A
Minor Project Report
On
"Coal Quality of Different samples (Singrauli)"
In Partial fulfilment of the requirement for the
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Candidate's Declaration

We hereby declare that the project report – "Coal Quality of different samples (Singrauli)" minor project – 2 (170602) 6th semester in "MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR (MP) is our genuine work done under the guidance of prof. Swati Gupta, Dept. of chemical engineering, "Madhav Institute of Technology & Science ", Gwalior.

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CERTIFICATE

This is to certify that the above declaration made by the candidate's is correct of my knowledge.

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<u>Acknowledgement</u>

The satisfaction that accompanies the successful completion of this project would be in complete without the mention of the people who made it possible, without whose constant guidance and encouragement would have made efforts go in vain. I consider myself privileged to express gratitude and respect towards all those who guided us through the completion of this project.

We convey thanks to my project guide **Prof. Swati Gupta ,** Head of Chemical Engineering Department for providing encouragement, constant support and guidance which was of a great help to complete this project successfully

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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. India has some of the largest reserves of coal in the world. Indian coal has high ash content and low calorific value. However, with the present rate of around 0.8 million tons average daily coal extraction in the country, the reserves are likely to last over a 100 years. 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.

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Chapter – 1

❖ Introduction

INTRODUCTION

Coal is the world's most abundant and widely distributed fossil fuel. It is a global industry that makes a significant economic contribution to the global economy. 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 . [1]

Although coal deposits are widely distributed, more than 58% of the world's recoverable reserves are located in four Partners: The United States (27%), China (13%), India (10%) and Australia (8.7%).

 Coal produces 40% of the world's electricity, which is double the share of its nearest competitors (gas and hydro) and coal is an essential element in over 65% of the world's steel production. These proportions are expected to remain at similar levels over the next 30 years.

Chapter – 2

❖ Objective

OBJECTIVE

The objective of this project work is to analyze the quality of various Indian Coals 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

Keeping this in view the objectives of the project work has been formulated as:

♣ Collection of coal samples from different mines
♣ Determination of different properties of coal samples in the laboratory by proximate analysis

Chapter -3

❖ Literature Review

What is coal ?

Coal is a combustible black or brownish-black sedimentary rock with a high amount of carbon and hydrocarbons. Coal is classified as a non-renewable energy source because it takes millions of years to form. Coal contains the energy stored by plants that lived hundreds of millions of years ago in swampy forests.

Types of coal

The ranking depends on the types and amounts of carbon the coal contains and on the amount of heat energy the coal can produce. The rank of a coal deposit is determined by the amount of pressure and heat that acted on the plants over time.

Coal is classified into four main types, or ranks.

1)Anthracite :

- It contains 86%–97% carbon and generally has the highest heating value of all ranks of coal
- Anthracite is mainly used by the metals industry

[2]

2) Bituminous :

- Bituminous coal contains 45%–86% carbon.
- Bituminous coal is used to generate electricity and is an important fuel and raw material for making coking coal or use in the iron and steel industry.

[2]

3) Subbituminous :

- Subbituminous coal typically contains 35%–45% carbon, and it has a lower heating value than bituminous coal.

4) Lignite :

- Lignite contains 25%–35% carbon and has the lowest energy content of all coal ranks.
- Lignite is mostly used to generate electricity

[2]

Chapter – 4

❖ Methodology

COAL ANALYSIS

Coals are tested prior to being used. Some markets require specific quality characteristics for the process in which the coal is used, and environmental regulations also require knowledge of a coal's quality. Some products also require analysis of physical characteristics of coals for handling or processing.

TYPES OF COAL ANALYSIS

There are two methods to analyse coal which are called proximate analysis and ultimate analysis.

