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ASSESSMENT OF COAL QUALITY OF VARIOUS COAL SAMPLES OF KORBA COALFIELDS OF CHHATTISGARH

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ABSTRACT

The objective of this project work is to analyze the quality of various coal samples of korba coalfields of Chhattisgarh and find out the suitability of different types of coals for different types of industries. Also coal sample analysis helps in determining the rank of the coal along with its intrinsic characteristics. Furthermore, these data will be used as the fundamental consideration for future concerns, for instance coal trading and its utilizations. Keeping this in view the objectives of the project work has been formulated as: Collection of coal samples from different mines of Korba Coalfield. Determination of different properties of coal samples in the laboratory by proximate analysis. Analysis of results of the experiments to find out their suitability for use in different industrial sectors.

INTRODUCTION

Coal, a fossil fuel, is the largest source of energy for the generation of electricity worldwide, as well as one of the largest worldwide anthropogenic sources of carbon dioxide emissions. Gross carbon dioxide emissions from coal usage are slightly more than those from petroleum and about double the amount from natural gas. Coal is extracted from the ground by mining, either underground or in open pits [1]. Coal is the most important and abundant fossil fuel in India. It accounts for 63% of the country's energy need. India now ranks 3rd among the coal producing countries. Most of the coal production in India cumbersome open pit mines contributing over 80% of the total production. Although coal plays an important role in catering to energy needs, it also causes environmental damage during mining, transportation and processing. It is a global industry that makes a significant economic contribution to the global economy [2].

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Coal is mined commercially in more than 50 countries and used in more than 70. Coal currently fuels 39% of the world's electricity and this proportion is expected to remain at similar levels over the next thirty years. Consumption of steam coal is projected to grow by 1.5% per year over the period 2002-2030. [3]The biggest market for coal is Asia, which currently accounts for 54% of global consumption. Coal will continue to play a key role in the world's energy mix, with demands in certain regions set to grow rapidly. Growth in both the steam and coking coal markets will be strongest in developing Asian countries, where demand for electricity and the need for steel in construction, car production and demand for household appliances will increase as incomes rise.

PROXIMATE ANALYSIS

Determination of Moisture Content:

Weighed accurately 1 gm finely powdered (-212μ) air dried coal sample in a silica dish (with cover). Spread it thinly, kept it in an Air Oven, electrically heated and temperature was controlled at 108±2°C for 1 hour.[4] Then taken out, kept in a desiccators to cool and weighed, from which it was calculated the percentage loss as moisture. The calculation is done as per the following.

$$\% \text{ moisture} = \% \text{ M} = \frac{Y-Z}{Y-X} \times 100$$

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 900˚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.[5] The calculation is done as per the following:

$$\% \text{ V.M} = \frac{Y-Z}{Y-X} \times 100$$

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 [6]was put in a muffle furnace at 500˚C for about 30 minutes. After that the temperature of the furnace was raised to 800˚C and the sample was heated for about 1 hr at that temperature. The calculation is done as per the following:

$$\% \text{ Ash} = \frac{Z-X}{Y-X} \times 100$$

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 (FC):

The residue left in the course of determination of volatile carbonaceous matter is the fixed carbon and ash. This fixed carbon is left as a result of destructive distillation of coal. Knowing the weight of ash, it is deducted from the weight of the residue.

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

$$\%FC = 100 - (\%M + \%VM + \%Ash)$$

Determination of Calorific Value

The Gross calorific values of coal samples were carried out by Leco (USA) make AC – 300. It consists of a bench top stand-alone unit with water circulation system fully incorporated with water return tank and pipette tank, a membrane keypad with display screen and a printer, making it compact and simple to operate.[7] It is a digital signal processing (DSP) microprocessor-based instrument developed to measure the calorific content of various organic solid/liquid materials such as coal, coke, and oil and food products.

