IJETCR Open Access

ISSN: 2348 - 2117

International Journal of Engineering Technology and Computer Research (IJETCR)
Available Online at www.ijetcr.org
Volume 2, Issue 4, Page No. 50-60

Analysis and Comparison of Different binders for Coal fines

KiranKumar Rathod[1], S.S.Inamdar[2], Ashoka.H.S[3]

[1] Assistant Professor, Department of Chemical Engineering, SDM College of Engineering and Technology Dharwad, Karnataka, India.

kiri.rathod@gmail.com

[2] Assistant Professor, Department of Chemical Engineering, SDM College of Engineering and Technology Dharwad, Karnataka, India.

nasi_chem@rediffmail.com

[3] Assistant Professor, Department of Chemical Engineering, SDM College of Engineering and Technology Dharwad, Karnataka, India.

ashok.hakare@gmail.com

ABSTRACT

In coal mining process and handling, enormous tons of coal fines are formed. Typically, after handling and cleaning is completed, about 15-20% of the coal mined consists of fines ranging in size from powder to small granules. For the most part, these fines are not directly usable, thereby leaving great quantities of material that is wasted and represents a hazardous and expensive disposal problem. Typically, coal fines are disposed of at or near the mine site in unsightly piles, trenches or ponds. The fines material from mining operations are frequently recovered in the form of a wet filter containing about 20-30% moisture, depending upon its size, distribution and ash content. Currently, there are over two billion tons of discarded coal fines throughout the Indian mines. While a portion of the coal fines can be combined with coarser fractions of mine production for sale, the inclusion of all fines often reduces the quality of the product below market requirements. Accordingly, coal fines handling, storage and disposal operations represent a significant and unproductive expense for the industry. Using different percentage of various binders to briquettes is produced from coal fines. And their physical and chemical properties are analyzed and compared by different test for various concentrations of binders.

Key words: Coal, binders, hazardous, moisture, Molasses, Lignin, Pitch, Dairy Waste

INTRODUCTION:

Mining and processing of coal to provide a product to meet market requirements inevitably results in the formation of a fine coal fraction, which is not favored by the user. In the early days of the industry, when steam trains burning large lumps of coal were the main form of industrial transport and power generation was achieved by burning coal on chain grate stokers, fine coal could be defined as being less than 6mm. Today coal burning power stations use pulverized fuel and accept a product down to 200 micron in size. The fine coal, or more correctly the ultra fine coal can carry in the order of 20 % moisture and difficulty can be experienced in discharging feedstock containing this material from railway trucks and from power station stockpiles.

In addition to the handling problem, the high moisture content reduces the "as received" calorific value and can reduce the capacity of pulverizing mills at power stations due to the extra moisture that must be driven off. The increased use of mechanized mining has increased the amount of fine coal generated, many mines reporting up to 6% of the run of mine coal as being in the minus 200 micron fraction. Until recently this material has been disposed of either underground in old workings or on surface in slimes dams[1]. Both practices are environmentally unacceptable and are a cost against the profit of the mine. During the 1990's there has been a move in South Africa to beneficiate the 200 micron material using froth flotation, which improves the calorific value of the product but still leaves the high moisture content to be dealt with[2]. Thermal drying can reduce the moisture to an acceptable level but there is a concern that the fine coal can pick up moisture during transport and stockpiling and that it may even return to equilibrium moisture in the 18 to 20 % region.

For the above reasons there is a renewed interest in the agglomeration of fine coal. The methods generally used are some form of briquetting, palletizing or spherical agglomeration. This study will review the practices that have been used in the past in the coal producing countries of the world. Much of briquetting development has been involved with the briquetting of brown coal and lignite.

1.1 RECYCLE SLACK COAL-A SERIOUS ECONOMIC CONSIDERATION:

During the mining, handling and transportation, there is a considerable amount of disintegrated coal being dropped on the ground. This disintegrated coal is usually called "slack coal ". The amount of slack coal can be 5% - 50% of the total coal mined, or even more[3]. That is to say, it is a serious economic consideration of recycle this waste slack coal. The most common application of slack coal is briquette production. On the market, the price of slack coal is considerably lower than lump coal from the same mine. However, after briquetting the slack into a coherent mass, its value can be equal to the original lump coal and coal briquettes of high quality even have a greater value.

1.2 LIMITATIONS IN USE OF COAL FINES:

A problem that contributes to the underutilization of coal fines for conventional uses is their relatively high moisture content after processing in coal preparation plants. Obviously, the price of coal depends on its heating value and is increased by reducing the moisture content. Reducing the moisture content of coal, increases the efficiency of power plants and decreases transportation costs. The process of reducing coal moisture, though, further contributes to the problem of coal fines production because water is removed by the weakening of the coal structure and the attrition of coal particles. Thus, coal drying operations represent another source of fines that are either wasted or represent an added operating expense.

