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Particle Size Analysis of Coal and Biomass for Co-combustion

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Abstract

With increasing demand of energy requirement and problem of global warming new technology were studied now a days to fulfill the requirement of energy concern. Co-combustion has getting much interest regarding environmental problem and good possibility for utilizing biomass for valuable product that is for power generation. The study were conducted for the particle size analysis of coal and biomass for co-combustion. In this regard, we had taken various biomass like cow dung, manure, tree leaves and banana tree waste for co-combustion. The samples were collected from different areas of Sindh province and that were analyzed by using different sieve. The maximum mass fraction were obtained in tree leaves is between 4-4.75mm, cow dung manure 0.3-1.00mm , banana tree waste 4-4.75mm and for lignite coal 4-4.75mm. With the increase in mass fraction of material, decrease in percentage finer and size analysis had effect on co-combustion of coal and biomass . Higher heating value of coal ,cow dung manure ,banana tree waste and tree leaves are 730539btu/lb, 712800btu/lb, 809612btu/lb and 794640btu/lb respectively..

KEYWORDS: Co-combustion, Lignite Coal, Biomass, Particle size

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INTRODUCTION

With the increasing amount of pollution in coal power plant and co-combustion of coal and biomass, there is need to identify the strategies behind that, particle size had also effect on air pollution regarding size of pollutants. . The energy sector in the global scenario faces a major challenge of providing energy at an affordable cost and simultaneously protecting the environment[1] The decomposition processes of agricultural biomass included evaporation, release of volatile matter and combustion as well as char oxidation. The thermal reactivity of coal gangue could be improved through the addition of agricultural biomass in suitable proportion and subsequent appropriate heating rate during combustion[2]In the characterization of particle size distributions, it is often useful to measure the size of smaller particles using optical magnifications that are higher than the magnifications used to measure relatively large particles (Mazumdar and Irdi, 1988) (Sung et al, 1997). A series of uniaxial compression tests were conducted on irregularly shaped coal specimens with diameters in the range of 0.8–6.3 mm, which are typical for Industrial-scale coal utilization processes. According to the test results, the compressive strength and Young's modulus of coal particles significantly increase as the specimen size decrease. The data obtained show reasonable agreement with results published in the literature. (Zhong et al, 2014).(Tsakomaskas et al, 2012) Field measurements were conducted to determine indoor air particulate pollutant emissions from the burning of coal and wood, two major household fuels, in rural households in Guizhou China. Chemical composition, particle mass and particle size distribution as well as number concentration were

measured. (Hefeng et al., 2012 ; Mastellone et al., 2010).

Particle size distribution (PSD) is not unique for the same product, and is dependent on the chosen measurement technique, especially for asymmetric shapes. (Arnaud et al., 2013) Laser diffraction and 2D image analysis are commonly used PSD measurement techniques. However, the results may not be representative of the true physical dimensions of the particles. The effect of particle size on the yield and composition of lignin derived oligomers (also known as pyrolytic lignin (PL) was studied in a fluidized bed reactor. Milled beech wood particles of sizes between 0.3mm and 0.55mm and cylinders of 3–14 mm were pyrolyzed at 500 °C. (Zhou et al., 2014). This study aims to investigate the effects of biomass particle size (0.18–5.6 mm) on the yield and composition of bio-oil from the pyrolysis of Australian oil mallee woody biomass in a fluidized-bed reactor at 500 °C. The yield of bio-oil decreased as the average biomass particle size was increased from 0.3mm to about 1.5mm. Further increases in biomass particle size did not result in any further decreases in the bio-oil yield (Shen et al., 2009). The study focuses on the particle size analysis of coal and biomass for co-combustion.

MATERIALS AND METHODS

Materials

Lignite coal was taken from lakhra Coal Power Plant. Different types of biomass were collected from different areas of Sindh province like cow dung manure ,banana tree waste and tree leaves from Jamshoro Phatk, Tandojam and Kotri respectively.

Methods

Methodology that were used for particle size analysis shown in below block diagram. Materals were used in research crushed and grinded using grinder After that samples put in sieve shaker to see the retained material in each sieve. Seive shaker were used to obtained different particle size for analysis. Crusher and Grinder were used for the size reduction of biomass samples. Weight of the samples was carried out by using electronic weighing balance. Sieve shaker were used to separate the fine particle with different mesh size. Then the samples were analyzed via mesh size for different co-combustion.