Operational Procedure

In AC-300 calorimeter about 1 gm sample weighed in crucible was placed in a high pressure (420 psi) pure (99.5%) oxygen environment called a bomb. The bomb is surrounded by water when placed inside the bucket of the calorimeter and the sample is ignited with the help of two terminals connected by fuse wire inside the bomb. [8]The temperature of water is then measured by an electronic thermometer with a resolution of 1 x 10^{-4} of a degree. During analysis the fan speed is modulated to control the jacket temperature.

In this iso peribol system there may be some energy exchange between the outside environment and the water surrounding the bomb. This is accounted for by continuously monitoring the bucket and the jacket temperature during analysis. The heat exchange due to environmental conditions was then calculated. The microprocessor measures the temperatures of the water surrounding the bomb every six seconds. An additional correction is made for sulphur, nitrogen and moisture content of the sample. The result, the calorific value, is calculated. [9] A separate titration of the contents of the bomb may then be made and the results recalculated if the sulphur or the nitrogen contents were not entered or entered incorrectly.

The results of proximate analysis, GCV and UHV for all the coal samples are presented in Table 4.1 & 4.2 respectively.

RESULT AND DISCUSSION

Exploration revealed that there are 05 coal seams exist in this coalfield. Seam-V is the topmost coal horizon of the Barakar formation. The coals normally analyze 7 to 8 percent moisture and 18 to 20 percent ash. The Seam-IV contains coal having moisture 6 to 8 percent and 19 to 23 percent ash. [10]The coals of Seam –III analyze 7 to 9 percent moisture and 15 to 24 percent ash. The coals of Seam-II analyze 5.5 to 9 percent moisture and 7 to 28 percent ashes while the coals of seam-I contain coals having 5 to 7 percent moisture and 18 to 33 percent ash.

While the volatile matter of this coalfield are ranges from 22.1% to 31%. The calorific value of this area varies from 4660 to 6620 Kcal/Kg. The UHV value indicates that this coalfield contains a varying grade of coals i.e. mostly B, C, & D. From the Ultimate analysis it is found that the carbon content of these coals varying from 77 to 82 percent (dmf basis). Total sulphur contents of all these coals are low varying from 0.3 to 0.6 percent [11].

These findings incorporated that the coals are of this coalfield are low-rank, non-caking and mostly sub-hydrous in nature. The fusion characteristic of coal ash shows that the flow temperature is more than 1400°C which indicates that the coal ash is refractory in nature and is best to use in cement industries. But in seam II where the softening temperature, hemispherical temperature and flow temperatures noted as 1030°C, 1320°C & 1360°C respectively which will create slagging/clinkering trouble in combustion equipments. As the sample collected were non–coking and so plastic properties were not determined [12-15].

Table 1. Observations

Name of the Seam	Name of the sample	M%	Ash%	VM%	FC%	GCV (Kcal/Kg)	UHV (Kcal/Kg)
Seam V	TR-1	7.8	20.0	27.0	45.2	5505	5064
	TR-2	8.2	18.5	26.5	46.8	5590	5215
Seam IV	TR-3	6.4	22.6	26.6	44.4	5460	4898
	TR-4	8.1	19.1	27.3	45.5	5545	5146
Seam III	TR-5	7.5	24.2	22.1	46.2	5150	4525
	TR-6	9.3	15.8	25.9	49.0	5680	5436
Seam II	TR-7	8.5	7.2	31.0	52.3	6620	6733
	TR-8	5.9	27.7	26.7	39.7	5045	4263
Seam I	TR-9	6.7	18.5	25.5	49.3	5810	5422
	TR-10	5.0	33.2	24.4	37.4	4660	3628

CONCLUSION

The coal samples from all these above said coalfields could be used in thermal power plants and in other small scale industries for combustion purposes. Since the ash content of the coals are very high, proper pollution control arrangements are required to be made because these coals are expected to give rise enormous amount of toxic pollutants during burning. The coals of the above said coalfields could be potentially used in steel, cement, fertilizer, chemical and paper industries. The low quality of Chhattisgarh coal (high ash, low calorific value) makes it undesirable for coking coal. These coals are mostly power coals and suitable for power generation.

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CONFLICT OF INTEREST:
The authors declare that they have no conflict of interest.

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