PROXIMATE ANALYSIS :

The proximate analysis indicates the percentage by weight of fixed carbon, volatiles, ash, and moisture content in coal. The amounts of fixed carbon and volatile combustible matter directly contribute to the heating value of coal. The fixed carbon acts as a main heat generator during burning. The high volatile matter content indicates easy ignition of fuel and the ash content is important in the design of the furnace grate, combustion volume, pollution control equipment and ash handling systems of a furnace. [3]

ULTIMATE ANALYSIS :

The ultimate analysis of coal involves determination of the weight percent carbon as well as sulphur, nitrogen, and oxygen (usually estimated by difference). Trace elements that occur in coal are typically included as a part of the ultimate analysis.

Experiment performed in laboratory :

Aim : To carry out proximate analysis of given coal of 1.18 gm

Apparatus Required : Furnace , muffle furnace , coal sample , dessicator , silica crucible and long legged tongs

Procedure :

1. Clean the crucible ,dry and weight.

2. Dry coal sample in air, transfer 1 g, of coal sample to the crucible and weigh it again.

3.Keep the crucible in the electric oven maintained at 105-110 °C for about 1 hour.

4.After heating, remove the crucible, put into a desiccator for cooling & weigh it.

5.The difference in the weight is reported in % as the amount of inherent moisture in coal.

6. Heat the dried sample of coal covered with a lid in a muffle furnace maintained at 925+ 20°C for around 7-10 minutes. Cool and weigh after putting the crucible first in air, then into the desiccator for some times, loss in weight corresponds to volatile matter content.

7.Heat the above treated sample in the crucible without lid inside the muffle furnace at 700 = 50°C for half an hour or until a constant weight is obtained.

8.Cool as usual and weigh the amount. The residue is reported as ash   on percentage basis.

Observation :

Wt. of empty crucible = 20 gm.

Wt. of empty crucible + sample-21.18 gm.

Wt. of Sample=Y-X-1.18 gm

sample, after heating at 105-110 °C = 1.10 gm

sample, after heating at 925 -9520 °C = 0.99 gm

sample, after heating at 700-750 °C= 0.63 gm.

Calculation

Moisture content : It is the weight loss or heating and expressed in the percentage as

% of moisture=loss in weight / weight of sample *100

$$= 1.18\text{-}1.10 / 1.18 * 100$$

$$=6.77\%$$

Volatile matter : It is not a constituent of coal, but it consists of a complex mixture of gaseous and liquid products resulting from the thermal decomposition of the coal substance. A high volatile matter containing coal bums with a long fame high smoke and has low calorific value. Hence lesser the volatile matter. better the quality of the coal

% of v.m = loss in weight due to V.M / weight sample *100

=1.10-0.99 / 1.18 * 100

=9.32%

Ash : It is a useless, non a combustible matter left after burning of the organic matter from the coal. It is usually consists of silica alumina, iron oxide and small quantities of lime magnesia etc. Ash reduces the heating value of a cool. The presence of ash also early wear of furnace walls, burning of apparatus, feeding mechanism and production cost. So lower the ash contain, better the quality of coal .

% of Ash = weight of ash left / weight of sample * 100

= 0.63 / 1.18 *100

=53.38%

Fixed Carbon : The amount of fixed carbon increases from low ranking coals to high ranking coals Le. peat to anthracite side. More the amount of fixed carbon in coal more will be its calorific value .

% of carbon = 100- % of (moisture + V.M + ash)

=30.53%

Results: Proximate analysis of given sample of coal has given the following results.

% of Moisture =6.77

% of Volatile matter= 9.32

% of Ash=53.38

% of Fixed carbon= 30.53

Precaution :

•The weighing should be taken upto 4 decimal place.

•After the heating, the crucible should be removed with the help of long legged tongs carefully.

The heating should be done by raising the temp. at slow rate.

