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ASSESSMENT OF COAL QUALITY OF SOME INDIAN COALS

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ABSTRACT

Coal is one of the primary sources of energy, accounting for about 67% of the total energy consumption in the country. Indian coal has high ash content and low calorific value. The energy derived from coal in India is about twice that of energy derived from oil, as against the world, where energy derived from coal is about 30% lower than energy derived from oil.

Introduction

The rock that we refer to as coal is derived from decomposed organic matter consisting of the element carbon. When coal is burned, it produces energy in the form of heat, which is used to power machines such as steam engines or to drive turbines that produce electricity. Almost 67% of the electricity produced in India is provided by coal combustion.

Among the coal-quality characteristics that will be important for future coal use are the concentrations, distribution, and forms of the many elements contained in the coal that we intend to burn. Knowledge of these quality characteristics in Indian coal deposits may allow us to use this essential energy resource more efficiently and effectively and with less undesirable environmental impact.

The objective of this work is to analyze the quality of various Indian coals and find out which coal is suited best for which kind of industry. Also these data will be used as the fundamental consideration for future concerns, for instance: coal trading and its utilization.

Coal Properties and their Tests

Coal samples were collected from 10 different mines of Talcher coal field, Talabira coalfield, Ib Valley coal field and Chirimiri coalfield following channel sampling procedure. Various coal properties were studied and their tests were carried out, which gives us some information about the quality of coals.

The various properties that were studied are as follows:

- Plastic properties
- Physical and chemical properties.
- Special property of coal.

The test which were carried out are:
Proximate analysis
Determination of Hard grove grind ability index
Determination of calorific value of coal by Bomb calorimeter.

The results of above parameters have been presented in Table 1

Table1:Coal Sample Results

	Proximate Analysis						
Sample No.	**M(%)**	**VM(%)**	**A(%)**	**FC(%)**	HGI	**Gross calorific Value(kcal)**	**Net calorific Value(kcal)**
1	4.4	25.02	33.56	25.01	67.64	3996	3696
2	6.64	28.23	25.92	35.98	60.01	4658	4358
3	5.23	25.02	33.05	38.01	66.08	4896	4596
4	5.07	26.05	44.18	26.32	61.50	4569	4269
5	6.62	33.83	26.02	37.99	58.00	4723	4423
6	5.40	28.84	35.01	31.00	75.99	3971	3671
7	8.25	33.98	8.90	54.16	61.13	4921	4621
8	13.13	24.93	34.05	27.39	48.7	4445	4145
9	11.19	25.03	40.01	24.69	66.01	4368	3988
10	4.44	27.87	35.99	32.51	60.27	5009	4709

Conclusion

It could be observed from this study they the coal samples collected for the study contain low to medium quantity of moisture, medium to high amount of volatile matter and high amount of ash in general. The grind ability index of majority of the coal samples being low they are very difficult to grind as well. The calorific values of the coals vary between 3671 kcal to 4709 kcal. Thus all these coals could be used in thermal power plants and in other small scale industries for combustion purposes. However proper pollution control measures are required to made since these coals are expected to give rise to huge amount of hazardous pollutants during burning as ash content of these coals are high.

References

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Chapter1

INTRODUCTION and OBJECTIVE

INTRODUCTION

Coal is the world's most abundant fuel Coal is mined commercially in more than 50 countries and used in more than 70. Annual world coal consumption is about 5,800 million tons, of which about 75% is used for electricity production. This consumption is projected to nearly double by the year 2030 to meet the challenge of sustainable development and a growing demand for energy.

Coal produces 40% of the world's electricity, which is double the share of gas and hydro Although coal deposits are widely distributed , more than 58% of the world's recoverable reserves are located in four partners: the Unite states (27%), China(13%), India (10%), Australia (8.7%). By rank Anthracite and bituminous coal account for 53% of the estimated recoverable coal reserves, sub- bituminous coal accounts for 30%, and lignite accounts for 17%.

China and India are very large countries in terms of both population and land mass, and both have substantial quantities of coal reserves. Together, they account for 70% of the projected increase in world coal consumption. As demand grows, society expects cleaner energy with less pollution and an increasing environmental sustainability. The coal industry recognizes it must meet the challenge of environmental sustainability in particular it must reduce green house gases.