Despite these disadvantages, though, lower-rank coals may also provide significant advantages to industry, often in the form of low ash and low nitrogen contents, high reactivity and lower mining costs. However, in order to exploit these advantages industrially, both the problems of moisture content and fines handling must be addressed.

As a result of these problems, as well as of strict customer demands with respect of coal quality and of increasingly stringent regulation of mine waste disposal practices to satisfy environmental standards, coal fines utilization has been recently reexamined by the industry. In the past, fines have been used mostly for manufacturing briquettes for home and commercial heating. Coal briquetting technology focused on low pressure agglomeration of coal fines, using a binder, to hold individual particles together.

The fines material from mining operations is frequently in the form of a wet filter cake containing between about twenty and thirty percent moisture, depending upon its size distribution and ash content. In a dry state, the fines are generally predominantly passable through a 28-mesh screen, a size that may be used for pelletizing and/or briquetting purposes. As used in this disclosure, the terms pellet, briquette, log and block are used interchangeably and are intended to refer to all forms of pellets, briquettes, logs, blocks and other coal agglomerates produced by binding coal fines into a concrete material. The current emphasis in finding useful applications for coal fines is their utilization in combination with binders to produce pellets. Thus, it could provide an outlet for the economic and efficient consumption of this material that is currently largely wasted.

1.3 COAL BRIQUETTING:

Coal briquetting is a process which converts coking coal & slack into hard and impact resistance agglomeration, making it useful with high calorific value for domestic and industrial purpose. Adoption of briquette technology will not only create a safe and hygienic way of disposing the waste, but turn into a cash rich venture by converting waste into energy and also contributing towards a better environment.

The briquetting process combines cutting-edge briquetting technology with a proprietary, wholly organic, environmentally safe, non-petroleum based binder to produce coal briquettes from the fines. The resulting product has a lower moisture content, lower toxin content (including reduced ash, sulfur and other impurities), higher BTU value, greater hardness, durability and integrity during handling and transport or when stored outside for extended periods of time exposed to the elements and extreme weather conditions.

1.4 TYPES OF COAL:

As geological processes apply pressure to dead biotic material over time, under suitable conditions it is transformed successively into:

- Peat**:** considered to be a precursor of coal, has industrial importance as a fuel. In its dehydrated form, peat is a highly effective absorbent for fuel and oil spills on land and water. It is also used as a conditioner for soil to make it more able to retain and slowly release water.
- Lignite **or brown coal:** It is the lowest rank of coal and used almost exclusively as fuel for electric power generation. Jet, a compact form of lignite, is sometimes polished and has been used as an ornamental stone since the Upper Paleolithic.

- Sub-bituminous coal: whose properties range from those of lignite to those of bituminous coal, is used primarily as fuel for steam-electric power generation and is an important source of light aromatic hydrocarbons for the chemical synthesis industry.
- Bituminous coal: It is a dense sedimentary rock, usually black, but sometimes dark brown, often with well-defined bands of bright and dull material; it is used primarily as fuel in steam-electric power generation, with substantial quantities used for heat and power applications in manufacturing and to make coke.
- Anthracite**:** It is the highest rank of coal, is a harder, glossy black coal used primarily for residential and commercial space heating. It may be divided further into metamorphic ally altered bituminous coal and "petrified oil", as from the deposits in Pennsylvania.

2. TEST OF COAL SAMPLE:

2.1. PROXIMATE ANALYSIS:

2.1.1DETERMINATION OF MOISTURE CONTENT (M*):*

About 1 gram of finely powdered air dried coal sample was weighed in a silica crucible and was then placed inside an electronic hot air oven, maintained at 108±2˚C. The crucible with the coal sample was allowed to remain in the oven for 1.5 hours and was taken out with a pair of tongs cooled in a desiccator for about 15 minutes and then weighed. The loss in weight is reported as moisture (on percentage basis). The calculation is done as per the following:

% moisture = % M = (Y - Z) / (Y - X)*100

Where,

X = Wt. of crucible in gm.

Y = Wt. of coal + Crucible in gm. (Before in heating)

Z = Wt. of coal + Crucible in gm. (After in heating)

2.1.2. DETERMINATION OF VOLATILE MATTER CONTENT (VM):

About 1 gram of finely powdered air dried coal sample was weighed in a VM crucible and was then placed inside a muffle furnace maintained at 925˚C. The crucible was then covered with its lid. The heating was carried out for exactly 7 minutes, after which the crucible was removed, cooled in air and then in a desiccators and weighed again. The calculation is done as per the following:

% V.M = (Y - Z) / (Y - X)*100

Where,

X = Wt. of crucible in gm, Y = Wt. of coal + Crucible in gm. (Before in heating), Z = Wt. of coal + Crucible in gm. (After in heating)

