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SOME STUDIES ON THE MIXING OF COAL BRIQUETTING MATERIAL

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Abstract

Studies carried out on mixing of coal briquetting material (coal, clay, limestone and water) are presented here. Drum mixer has been found ideal for mixing moist mixture of solids. Drum (concrete) mixer has been found to be better with respect to degree of mixing and time and hence is energy conserving.

Keywords: Mixers, Briquettes, Lignites, Ignition/Combustion, Energy.

Introduction

Graham's Law of diffusion of gases states that rate of diffusion of two gases is inversely proportional to the square root of their densities or their molecular masses. In simple words, lighter gases diffuse faster. It is also remarked that polar liquids dissolve polars and non-polars dissolve non-polars. Mixture of polar and non-polar forms a distinct/visible layer between them, making them immiscible. Solids, on the other hand, do not mix easily.

Equipped with this background, these studies for mixing of coal briquetting material have been carried out. For uniform/homogeneous mixing, a large number of equipments are available. However, selection for the best suited results needs consideration since mixing in general and moist mixtures in particular require different approaches. The studies for mixing of coal briquetting material were made on ribbon, muller and drum mixers.

Muller mixer is a metallic cylindrical mixer with larger diameter compared to height with two rollers and ploughs in the mixer for the movement of the mixture horizontally on circular base. Rollers crush the lumps developed in the moist mixture. The mixed material is drawn from the opening on the side of the mixer.

Ribbon Mixer is a metallic cylindrical mixer with circular ribs mounted on 50mm shaft driven by an electric motor at any desired speed (in rpm) with reverse and forward facility to move the mixture to and fro. Normally, ribbon mixers are used for pastes and ointments or creamy mixtures.

In a drum (concrete) mixer, solids are mixed by the movement of the mixer. The material is not stirred but entire constituents of mixture are shuffled by rotating movement of the mixer, as has been observed in concrete mixers. This type of mixer has been found ideal for mixing of coal briquetting moist material.

A mixture of coal of 16 mesh, powdered limestone and water was tested for homogeneous mixing by determining ash contents of the mixture drawn from the mixers after every 30 minutes. For calculation purposes, the quantity of water is not taken into consideration as ash is, normally, determined on dry basis.

Quantity of ash of each sample, after mixing, was compared with the actual ash content of constituents of the mixture before mixing to examine the extent of the degree of mixing. These experiments were carried out in 2001.

Moist coal briquetting material is moulded into a briquette tablets using briquetting press. Coal in general and lignites in particular can be briquetted as lignite coal is of low grade. For classifications, see Table 1.

There are 185 billion tonnes of coal available in the country but hardly three million tonnes of coal is annually mined out, of which 97% is consumed in brick kilns to bake construction bricks (Economic Survey 1992-93). During mining and transportation of coal, it is broken as lignite is friable (brittle). It is why, lignites, particularly, Pakistani lignites are briquetted for transportation, thus minimising risk of spontaneous combustion. It is proposed that

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Pakistani lignites should be briquetted at the mine's head just after mining. Spontaneous combustion is one the reasons of failure of coal fired power plants. Stoichiometric calculations for the combustion of lignites are disturbed and the desired results are not obtained (Ali, 1996). Briquettes are ideal for space heating, particularly, chicken sheds but not recommended for domestic use, due to environmental point of view.

Table 1. Classification of coals (Perry, 1963)

Constituents	Peat	Lignite	Bituminous	Anthracite
Carbon	60	67	88.4	94.1
Hydrogen	5.9	5.2	4.6	3.4
Oxygen	34.1	27.8	7.0	2.5
Heating value (MJ/kg)	27.8	25.27	26.3	34.6

Material and Method

There are three criteria for examining the extent of the degree of mixing:

1. Comparing moisture contents of mixture before and after mixing.
2. Comparing heating values of the mixture before and after mixing.
3. Comparing ash contents of the mixture before and after mixing.

Comparing moisture contents of mixture before and after mixing is no good criterion as water of mixture may be lost, due to evaporation. Furthermore, Comparison of heating values of samples is time consuming while comparing ash content of mixtures before and after mixing seems to be a better criterion for checking homogeneous mixing of the coal briquetting material.