The quality of coal must be assessed so that it can be suitably used in different industries like plastic property knowledge of coal gives an idea to use in steel industry. Knowledge about HGI will help in deciding the type and capacity of crushing and grinding machine required in coal benefaction plants. Considering all these points the current work has been done to analyze various coal samples taken from different mines and find out its properties so that it can be utilized in an optimum way.

1.1 OBJECTIVE:

The objective of this work is to analyze the quality of various Indian coals and find out the suitability of different types of coals for various industries. Also coal sample analysis helps in determining the rank of the coal along with intrinsic characteristics. Also this data helps in coal trading and utilization. In view of all these the objective of work has been formulated as:

- Collection of samples from different mines
- Determination of different properties of coal samples in laboratory by
- Proximate analysis
- Hard grove grindability analysis
- Calorific value by using Bomb calorimeter.

Chapter2

SAMPLE COLLECTION and SAMPLING PROCEDURE

1. SAMPLE COLLECTION

The word sample denotes something that has been physically removed from its natural location to be tested in the laboratory. Any sample even the most simple , brings with a cascade of possible errors, some of which are related to the structure of the ore, and some to its distribution and its texture, with still others resulting from the particular sampling technique used, from the way the technique is applied or from the sampling apparatus used. A collection of samples should be typical of a coal mass. The standard method of sampling includes the use of various types of drills. The conventional method of doing this is by channel sampling.

1.1 SAMPLING PROCEDURE

The following procedure was used to collect channel samples of coal.

- A freshly exposed coal sample was selected; coal showing various signs of oxidation or rock dusted coal was avoided. In a deep mine sampling of a new face may be possible just after the roof has been bolted and before the next cut is made. In surface mine a fresh face can be sampled following the loading stage of mining.
- A face having plane was selected that was normal to beading. Coal might be cut back with a hand pick at the top and bottom to produce a proper surface.
- 3,4-mnylon-reinforced vinyl tarpaulin was spread on the floor.
- 2 parallel, vertical lines using (crayon) about 10 cm apart were marked on the coal surface.
- Using a pick, digging was started at the bottom of the coal between the lines to a depth of Approximately 8 cm was chipped out; the steps were repeated from bottom to the top of the channel.
- Carefully the back of the channel was squared so that the channel cut was of uniform volume.
- The entire sample was transferred into polyethylene- line canvas bags or drums.
- Representative splitting could be done later in the laboratory.
- A properly marked sample tag was placed inside the inner most bag and the outside container was labeled and each container was separately sealed.

Chapter 3

COAL PROPERTIES AND THEIR TESTS

CHEMICAL PROPERTIES

Coal properties and their tests

The utility of a particular coal for different purposes is based on different properties. These properties are physical, chemical, thermal plastic and special properties. These properties are determined by following tests.

CHEMICAL PROPERTIES

Coal comes in four main types or ranks: Lignite or brown coal, bituminous coal or black coal, anthracite and graphite. Each type of coal has a certain set of physical properties which are mostly controlled by moisture, volatile content (in terms of aliphatic or aromatic hydrocarbons) and carbon content.

Moisture: it is an important property of coal, as all coals are mined wet. Ground water and other extraneous moisture are known as adventitious moisture and are readily evaporated. Moisture held within coal itself is known as inherent moisture and is analyzed quantitatively. Moisture may occur in four possible forms within coal:

- Surface moisture : macerals or water held on the surface of the coal particles
- Decomposition moisture: water held within the coal decomposed organic compounds
- Hydroscopic moisture: water held by capillary action within the micro fractures of the coal.
- Mineral moisture: water which comprises part of the crystal structure of hydrous silicates such as clays.

Total moisture is analyzed loss of mass between untreated samples once analyzed. This is achieved by any of the following methods:

1. Heating the coal with toluene
2. Drying in a minimum free space over at 150^0 C within a nitrogen atmosphere
3. Drying in air at 100 to 105^0 C and relative loss of mass determined.

Methods 1 and 2 are suitable with low rank coals but method 3 is only suitable for high rank coals as free air drying low rank coals may promote oxidation.

Volatile matter: volatile matter in coal refers to the components of coal, except for moisture, which are liberated at high temperature in the absence of air. This is usually a mixture of short and long chain hydrocarbons, aromatic hydrocarbons and some sulphur.

It is determined under rigidly controlled standards. Any coal which has high volatile matter content:

- Has tendency of catching fire
- Low calorific value
- Can ignite easily
- Needs large furnace volume for combustion
- Burns with long smoky yellow flame.