2.1.3. DETERMINATION OF ASH CONTENT (ASH):

About 1 gram of finely powdered air dried coal sample was weighed and taken in an empty silica crucible. Before that the crucibles were heated at 800˚C for about 1 hr to remove any foreign particles in the crucible. The crucible along with the sample was put in a muffle furnace at 450˚C for about 30 minutes. After that the temperature of the furnace was raised to 850˚C and the sample was heated for about 1 hr at that temperature. The calculation is done as per the following:

% Ash = (Z - X) / (Y - X)*100

Where, X = Wt. of crucible in gm., Y = Wt. of coal + Crucible in gm. (Before heating), Z = Wt. of coal + Crucible in gm. (After heating)

Table1: The results of proximate analysis for all the coal samples

Parameters	Percentage of content %
Moisture	9.4
Volatile Matter	20.7
Ash Content	10.5
Fixed Carbon	59.4

2.2. ULTIMATE ANALYSIS:

2.2.1. SULFUR CONTENT:

- Affects clinkering and slagging tendencies
- Corrodes chimney and other equipment such as air heaters and economizers
- Limits exit flue gas temperature.

A known quantity of coal is heated with Eschka mixture (which consists of 2 parts of MgO and 1 part of anhydrous Na_2CO_3) at 800˚C.After burning amount of sulfur present in the mix is retained as oxides and it is precipitated as sulfates. The sulfate formed is precipitated as BaSO4 (by treating with BaCl2). Typical range is 0.5 to 0.8% normally.

% of sulfur in coal = 100.0 * 0.1374 * (Y / X)

Where, X- weight of coal sample taken

Y-Weight of BaSO4 precipitate formed

%H = $0.036FC + 0.086 (VM - 0.1*A) - 0.0035M^2 (1 - 0.02M)$

%N2 = $2.10 - 0.020$ VM

%C = $0.97FC + 0.7(VM - 0.1A) - M(0.6 - 0.01M)$

Where, FC = Fixed Carbon, VM = Volatile matter, M = Moisture, A = Ash.

Table2: The results of proximate analysis for all the coal samples

Parameters	Percentage of content %
Hydrogen	3.583
Nitrogen	1.686
Sulfur	0.563
Oxygen	13.048
Carbon	70.62

2.3. PHYSICAL PROPERTIES:

2.3.1 SPECIFIC GRAVITY:

The proportion and nature of both the organic mass and mineral matter influence the specific gravity of coal. For the same type of coals, the higher ash coals have higher specific gravity. The true specific gravity of bituminous coals varies between 1.27 & 1.45.

S = K + (A/100)

Where, S = Specific gravity, A = Percentage of Ash, K = A constant, value is 1.25

2.3.2. DENSITY:

Partly due to the intricately structured void volume of coal, its density not only varies with rank, but also depends on how it is measured. “Coal density” therefore carries several different connotations, and a distinction must, in particular, be made among Bulk densities which are determined by the average particle (or lump) size, size distribution, and packing density of the coal, and bear on handling, transportation, and storage. In-place densities which refer to the weight-to-volume ratios of undisturbed coal in their respective seams and are important parameters for estimating coal reserves.

Density of coal = Specific gravity * Density of Water

2.3.3. HARD-GROVE GRIND ABILITY INDEX OF COAL:

It gives an idea about the relative ease of grinding coals or the power required for grinding coals. A standard test called Hard-Grove method is employed to determine the Hard-Grove grind ability index. 50gms of air dried coal size –16+30 mesh is subjected to 60 revolutions in a small mill (miniature pulverizes). After grinding, the coal is screened the coal is screened through a 200 mesh sieve.

Coals which are easy to grind have an index near to 100. The 2 methods to determine the ease of grinding are ball mill method and Hard-Grove method. A high value of G indicates a soft and easily grinds able coal. HGI of coal initially increases with the rank, reaches a maximum of about 105 for bright coals of 89-90% carbon, and then falls sharply to about 35 for anthracites. The average HGI for Indian coals is 55-65.

3. EXPERIMENTAL PROCEDURE:

500 g of coal sample was taken and crushed to pass through 1.18mm sieve. The 1.18mm by 600µ size 50gm sample was taken in a ball mill along with 8 iron balls. The mouth of the ball mill was closed and it was set to rotate for about 60 revolutions, when the rotation is achieved, the machine was stopped. The sample left in the ball mill was then collected along with any powdered substance sticking to the surface of the machine by help of a brush. This sample was then put in a sieve of 75µ size and was shaken for about 10 minutes. After sieving for about 5 minutes, the sample which passes through 75µ size was weighed on the balance.

3.1. CALCULATION:

The hard groove grind ability index of coal is calculated using the following formula.

HGI = 13 + 6.93W, W = weight of the test sample passing through 75µ sieve after grinding i.e. 200mesh.