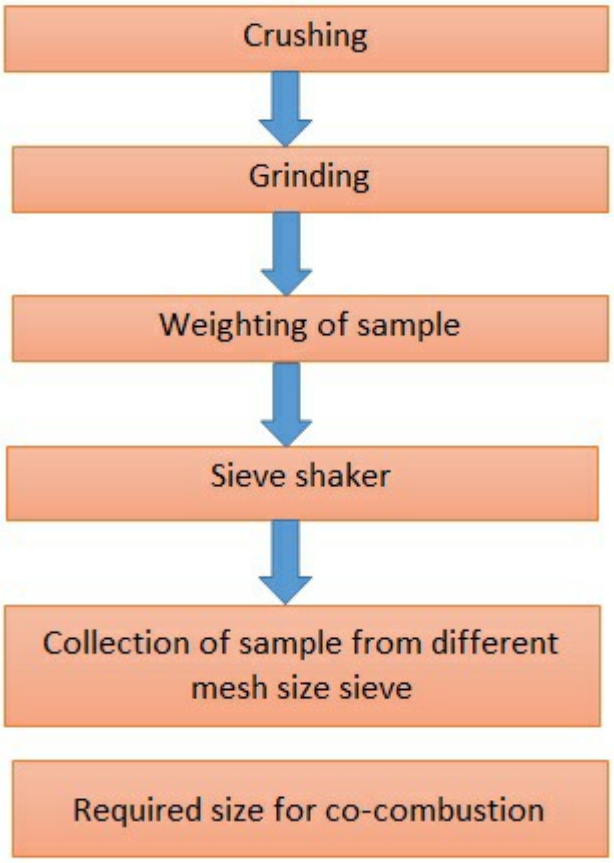

Figure 1: Block Diagram for Methodology

RESULTS AND DISCUSSION

Particle size analysis that were studied are given below

Particle size analysis of lignite coal

Lignite coal is taken from lakhra Plant near Khanot and performed the size reduction experiments. The particle size shows the highest percentage of size that is between 4.75mm-4mm and minimum percentage that are obtained is about to be 0.3mm-o.15mm, when we done using sieve shaker to obtained desired product as per design of various combustor or fluidized bed combustor. Material taken 300 gram for Sieve shaker. Analysis Shown in Table. 1. and Fig. 2.

Particle size analysis of Banana Tree waste

Collected Banane tree waste sample were taken dried and then crushed after that sample were analyzed in sieve shaker in order to separate the different particle size according to then sieved size. The material from a 0.6mm to 2mm maximum mass

fraction obtained and minimum mass fraction obtained from 4.00mm to 4.75 mm According to design of various combustor used for co-combustion is about to be 2.00 to 4.00 mm. Analysis Shown in Table. 2 and Fig. 3.

Particle size analysis of Tree waste

Particle size of tree leaves analyzed using sieve shaken to separate the various size of tree leaves into different size .Table III shows the different size of tree leaves from different sieve trays. The maximum mass fraction obtained from 0.3 to 1.0mm and minimum mass fraction obtained from 4.00 to 4.75mm. Analysis Shown in Table. 3 and Fig. 4.

Particle size analysis for cow dung manure

Collected samples were crushed to reduced size of material .After that material obtained above the different size of sieve. The maximum mass fraction obtained is between 0.3mm to 1.0 mm and minimum mass fraction that are obtained between 2.0mm to 4.75mm Shown in Table. 4 and Fig. 5. The main objective to analysis particle with the different size in order to get required size that will be used to fulfill the requirement of combustion. Because in combustion surface area of material play an important role to control for co-combustion.

Tables and Figures

Table I: Particle size analysis of lignite coal

Sr.no	Sieve size (mm)	Mass of each sieve (gram)	Mass of retained material on each sieve (g)	Mass of each sieve+retained material (g)	%Mass retained on each sieve	Cumulative % retained (∑Rn)	%Finer (100-∑Rn)
01	4.75	465	259	724	86.333	86.33	13.67
02	4.00	541	12	553	4	90.33	9.67
03	2.80	517	15	532	5	9	91
04	2.00	499	6	505	2	7	93
05	1.00	451	6	457	2	4	96
06	0.60	413	3	416	1	3	97
07	0.30	375	1	376	0.33	1.333	98.67
08	0.15	353	0.005	353	0.0017	0.33467	99.67
09	pan	325	2	327	0.6667	0.66837	99.33