Ash: ash content of coal is the non- combustible residue left after coal is burnt. It represents the bulk mineral matter after carbon, oxygen sulphur and water (including from clays) has been driven off during combustion. analysis is a straight forward, with the coal thoroughly burnt and the ash material expressed as a percentage of the original weight.
Mineral Matter: There are two types:

(1) Inherent
(2) Extraneous

-Inherent comes from inorganic constituent of plant materials, but the amount is less.

-Extraneous comes from the amount that gets associated with substances during its conversion process. These are associated with internal structures and amount is high. It is difficult to remove them.
Relation between mineral matter and ash is given below: M.M=1.08 Ash+0.555
For Indian coals: M.M = 1.1Ash

Coal containing high ash is:

1. Low calorific value
2. Will produce slag
3. Harder and stronger
4. Clinker formation

Fixed Carbon: The fixed carbon content of the coal is the carbon found in the material which is left after volatile materials are driven off. This differs from the ultimate carbon content of the coal because some carbon is lost in hydrocarbons with the volatiles. Fixed carbon is determined by removing the mass of volatiles determined by the volatility test, above from the original mass of the sample.
The above parameters are determined by proximate analysis. The elemental constituents of coal are carbon, hydrogen, nitrogen, sulphur and oxygen and these are determined by ultimate analysis.

Proximate Analysis

Determination of moisture, volatile-matter, ash and fixed carbon in coal comprises its proximate analysis.
Determination of moisture content: Loss in weight of coal caused by heating of coal sample for one hour at 105˚C is the moisture content of coal. A known amount of finely powdered coal sample is kept in a silica crucible and heated in a muffle furnace at 105-110˚C for one hour. There after the crucible is taken out, cooled in a desiccators and weighed. The percentage of moisture is given by
% moisture in coal= {loss in wt. ofcoalX100}/wt. of coal initially taken

Determination of Volatile Matter: It is the loss in weight of moisture free powdered coal when heated in a crucible fitted with cover in a muffle furnace at 925˚C for7 minutes.
%volatile matter ={loss in wt. of moisture free coal X 100} / wt. of moisture free coal taken

Determination of Volatile Matter: It is the weight of residue obtained after burning a weighed quantity of coal in an open crucible (i.e.in presence of air) at 750˚Cin a muffle furnace till a constant weighed is achieved.
%ash in coal={wt.of residue ash formed X 100} /wt.of coal initially taken

Determination of Fixed Carbon: It is determined indirectly by deducting the sum total of moisture, Volatile matter, and ash percentage from 100.
% fixed carbon in coal =100-(% moisture+% ash+%volatile matter)

Ultimate Analysis

Determination of total carbon, hydrogen, nitrogen, oxygen and sulphur percentages in coal comprises its ultimate analysis.
Determination of Carbon and Hydrogen in coal: A known amount of coal is burnt in a current of dry oxygen there by converting C and H of coal into CO_2 and H_2O respectively. The products of combustion (CO_2 and H_2O) are passed over weighed tubes of anhydrous $CaCl_2$ and KOH which absorbs H_2O and CO_2 respectively. The increase in the weight of $CaCl_2$ tube represents the

Weight of water (H_2O) formed while increase in the weight of KOH tube represents the weight of $CO_{2\text{ formed}}$.
% of H and C it can be calculated as follows as given below:

Let , $x =$ wt.of coal sample taken,

$Y=$ Increase in the wt.of $Cacl_2$ tube

$Z=$ Increase in the wt.of KOH tube

% carbon in the coal sample= $Z \times 12 \times 100 / x$

Similarly, % of hydrogen in coal sample = $Y \times 2 \times 100 / x \times 18$

Determination of Nitrogen: It is done by kjeldahal‟s method. A known weight of powdered coal is heated with conc. H_2SO_4 in presence of Potassium sulphate and Copper sulphate in a long necked flask there by converting nitrogen of coal to ammonium sulphate. When clear solution is obtained it is treated with 50% NaOH solution. The ammonia thus formed is distilled over and absorbed in a known quantity of standard sulphuric acid solution. The volume of unused H_2SO_4 is then determined by titrating against standard NaOH solution .Thus, the amount of acid neutralized by liberated ammonia is determined.
% of Nitrogen in coal= {vol.of acid used X Normality X1.4} / wt. of coal taken

Determination of Sulphur: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 sulphur present in the mix is retained as oxides and it is precipitated as sulphates.The sulphate formed is precipitated as $BaSO_4$(by treating with $BaCl_2$).