3.2. DETERMINATION OF CALORIFIC VALUE OF COAL BY BOMB CALORIMETER:

A known volume of the sample is burnt completely in excess oxygen. The librated heat is absorbed by surrounding water and calorimeter. Thus the heat librated during the combustion of fuel is equal to the heat absorbed by water and water calorimeter. The higher calorific value of the fuel is calculated from the data.

Unit of calorific value is J/Kg

Heat lost by 'M' gram of fuel = heat gained by water + heat gained by calorimeter

$= (W_1 + W_2)\,(T_2 - T_1)$ Cal

$$\text{Higher calorific value of fuel} = \frac{(W_1 + W_2)\,(T_2 - T_1) * 4184}{M}$$

3.3. CAKING INDEX:

It is the measure of binding or agglutinating property of coking coal. Numerically it is the maximum number ratio of sand to coal in a 25gm mixture of the two (Sand + Coal) which on heating under standard conditions produces a residue coke capable of supporting a weight of 500gms without producing more than 5% of loose grains of coke. The Caking Index of coal blend charge for coke ovens is about 21 to 22. Free Swelling Index: It denotes the caking capacity of coal. In this test 1gm of coal samples are taken and heated in a silica crucible of particular dimension. It is heated in a burner or in a furnace maintained at 825-850˚C.Heating is carried out for 4 minutes. Maximum value of free swelling index is 9. Coal having free swelling index between 4-5 are taken for coke making. Gray King Low Temperature Assay (GKLT): It is carried out to observe coking property of coal. After that detach the apparatus. The profile inside the crucible is compared with standard coal burden from A-G, G1, G2….G9, G10. A - The residue is powder with no swelling, B - None coking, C & D - weakly caking, E, F & G - medium caking, G1 - G9 - High caking.

After heating the sample hard mass obtained = Vol. of the coal sample Then it is G. The suffix 1, 2, 3 indicates the no. of grams of inert C required to be added to the hard mass to give the original profile or standard G-type coke.

Table 3: The results of proximate analysis for all the coal samples

Parameter	Test result
Density	1350 kg/m^3
Calorific value	6150 kcal/kg
HGG Index	78.21
Specific gravity	1.35

4. TYPES AND PROPERTIES OF BINDERS:

4.1. MOLASSES:

Molasses is the dark, sweet, syrupy byproduct made during the extraction of sugars from sugarcane and sugar beets. Molasses can vary in color, sweetness, and nutritional content depending on the variety or how much sugar has been extracted.

The binding power of molasses is said to be due to pectin, which is a body closely related to mucilage and has the constitution of a typical lignocellulose. To a less extent the binding power is due to sugar. Molasses contains only about 10 per cent of ash. From 6 to 8 per cent of molasses in water is said to be sufficient for binding, but the experiments do not verify the statement. There was hardly increase in coherence of the briquette by using more than 8 per cent of molasses. The failure to obtain good briquette with smaller percentages or to obtain satisfactory briquettes even when the higher percentages were used is hard to explain.

4.2. LIGNIN:

The sample was obtained from West Coast Paper mill, Dandeli. The sample was preheated and diluted before using as binder. Lignin is a good binder as per its properties and shows better properties as a fuel combining with coal. The briquettes formed are of good strength but not waterproof.

This is waste liquor, amounting to ten or twelve times as much as the cellulose fiber produced, yields on evaporation an average of 9 to 10 per cent of solid residues. Roughly, therefore, the amount of this solid waste material is equal to the amount of cellulose obtained. The water could be removed by evaporation, during which process the complex groups are to some extent broken down, sulfur and sulfur compounds being formed and some of them escaping of the solid residue left from evaporation 20 percent is inorganic material and 80 percent is organic. Carbon content of lignin 50.22 to 56.27 percent, hydrogen 5.22 to 5.87 percent, sulfurs 5.52 to 8.80 percent.

4.3. PITCH:

Owing to fluctuations in the price of rosin, pitch, which is a mixture of rosin and tar, is variable in cost. The sample was obtained from the road construction site & pitch tested was of this grade. Only 5 to 7 per cent of this pitch is necessary to produce a satisfactory briquette. The briquette stood the weather well and, except those made with the lignite, proved satisfactory in the fire.

4.4. DAIRY WASTE:

The sample was brought from Karnataka milk factory, Dharwad. Briquettes made from this sample dint have very high compressive strength it was analyzed from 8-14 percent as it had less coherence properties. The strength of briquette increased with the percentage of binder used but the calorific value decreased.

Figure 1: Various binders used for producing briquettes

5. MATERIALS AND METHODOLOGY:

5.1. RAW MATERIALS:

The raw materials used are coal fines, additives and different types of binder.