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 provide with two electrodes and an oxygen inlet 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. [4]

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. Page | 20 Oxygen supply is forced into the bomb till a pressure of 25-30 atm 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

Coal mining in India

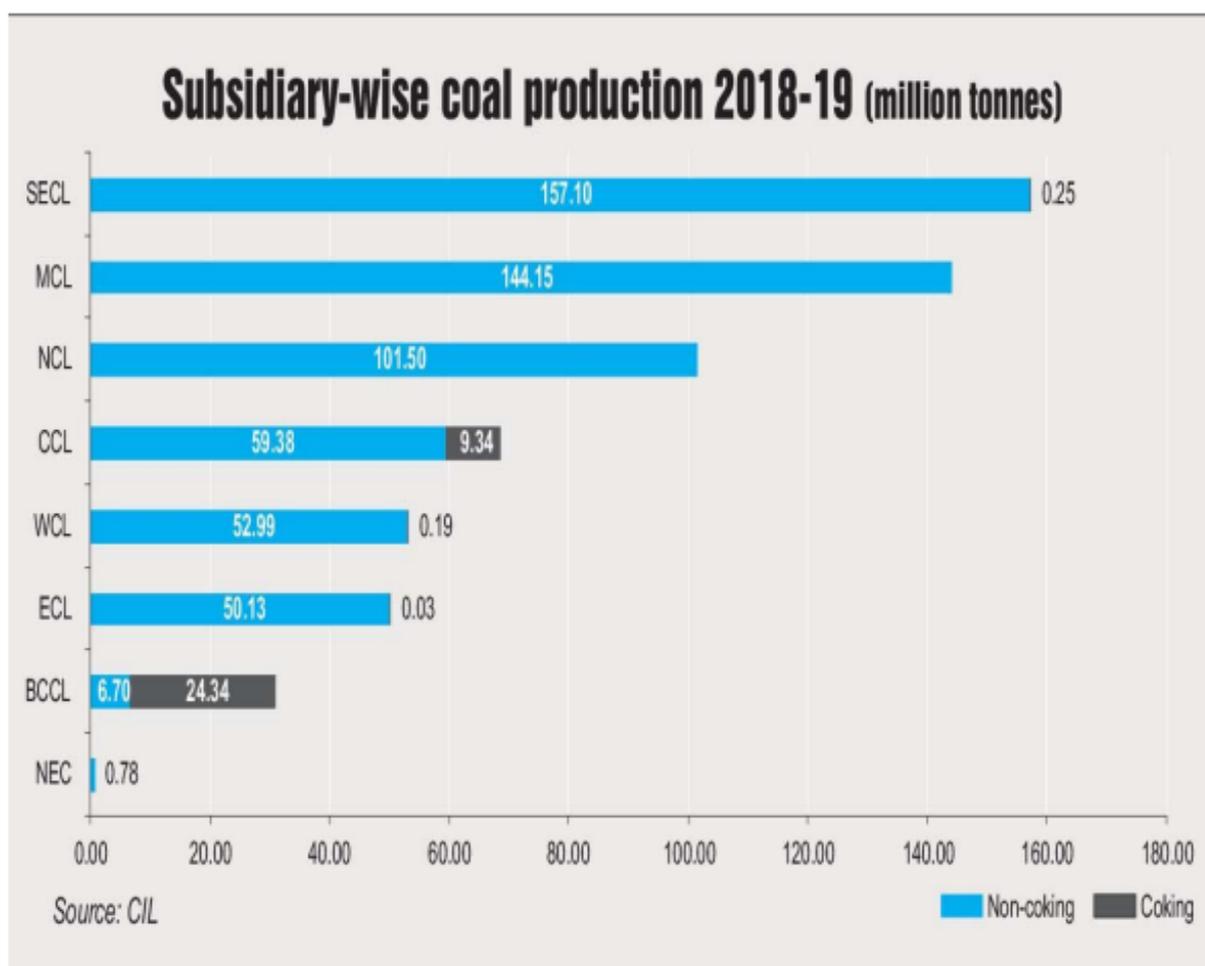India has abundant domestic reserves of coal. Most of these are in the states of

- Jharkhand
- Odisha
- West Bengal
- Bihar
- Chhattisgarh,
- Telangana
- Madhya Pradesh.