Same ash content of the samples of mixture drawn at different intervals of time also confirms homogeneous mixing but it is better to compare the ash content of mixture with the calculation for individual constituents before mixing.

Ash of the Lakhra lignite was determined by heating ten 10g of coal at 800^0C for thirty minutes in the oven. 2.5g was found as residue as compared with the ash percent determined on Mac 400 LECO of USA. The results are reported in Table 2.

Similarly, ash of limestone was determined by heating 10g of powdered limestone at 800^0C in an oven. 4.26g loss of mass due to release of carbon dioxide (CO_2), was observed. Hence, ash of limestone ($CaCO_3$) of 10g has 10 – 4.26 = 5.74g of calcium oxide (CaO).

Table 2. Proximate Analysis of Lakhra lignite

Constituents	Percent
Moisture	14.43
Volatile matter	29.17
Ash	25.12
Fixed carbon	31.28

Table 3. Analysis of limestone

Constituents	Percent
Carbon dioxide	42.6
Residue (CaO)	57.4

Total ash of mixture of Lakhra lignite and limestone is 5.024g in 20g of lignite plus 2.87g (5 gm. of limestone) which sums to7.894g. Hence percent ash in the mixture is 31.576% before mixing the constituents.

Three mixtures of 25kg each of Lakhra lignite and limestone were prepared in the following composition:

1. Lakhra lignite	20kg
2. Limestone ($CaCO_3$)	5kg
3. Water	2.5 l (added by spraying)

(Quantity of water in the determination of ash content of the mixture was ignored as ash is determined on dry basis)

The mixtures were transferred into drum (concrete), Muller and ribbon mixers to mix the contents for two hours. Three samples of the mixture from each mixer were drawn and tested for ash contents for examining the extent of the degree of mixing of the contents after every thirty minutes. Results are reported in Table 4.

Table 4. Comparison of ash contents of the samples drawn from the mixers after mixing. (Percent ash content of mixtures before mixing = 31.576)

Time	Muller mixer	Ribbon mixer	Drum (concrete) mixer
30 minutes	40.32	36.37	30.42
	60.48	68.74	30.64
	38.46	36.49	30.56
60 minutes	45.68	40.76	30.58
	40.32	36.37	30.49
	50.48	68.74	30.65
90 minutes	48.46	36.98	31.40
	46.37	58.46	31.69
	40.32	36.39	31.29
120 minutes	40.38	36.97	31.49
	40.62	36.77	31.41
	48.56	40.96	31.78

Importance of constituents of the mixture

Lakhra lignite is a source of energy. It is a combustible matter of the briquette releasing flue and particulate matter and ash after combustion. Second, powdered limestone is used as binding material and for fixing sulphur. It has been found and observed that it is more active compared to quicklime for trapping sulphur. Furthermore, clay is used as binding material as well as to minimise particulate matter in the flue. Water is used for binding the constituents of coal briquettes.

Briquettes have to be dried before combustion. It is better to use dried coal briquettes for easy/smooth ignition/combustion for the extraction of maximum energy potential.

Results and Discussions

As obvious from the results, mixing of solids and water depends on:

1. Particle size of constituents of the mixture,
2. Duration of time period of mixing,
3. Equipment used for mixing,
4. Speed in rounds per minute of mixer.

Conclusion

Drum (concrete) mixer has been found to be better for mixing moist solids mixture. Homogeneous mixing depends on particle size, time duration of mixing and revolutions per minutes (rpm) of the mixer. As obvious from the results given Table 4, the performance of drum was found far better as compared to muller and drum mixers with respect to degree of mixing and time. It appears from the results that the material could be mixed in minimum time. Hence, it is energy conserving too. The results of ash content of the samples, drawn from Muller and ribbon mixers, were not in uniform, showing wide variations and improper mixing, whereas in case of drum mixer, the results are quite consistent and very near to actual ash content of the sum of ash contents of the constituents of the mixture. Ignition/combustion performance depends on homogeneous mixing of coal briquetting material. Uniform mixing is better for maximum sulphur trap.

References

Economic Survey, 1992-93. Government of Pakistan.

Ali, I. 1996. Coal Briquettes - An economic and efficient fuel from Pakistani coal. Vision, 1(4), pp. 51-61.

Perry, J.H. 1963. Chemical Engineers' Handbook 4th Edition.