5.1.1. COAL FINES:

The coal fines should have the following characteristics to obtain good quality of briquettes:-

- Good combustion characteristics: high calorific value, low ash content, medium percentage of volatile matter, low sulfur content for the environment.
- Good compact ability: low size-range, low moisture content.

.

Figure 2: Raw material coal from mines

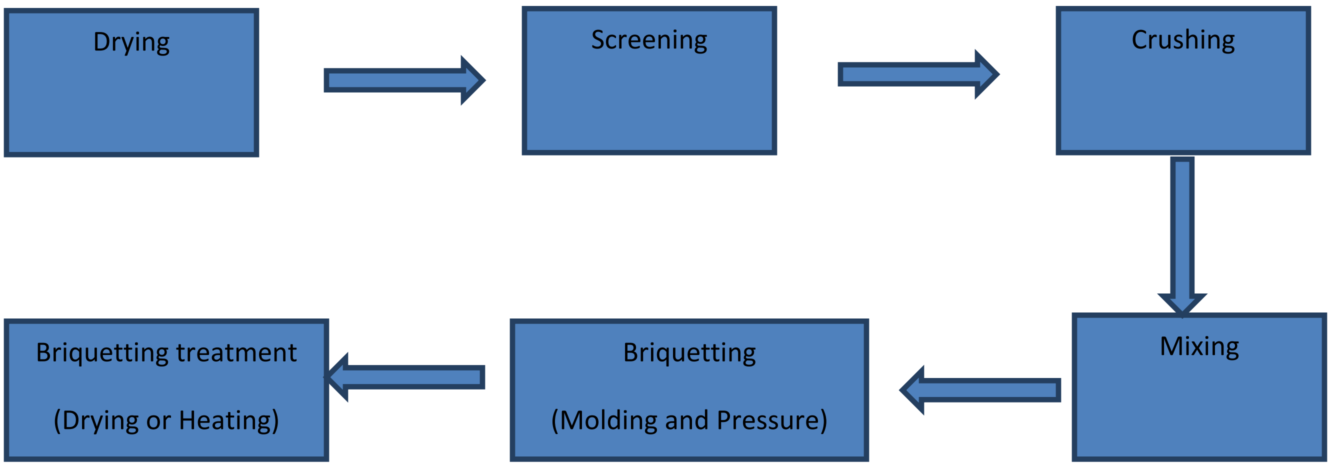
5.1.2. SIZE RANGE OF COAL FINES:

The coal fines usually have a size range between 0 and 3mm, but small quantity of grains larger than 3 mm and smaller than 5 mm is acceptable. To obtain good quality of briquettes, it is essential to have the widest fines size distribution possible, with very fine grains among larger grains: during briquetting, the fine grains will interlock with the larger grains and it will ensure the highest possible compactness. This parameter is directly connected with the quality of briquettes, in particular their crushing and handling strength.

5.1.3. BINDERS:

The coal fines are not self-agglomerating they require the addition of a liquid or solid binder in order to obtain briquettes of a sufficient quality. Briquetting of coal or coke must be compressed with bonds in order to manufacture briquettes. The binding materials used for binding together the small particles of coal fines for making briquettes in which we have used molasses, pitch, dairy waste, lignin and white Portland cement.

5.2 METHODOLOGY:



The methodology for making coal briquettes involves different unit operations and process. The manufacturing of briquettes includes following units. The waste coal fines from the mining industries and waste coal during transportation contains large number of impurities. The coal must be thoroughly cleaned and separated from all extraneous matter. The cleaner the product, the burning quality of briquette will be high.

Drying:

The coal from mining area contains large amount of moisture. Before the size reduction of coal it is necessary to remove moisture from coal. And for coal briquetting, moisture content should be low in order to increase its combustion characteristics. Drying process is used to remove excess content of moisture from coal.

The moisture content in the coal or coal fines from mining area is too high. To remove the moisture from the coal drying unit is used in industries. Drying can also do at room temperature. For drying of coal we took coal sample on paper sheet and put into sunlight for one day.

Screening:

Screening or separation of different size of coal grains is required in making of coal briquetting. And according to their size different size reduction equipment is to be used. The coal sample which we got was already of smaller size, so we performed sieve analysis and separated different size of coal.

Crushing:

It is very important that the coal should be reduced to a uniform size. The most satisfactory results are obtained from coal of an even size. The finer the coal the grater is the quantity of binder required to agglomerate it.

For larger size we used ball mill to convert it into coal fines and for smaller size we used hammer. And we got uniform size of coal fines.

Figure 3: Crushing using ball mill and Mechanical Press applied on briquette

Mixing:

The uniform size of coal fines with a known quantity is mixed with a known quantity of binder. And additives are also required to remove sulfur content or for binding. Proper mixing of coal fine, additives and binder helps into minimize the requirement of quantity of binder. Mixing also helps in increase of density of briquette. Before, the mixing heating of the liquid binders is required it decreases viscosity of liquid binders which minimize the quantity of binder for briquetting.