S.NO	STATE	COAL RESERVES (MILLION TONNES)	COAL PRODUCTION (MILLION TONNES)
1.	Chhattisgarh	52,533	127.095
2.	Jharkhand	80,716	113.014
3.	Odisha	75,073	112.917
4.	Madhya Pradesh	25,673	75.59
5.	Andhra Pradesh	22,468	50.469
6.	Maharashtra	10,964	37.223
7.	West Bengal	31,318	28.242
8.	Uttar Pradesh	1,062	14.721
9.	Meghalaya	576	5.732
10.	Assam	515	0.664

[5]

Coal India Subsidiaries

- Eastern Coalfields Limited (ECL)
- Bharat Coking Coal Limited (BCCL)
- Central Coalfields Limited (CCL)
- Western Coalfields Limited (WCL)
- South Eastern Coalfields Limited (SECL)
- Northern Coalfields Limited (NCL)
- Mahanadi Coalfields Limited (MCL)

Subsidiary-wise coal production 2018-19 (million tonnes)

Subsidiary	Non-coking	Coking
SECL	157.10	0.25
MCL	144.15	
NCL	101.50	
CCL	59.38	9.34
WCL	52.99	0.19
ECL	50.13	0.03
BCCL	6.70	24.34
NEC	0.78	

Source: CIL

[6]

Chapter-5

- ❖ Result
- ❖ Discussion and Conclusion

Proximate Analysis of Coal Samples :

SAMPLE NO.	MOISTURE (%)	VOLATILE MATTER (%)	ASH (%)	FIXED CARBON (%)
1	4.5	25.04	34.56	24.6
2	6.65	28.25	26.92	34.92
3	5.24	25.01	33	37.1
4	5.09	26.06	43.18	25.32
5	6.64	33.82	25.67	38.23
6	5.39	28.86	34.85	30.9
7	8.24	33.96	8.84	53.16
8	13.15	24.95	33.57	28.38
9	11.18	25.07	39.85	24.58
10	4.45	27.87	36.19	31.51
11	6	26.74	28.1	39.16
12	5	29.01	37.6	28.7
13	2.4	23.27	52	22.6
14	4.45	25.01	44.02	26.68
15	8.39	31.4	33.42	27.81

The proximate analysis of all the 15 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 .

 It may be observed from figure that the sample no.8 has the highest moisture content (13.15%) and sample no.13 has the lowest(2.4%). 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 (33.82% and 33.96%) respectively, where as sample no .13 has the lowest volatile matter content (23.27%). 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 form 8.845 for sample no. 7 to 52% for sample no. 13. 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 22.6% (sample no. 13) and 53.16% (sample no. 7). It could be observed from table that the fixed carbon content of 14 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.

Result of calorific value :

SAMPLE NO.	Gross calorific value (Kcal)	Net calorific value (Kcal)
1	3896	3596
2	4558	4258
3	4796	4496
4	4469	4169
5	4623	4323
6	3871	3571
7	4821	4521
8	4345	4045
9	4268	3968
10	5003	4703
11	4963	4663
12	3962	3662
13	3645	3345
14	3692	3392
15	4538	4238

The calorific value was found out using bomb calorimeter. It was found that sample no.10 and 11 have 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 nos. 13 & 14 were found to have the Page | 42 low calorific values, they also have the ash% in the higher range. It could be inferred that sample nos. 10, 11 are better for fuel purposes than rest of the samples.

Conclusion

It could be observed from this study that 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 grindability index of majority of the coal samples being low they are vey difficult to grind as well. The calorific values of the coals vary between 3345 kcal to 4703 kcal. A few of these coals could be washed easily, but for majority of the samples the washing problem varies between very difficult to formidable. Thus all these coals could be used ion 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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