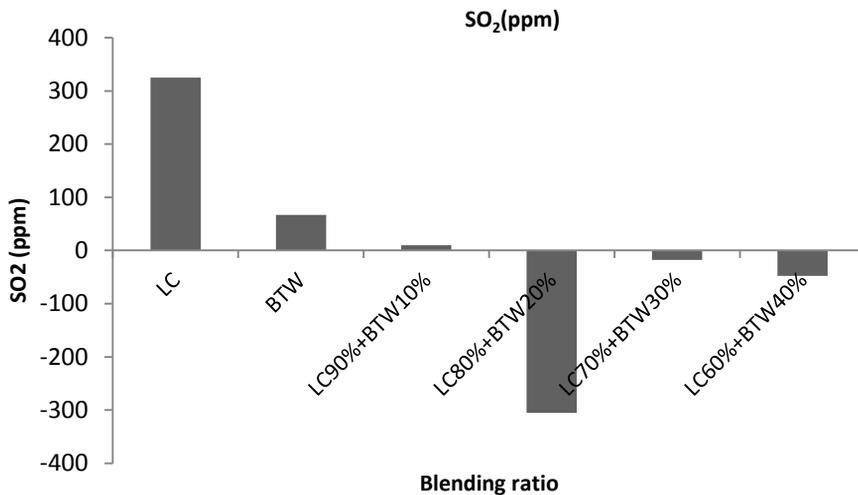


Figure 5: Effect of different blending ratio on SO₂ emission

CONCLUSION

Study was made to investigate the potential of low rank lignite coal and banana tree waste for co-combustion with blending ratio 80/20. It gives a minimum amount of emission of NO_x and SO₂, but for CO₂ emission banana tree waste gives minimum amount apart from this calorific value of 80/20 blending ratio of coal and banana tree waste. It is high when compared with other blending ratios. So it is concluded that low value biomass gives a direction in addition to lignite coal satisfies the environment conditions .and also for energy production.

REFERENCES

- Backreedy R I, Fletcher L M, Jones J M, Ma L, Pourkashanian M, Williams A. (2005). Co-firing pulverised coal and biomass: a modeling approach. *Proceedings of the Combustion Institute*. 30:2955-2964.
- Baxter L. (2005). Biomass-coal co-combustion: opportunity for affordable renewable energy. *Fuel* 84:1295-1302.
- Chuncai Zhou, Guijian Liu, Siwei Cheng, Ting Fang, Paul Kwan Sing Lam. (2014). Thermochemical and trace element behavior of coal gangue, agricultural biomass and their blends during co-combustion. *Bioresource Technology* 166:243–251.
- Obernberger I. (2005). ash related problems in biomass combustion plants. Presented on May 20, 2005 at Technische Universiteit Eindhoven. PP 1-31.
- Sahu S G, Chakraborty N, Sarkar P. (2014). Coal–biomass co-combustion: An overview Review Article. *Renewable and Sustainable Energy Reviews* 39:575–586.
- Zhong Z, Jin B, Huang Y, Zhou H, Lan J. (2006). Experimental research on emission and removal of dioxins in flue gas from a co-combustion of MSW and coal incinerator. *Waste Management* 26:580-586.