% of sulphur in coal= $y \times 32 \times 100 / x \times 233$

Where, $x=$ weight of coal sample taken

y=Weight of $BaSO_4$ precipitate formed

Determination of Oxygen: It is deduced indirectly as follows.

% of oxygen in coal= 100 – (% of C+H+N+S+ash)

1.2 PHYSICAL PROPERTIES

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.The following formula is valid for many coals of India.

Specific gravity = W / V

Where W = Wt of the sample

V = average sample volume

Densities: 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.

Porosity, surface area and heat of wetting: In Anthracite coal pore space always so extensive and so intricately structured as to make coal something like a solid sponge and endow it with the characteristics of a solid colloid. Heat of wetting is a measure of surface area of coal. Porosity, surface area and heat of wetting vary with the rank of coal as the same manner as moisture.

Specific Heat: The specific heat of coal increases with increase in the volatile matter and decrease in the C/H ratio. The relationship between specific heat and moisture is linear.

Hard-Grove Grind ability Index of Coal: It gives an idea about the relative ease of grinding coalsor the power required for grinding coals in a pulverizer. 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 pulveriser). After grinding, the coal is screened the coal is screened through a 200 mesh sieve. Hard-Grovegrind ability index (HGI) is then calculated as

$G=6.93W+13$

Where W = weight of sample passing through the 200 mesh sieve, in gm

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 grindable coal. HGI of coal initially increases with the rank, reaches a maximum of about105 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 but coking coals of Jharia and Giridih show value upto75.

THERMAL PROPERTIES

When a sample of powdered coal is heated out of contact with air, it loses occluded gases consisting of methane, ethane, nitrogen; carbon dioxide etc. at temperatures below 100˚C. Moisture is evolved between 100˚C and 150˚C. The initial temperature of decomposition of bituminous coals is 200-300˚C while active decomposition starts at 300-375˚C for the sea coals.

Pyrogenic water, primary tar and gases evolve during the primary devolatilization (at 300-550˚C), while gases (mainly hydrogen) are evolved during the secondary devolatilization at around 700˚C. While coal undergoes decomposition on heating, the residue becomes richer in carbon content. In the case of caking coals, the residue passes through a plastic state in the range 300-350˚C to 500-550˚C.The fluidity of the plastic mass initially increases, attains a maximum and then decreases to zero. If coke is heated further, significant changes take place around 2000˚C when graphite likes materials results. This process is called graphitization and is used in the production of graphite electrode and other articles. Non-caking coals are not amenable to graphitization.

1.3 PLASTIC PROPERTIES

When coal is heated, it passes through a transient stage which is called as plastic state (caking). If a particular coal does not pass through a plastic state, it is called sintered mass(non-coking).Plastic properties of coal is determined by caking index test, free swelling test, GKLT,Plastometer.

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. If the coal has higher than 17% ash, it has to be washed before testing.

Free Swelling Index: It denotes the caking capacity of coal. In this test 1gm of (-212µ) 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. First, 20gm of fine coal of-212µ size is taken in a silicon crucible and then the furnace is pre-heated at 300˚C.Heating is carried at a rate of 5˚C/minute till the temperature reaches 575˚C, & then increased to 600˚C quickly. At 600˚C hold it for 15minutes. After that detach the apparatus, the profile inside the crucible is compared with standard coal burden from

A - G, G_1, G_2 ….G_9, G_{10}.

A	-The residue is powder with no swelling
B	-Non coking,
C&D	-Weakly caking,
E,F&G	-medium caking,
G_1-G_9	-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 beaded to the hard mass to give the original profile or standard G-type coke.

Chapter 4

EXPERIMENTAL INVESTIGATION

PROXIMATE ANALYSIS

Determination of Moisture Content (M*)*

About 1 gram of finely powdered (-212µ) 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 dessicator 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 = $Y\text{-}Z / X$

Where,X= Wt of crucible in gms

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

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

Determination of Volatile Matter content (VM)

About 1 gram of finely powdered (-212µ) 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 = $Y\text{-}Z / X$

Where$X$= Wt of crucible in gms

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

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

Determination of Ash content (Ash)

About 1 gram of finely powdered (-212µ) 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 to850˚C and the sample was heated for about 1 hr at that temperature.The calculation is done as per the following

% Ash = $Y-Z / Y- X$

Where X= Wt of crucible in gms

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

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

Determination of Fixed Carbon(C)

The fixed carbon content of coal is given by the following formulae

% C = 100 – (% M + % VM + % Ash)

The results of proximate analysis for all the coal samples are presented in Table 4.1.