Briquetting:

After the mixing of coal fines and binder we filled the mixture in mold and pressure is applied on that to make strong and tough briquette, to get proper size and shape, and to reduce the void space between coal fines.

5.3. THE FINAL BRIQUETTES PRODUCED:

Figure 4: Briquettes obtained using different binder varying the percentage.

6. RESULTS AND DISCUSSION:

6.1. COMPRESSIVE STRENGTH TEST:

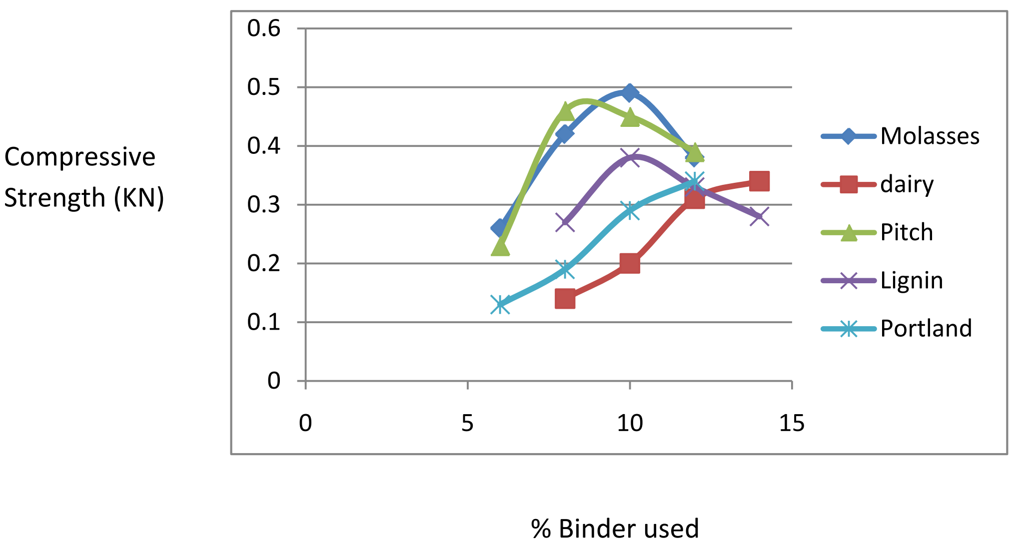


Figure 5: Compressive strength (KN) vs % of binder used

The compressive strength test conducted showed the quality of binding does each binder give. Sample of each binder with 4 different concentrations were taken for analysis. The Molasses showed high compressive strength whereas for dairy waste it could not take load above 0.15-0.35. Portland showed better performance than dairy whereas lower than lignin. The lignin also had high strength. Molasses & Pitch are considerably good best in this test.

6.2. CALORIFIC VALUE THROUGH BOMB CALORIMETER:

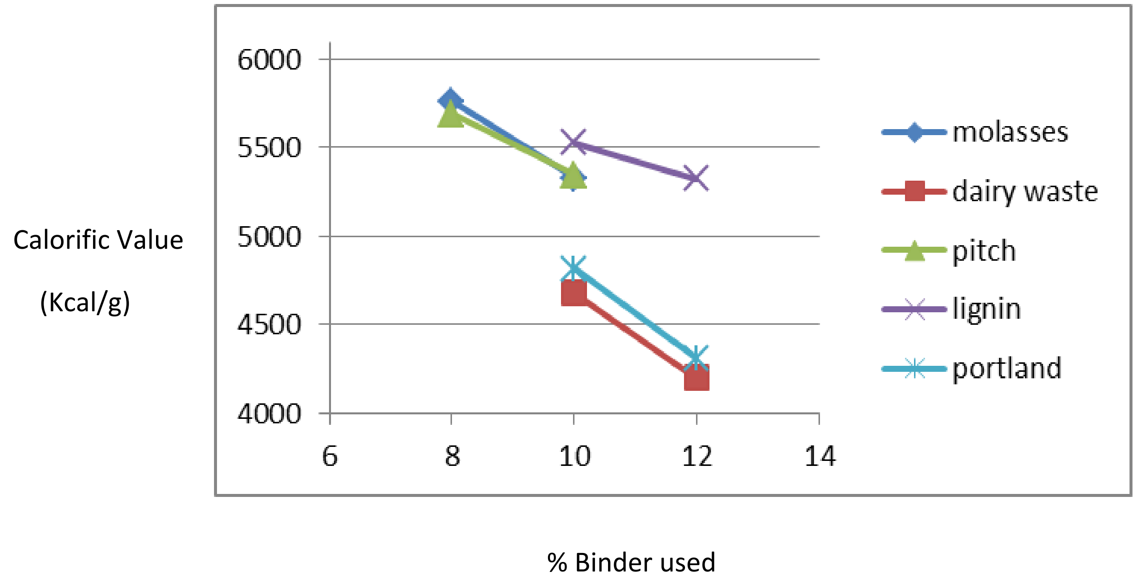


Figure 6: Calorific value vs % of binder

In calorific value analysis the dairy waste and Portland cement showed the least profile whereas molasses & pitch showed the highest graph. Lignin calorific value in sufficient as a fuel. We can also observe the values & pattern that as the percentage of binder increases the calorific value decreases. Thus, we should try using min binder required for briquetting. The highest performance was given by pitch, molasses & lignin.