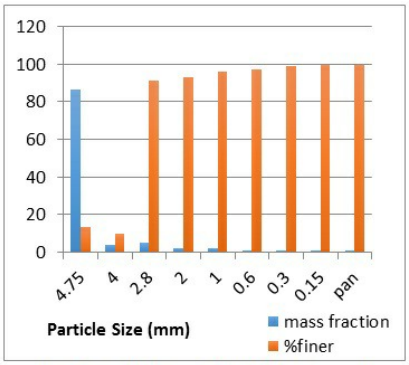

Figure 2: Particle Size analysis for lignite coal

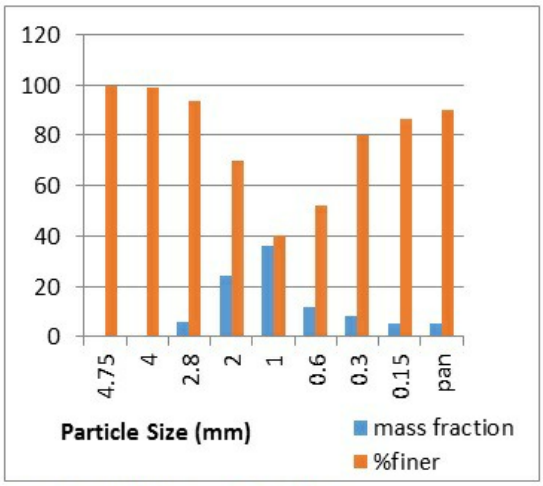

Figure 3: Particle Size analysis for Banana tree waste

Table 2: Particle size analysis of Banana Tree waste

Sr.No	Sieve size (mm)	Mass of each sieve(gram)	Mass of retained material on each sieve(g)	Mass of each sieve+retained material(g)	%Mass retained on each sieve	Cumulative % retained (∑Rn)	%finer (100-∑Rn)
01	4.75	465	1	466	0.33	0.33	99.67
02	4.00	541	2	543	0.67	0.99	99.0
03	2.8	517	18	535	6	6.67	93.33
04	2.00	499	72	571	24	30	70
05	1.00	451	108	559	36	60	40
06	0.6	413	36	449	12	48	52
07	0.3	375	24	399	8	20	80
08	0.15	353	16	369	5.33	13.33	86.67
09	pan	325	15	340	5	10.33	89.67

Table 3: Particle size analysis of tree waste

Sr. No	Sieve size(mm)	Mass of each sieve(gram)	Mass of retained material on each sieve(g)	Mass of each sieve+retained material(g)	%mass retained on each sieve	Cumulative % retained (∑Rn)	%finer (100-∑Rn)
01	4.75	465	0.001	465.001	0.00033	0.00033	99.99
02	4.00	541	0.1	541.1	0.0333	0.03363	99.96
03	2.8	517	5	522	1.666	1.699	98.301
04	2.00	499	34	533	11.33	13.029	86.971
05	1.00	451	135	586	45	58.02	41.98
06	0.6	413	62	475	20.66	78.68	21.32
07	0.3	375	31	406	10.33	89.019	10.981
08	0.15	353	18	371	6	98.01	1.99
09	pan	325	5	330	4.33	99.6767	0.3233

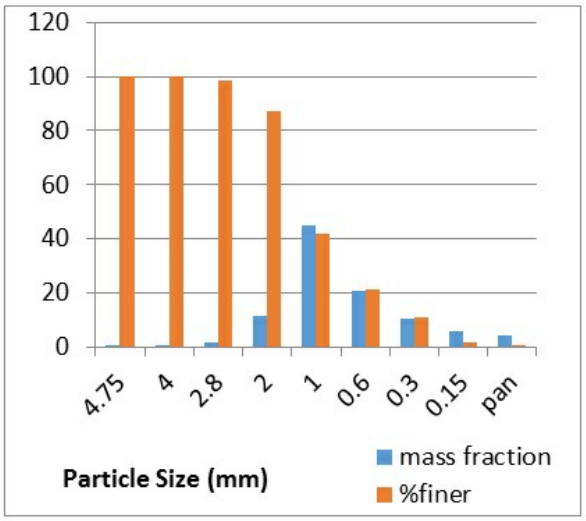

Figure 4: Particle size analysis for Tree waste

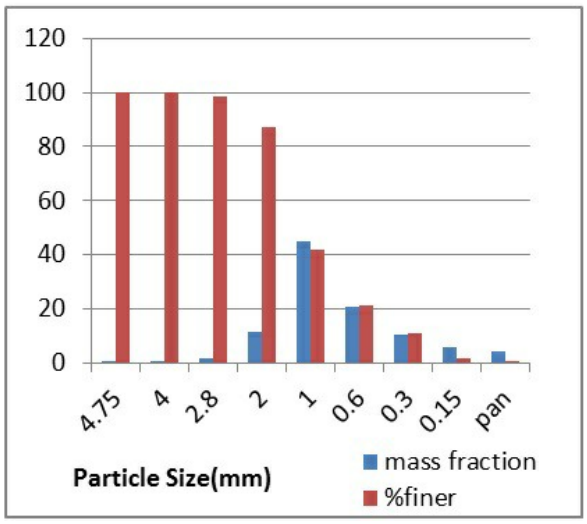

Figure 5: Particle size analysis for Manure

Table 4: particle size analysis for cow dung manure

Sr. No	Sieve size (mm)	Mass of each sieve (gram)	Mass of retained material on each sieve(g)	Mass of each sieve+retained material(g)	%Mass retained on each sieve	Cumulative % retained (∑Rn)	%finer (100-∑Rn)
01	4.75	465	0.001	465.001	0.00033	0.00033	99.99
02	4.00	541	0.1	541.1	0.0333	0.03363	99.96
03	2.8	517	5	522	1.666	1.699	98.30
04	2.00	499	34	533	11.33	13.029	86.97
05	1.00	451	135	586	45	58.02	41.98
06	0.6	413	62	475	20.66	78.68	21.32
07	0.3	375	31	406	10.33	89.019	10.98
08	0.15	353	18	371	6	98.01	1.99
09	pan	325	5	330	4.33	99.6767	0.32

CONCLUSION

Regarding co-combustion of coal and biomass, the particle size has also effect on combustion behavior of co-combustion. The maximum mass fraction of coal and biomass obtained 4-4.75mm lignite coal and 4-4.75mm banana tree waste and 1 -3.5 mm cow dung and for tree leaves the maximum mass fraction obtained between 4mm and 4.75mm. Due to the brittleness in cow dung manure when dried that give minimum size at high percentage of mass fraction.

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