Table 4.1: Proximate Analysis of Coal Samples

SAMPLE NO.	MOISTURE (%)	VOLATILE MATTER (%)	ASH (%)	FIXED CARBON (%)
1	4.4	25.0	33.56	25.01
2	6.64	28.23	25.92	35.98
3	5.23	25.02	33.05	38.01
4	5.07	26.05	44.18	26.32
5	6.62	33.83	26.02	37.99
6	5.40	28.84	35.01	31.00
7	8.25	33.98	8.90	54.16
8	13.13	24.93	34.05	27.39
9	11.19	25.03	40.01	24.69
10	4.44	27.87	35.99	32.51

DETERMINATION OF HARD GROVE GRIND ABILITY INDEX

The grind ability of Coal is a measure of the ease with which it can be ground fine enough for use as a pulverized fuel, & it also shows the physical properties of coal like hardness, tenacity and fracture. There is a fixed relationship between Grind ability and rank of coal in the natural series from brown coal to lignite & anthracite. Coals easier to grind have 14 to 30 percent volatile matter. Coals with higher volatile matter are more difficult to grind. However petrographic & mineral constituents influence grind ability. The hard groove index of coal is affected by its moisture content and hence on the humidity oft heat atmosphere in which the test is carried out.

Experimental Procedure

1 kg of coal sample was taken and crushed to pass through 4.75mm sieve. The result in g sample was put in two sieve of 1.18mm sieve (upper sieve) and +600µ size (lower sieve). Sieve the material for 2 minutes until the entire material pass through 1.18mm sieve. The 1.18mm by600µ size coal was mixed thoroughly and 120 gm of the sample was removed for sample divider.

The 50gm sample was taken in a ball mill along with 8 iron balls with diameter 25.4±0.003 mm. 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.
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 through75µ sieve after grinding.

Table4.2 gives the grindability index of all the coal samples that were collected for the study.

Table 4.2: Values of HGI of the Coal Samples

SAMPLE NO.	Hard groove Grind ability Index (HGI)
1	67.64
2	60.01
3	66.08
4	61.50
5	58.00
6	75.99
7	61.13
8	48.7
9	66.01
10	60.27

DETERMINATION OF CALORIFIC VALUE OF COAL BY BOMB CALORIMETER

The bomb calorimeter consists of a strong stainless steel vessel, called bomb, capable of withstanding high pressures. The bomb is provided with a lid which can be screwed firmly on the bomb. The lid in turn is providing with two electrode sand oxygen in let valve. One of the electrodes is provided with a ring to accommodate the silica crucible. The bomb is placed in a copper calorimeter having a known weight of water. The copper calorimeter, in turn, is surrounded by an air jacket and a water jacket to prevent loss of heat due to radiation. The calorimeter is provided with an electrical stirrer for stirring water and a Beckmann‟s thermometer.

Experimental Procedure

A weighed amount of the fuel is placed in the silica crucible. The crucible is supported over the ring. A fine magnesium wire touching the fuel sample is stretched across the electrodes.

Oxygen supply is forced into the bomb till a pressure of 25 - 30at m is reached. Initial temperature of the water in the calorimeter is noted after thorough stirring. The current is switched on the fuel in the crucible burns with the evolution of heat. The heat produced by the burning of fuel is transferred to water which is stirred throughout the experiment by the electric stirrer. Maximum temperature shown by the thermometer is recorded. The calorific value of the fuel can now be calculated as below.

OBSERVATION:

Wt. of the fuel taken in crucible =x kg

Wt. Of water in calorimeter= y kg
Water equivalent of the calorimeter, stirrer, thermometer & bomb = z kg
Initial temperature of water in calorimeter = t_1˚C
Final temperature of water in calorimeter=t_2˚C

Let, the higher (gross) calorific value of the fuel=C kcal/kg

Calculations:

Heat gained by water = y =t_2- t_1K cal

Heat gained by calorimeter = $Z(t_2 – t_1)$

Heat liberated by coal = x X C kcal

Now heat liberated by coal = heat gained by water + calorimeter

i.e x X C = y (Z(t_2 – t_1)

so, gross calorific value = c= y-z /x t_2

Table 4.3.gives the net calorific values and gross calorific values of the samples collected.