6.3. MOISTURE CONTENT IN FINAL BRIQUETTE SAMPLES FOR DIFFERENT % OF BINDER:

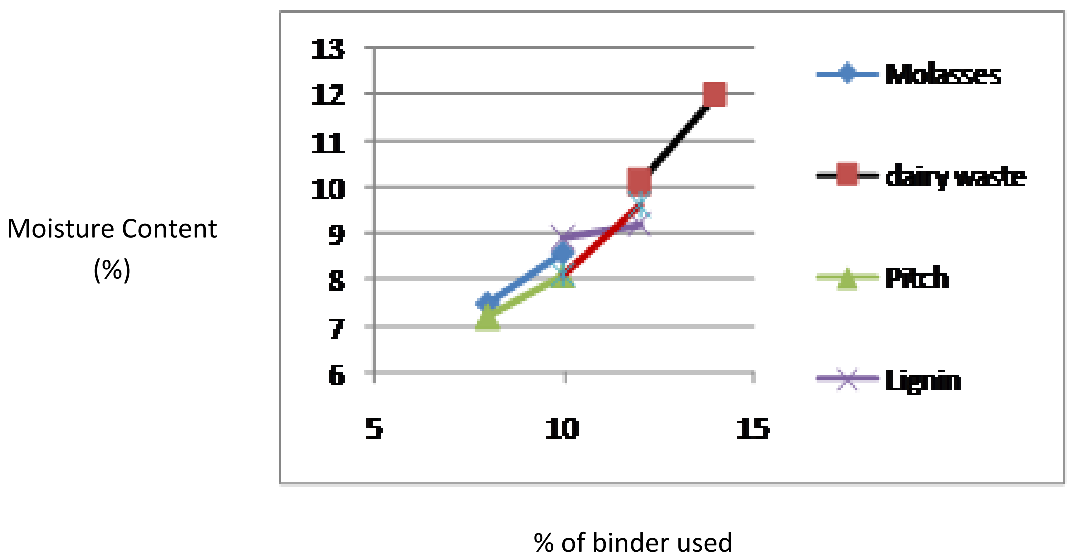


Figure 7: Moisture content vs % binder used

The moisture content test was carried as for initial coal fines. The dairy waste briquette had highest moisture content. The lowest moisture content was present in pitch briquette. The moisture content in lignin & molasses was optimum. The moisture content in pitch should not be very high as its ignition property will be affected also it should not be very less or else binding will be tough. The best two binders for moisture content are- lignin, molasses.

6.4. PERCENTAGE ASH OBTAINED FOR DIFFERENT BRIQUETTES USING VARIOUS % OF BINDERS:

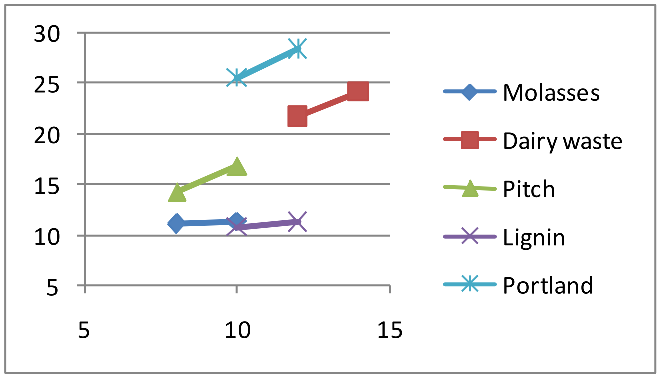


Figure 8: Ash content in final briquettes

Ash content in coal must be less for better heating values. From, the values obtained we can see that Dairy and Portland waste had highest ash content. Portland cement briquette does not burn completely producing more of ash. Lignin gave the least ash. The best result was given by molasses & lignin

6.5. Sulfur content in final briquette for different % of binder:

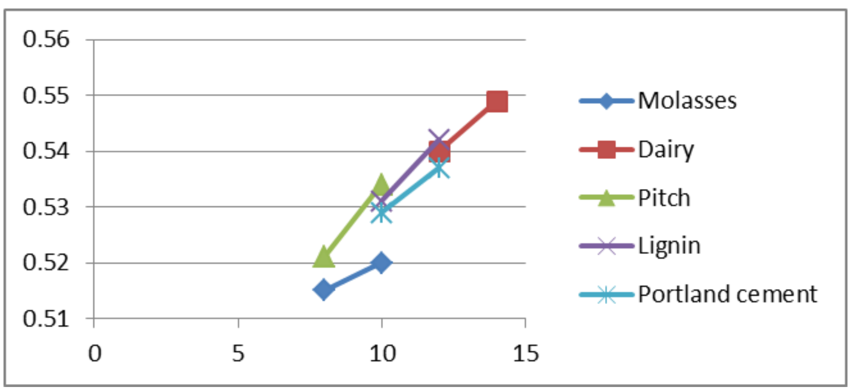


Figure 9: Sulfur content in final briquettes

Sulfur content of sulfur is reduced by using $CaCO_3$ as its content should be very less to avoid pollution. The lowest sulfur content was determined in molasses. The highest sulfur content was found in dairy waste. Portland has less sulfur compared to dairy waste.

7. CONCLUSION:

Briquettes made with varying concentration of different binders namely (1) molasses (2) lignin (3)dairy waste(4)coal-tar pitch(5) white Portland cement were analyzed and compared on the basis of different tests performed. The production of briquettes from coal and the above binders produced a high toughness. Studies have shown that the quality of a fuel briquette is highly dependent on the choice of appropriate binders and the moisture content of the waste material.

Molasses is used in a diverse range of industries due its excellent non pollutant binding properties. It has an advantage over other binding materials it does not produce a toxic emission on combustion instead it produces only carbon dioxide thus is much safer for the environment.

Additional increase of mass participation of biomass does not produce a significant decrease in resistance of the briquettes, but lessen the energy effect during their burning in furnaces. The acquisition of a high value of resistance to gravitational drop, together with resistance to the compression, to a large degree depends on the moisture of the mixture, pressing stamp pressures, and likewise the period of briquette seasoning.

We tried to work out with using dairy waste as a possible binder, but it resulted in large increase of ash content and a considerable decrease in calorific value. Since we have used high quality coal fines, it is not a feasible binder, but it can be used as coal bonder for coal briquetting of brown coal.

Pitch gives waterproof briquettes and allows storage of briquettes outside. . It was proved that briquettes showed sufficient resistance, even in fresh form; however, it is advantageous to use them during a period of 1-2 weeks. But because of environmental concerns can be used limited. give out fumes during combustion, due to the volatile matters in the binder : the quantity of volatile matter being high as far as coal pitch is concerned, in this case, the briquettes can be treated in a smoke curing oven to make them smokeless.

The lignin are low resistant to moisture. But the compressive strength of briquettes was low as compared to other binders.

White Portland cement-the disadvantage resulting from the addition of any large percentage of an inorganic binder is too great to justify its use except as a matter of great saving in cost, or as a matter of necessity, in order to hold together in the fire some entirely non caking coal and produce a low grade of fuel there from. . In water the briquettes acquire moisture from environment.

Overall molasses proved the promising solution as coal binder. If it is available near the processing unit, it is very feasible option as coal binder for coal briquetting. For a concentration of 6-8% of molasses, it is also economically viable.

8. REFERENCES:

1. Yougou, "Chinas Coal Demand Outlook for 2020 and Analysis of Coal Capacity". China Coal Industry Development (2003), Researches and Consulting Co-Ltd Beijing.
2. Eremin, A. Y., V. I. Babanin, and S. Y." Requirement to indices of mechanical strength of briquettes with Binder". Metallurgist 11: 32–38. Kozlova. 2003.
3. E. Altun, C. Hicyilmaz and M.V. Kok "Effect of different binders on the combustion properties of Lignite". Journal of Thermal Analysis and Calorimetry, Vol.6 (2001).
4. Matter's Thesis, "The Development of Binder less, Smok Briquetts from Bituminous Colliery Waste", Wits University, October 1993.
5. Dr-Ing Pietsch W "New Applications of Roller Presses in Coal related Technologies", 18th Int. Tech. Conf. Coal Utilisation and Fuel Systems.
6. Clark K Thermal Drying and Binder less "Briquetting of Low Rank Coal in the Collie Basin Western Australia", 13th ICPC Brisbane Australia 1998.
7. Kalb G.W. "Binderless Briquetting of Bituminous Coal", 13th ICPC Brisbane Australia 1998.
8. Clark K. "Economic Coal Fines Agglomeration", Research Programme No. 3013 CISRO Australia 1994.
9. Boruk, S. and I. Winkler. "Ecologically friendly utilization of coal processing waste as a secondary energy source" In Energy and Environmental Challenges to Security", 251–259. Springer Publishers, 2009.