Table 4.3: Calorific Values of Coal Samples

SAMPLE NO.	Gross calorific value (Kcal)	Net calorific value(Kcal)
1	3996	3596
2	4658	4258
3	4896	4496
4	4569	4169
5	4723	4323
6	3971	3571
7	4921	4521
8	4445	4045
9	4368	3968
10	5009	4703

Chapter 5

DISCUSSION AND CONCLUSION

To determine the quality of some Indian coals a number of experiments were conducted during our work. The experiments that were conducted are proximate analysis, determination of hard grove Grind ability Index (HGI) , determination of calorific value by using bomb calorimeter.

As the sample collected were non–coking and so plastic properties were not determined. Also adequate facility to conduct the experiments required for ultimate analysis was not available so this test was also not carried out.

The proximate analysis of all the 10 samples which were carried out following the Indian Standard procedure. The percentages of moisture(M), volatile matter(VM) and ash content(A) of all the samples have been shown in figure 5.1.It may be observed from table 4.1 and figure 5.1that the sample no.8 has the highest moisture content (13.13%) and sample no.1 has the lowest(4.4%). Generally the moisture values varied from 6%– 10%. From this we conclude that sample no.8 will take more time for heating and will have lower calorific value. Also sample no.8 will be consumed more for a certain heating purpose than other coals.

It was also found that sample no. 5 and 7 have the highest volatile matter content (33.83% and 33.98%) respectively, where as sample no.8 has the lowest volatile matter content (24.93%). It has been observed in the past that coals with high volatile-matter content ignite easily and are highly reactive in combustion applications. With increase in volatile matter content of coal there is a decrease in the calorific value of coal. Sample no. 5 and 7 could be utilized for combustion applications very conveniently, but they may need a larger furnace volume for the same. These types of coals may even consider for liquefaction and gasification purposes since the yield of tar and gases for such coals will be higher.

The ash content of the samples varied to a large extent from 8.90 for sample no. 7 to 44% for sample no. 4. Majority of the samples have ash content in excess of 25% and will create problems during combustion. These may give rise to formation of clinkers in the furnaces hindering the reactions. These samples when burnt will give rise to environmental pollution to a significant extent. It is therefore essential that these coal samples be washed before being utilized by the industries.

The ash content of the samples varied to a large extent form 8.90 for sample no. 7 to 44% for sample no. 4. Majority of the samples have ash content in excess of 25% and will create problems during combustion. These may give rise to formation of clinkers in the furnaces hindering the reactions. These samples when burnt will give rise to environmental pollution to a significant extent. It is therefore essential that these coal samples be washed before being utilized by the industries.

The fixed carbon content which has a direct relation with the calorific value varied between 24.69% (sample no

9) and 54.16% (sample no.7) it could be observed from table 4.1 that the fixed carbon content of 9 samples are below 40% and it is expected that their calorific value will be low. These samples could be utilized in thermal power plants and other small industries for combustion processes.

The grind ability index of the coal gives an idea about the strength of coal. It is a measure to know as to how easy or difficult it is to grind a particular coal. The grind ability index of the samples varied between 48.7 (sample no 8) and 75.99 (sample no. 6). It could be seen from table 4.2 that only a few samples are easy to grind and the rest are very difficult. This index will help in deciding the size of the crushers and grinders that would be required in coal preparation plants.

The calorific value was found out using bomb calorimeter. It was found that sample no. 10 has the highest calorific values which are also consistent with the fact that they fixed carbon content in the higher range and low ash content. Sample 1 and 6 have low calorific values, they also have the ash % in the higher range. Sample 10 is better for fuel purpose than rest of the samples.

CONCLUSION

It could be observed from this study that coal samples collected for the study contain low to medium quantity of moisture, medium to high amount of volatile matter and high amount of ash. The grind ability of majority of samples being low they are very difficult to grind as well. The calorific value of the coal varies between 3671 to 4709 kcal. Thus all these coals could be used in thermal power plants and in other small scale industries for combustion purposes. However , proper pollution control arrangements are required to made since these coals are expected to give rise to huge amount of noxious pollutants during burning, because the ash content of the coals are very high.

Chapter 6

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