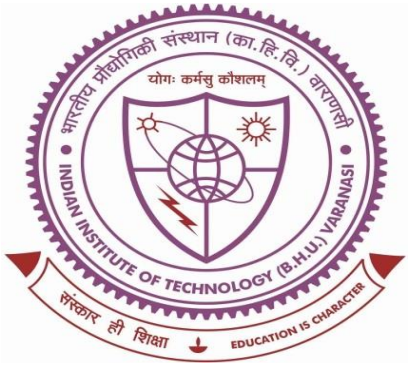
CHEMICAL CHARACTERIZATION AND BENEFICIATION OF PERMIAN COAL FROM SINGRAULI COALFIELD, INDIA



Thesis submitted in partial fulfillment for
the Award of Degree

Doctor of Philosophy

By

Ankur Dwivedi

DEPARTMENT OF MINING ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY
(BANARAS HINDU UNIVERSITY)
VARANASI – 221005
INDIA

Roll No. : 15151501 **2023**

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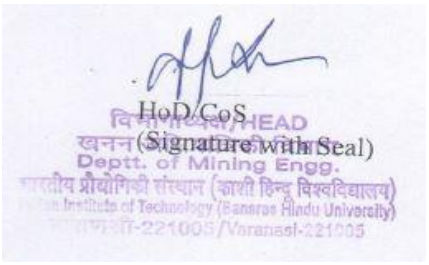

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Department of Mining Engineering

Indian Institute of Technology (BHU), Varanasi

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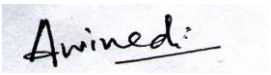

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It is certified that the above statement made by the student is correct to the best of my/our knowledge.

Supervisor **Head of Department**

(Amrendra Kumar)
Associate Professor
Department of Mining Engineering
Indian Institute of Technology
(Banaras Hindu University)
Varanasi -221005, India

(Professor Suprakash Gupta)

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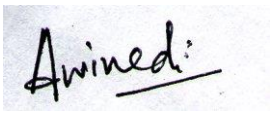

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Date: 22.07.2022 Ankur Dwivedi

Dedicated in the honour of late Professor M. P. Singh, a renowned international coal scientist

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SYMBOLS AND ABBREVIATIONS

NCL	:	Northern Coalfield Limited
NTPC	:	National Thermal Power Corporation
AMD	:	Acid Mine Drainage
CFA	:	Coal Fly Ash
FA	:	Fly Ash
WCA	:	World Coal Association
NCL	:	Northern Coalfields Limited
CIL	:	Coal India Limited
CCT	:	Clean coal technology
ROM	:	Run-of-mine
SEM	:	Scanning electron microscopy
XRD	:	X-ray Diffraction
TEM	:	Transmission electron microscopy
FTIR	:	Fourier transform infrared spectroscopy
XPS	:	X-ray photoelectron spectroscopy
EDS	:	Energy dispersive spectroscopy
IEA	:	International Energy Agency
ASTM	:	American Society for Testing and Materials
GDP	:	Gross domestic product
TG_{spi}	:	Thermogravimetric index (% $°C^{-1}$ min^{-1})
TGA	:	Thermogravimetric analysis
TG	:	Thermogravimetry
DSC	:	Differential Scanning Calorimetry
DTG	:	Derivative thermogravimetry
wt %	:	Weight percent
ad	:	Air dried basis
daf	:	Dry ash free basis

GSI	:	Geological Survey of India
HI	:	Hydrogen Index
WCA	:	World Coal Association
FC	:	Fix Carbon
VM	:	Volatile Matter
BT	:	Billion Tonnes
MT	:	Million Tonnes
DES	:	Deep Eutectic Solvents
GCV	:	Gross Calorific Value
T	:	Temperature (°C)
T_o	:	The starting temperature value of the thermo-analytical measurement
HR	:	Heating rate
FR	:	Fuel ratio
T	:	Time (min)
C	:	Carbon
H	:	Hydrogen
N	:	Nitrogen
O	:	Oxygen
S	:	Sulfur
Hg	:	Mercury
U	:	Uranium
Th	:	Thorium
As	:	Arsenic
Zn	:	Zinc
Mg	:	Magnesium
CO_2	:	Carbon dioxide
CO	:	Carbon monoxide
CH_4	:	Methane

H_2O	:	Water
km	:	Kilometer
m	:	Meter
cm	:	Centimeter
%	:	Percentage
°C	:	Degree Celsius
µm	:	Micro meter
km^2	:	Square kilometer

PREFACE

Coal in Singrauli occurs in different basins. The qualitative and quantitative studies of these coals have been insufficient to understand the nature and type of coal. Five coal fields, namely Bina, Kakri, Krishnshila, and Jayant Dudhichua, have productive open-cast mines and have been selected for the study. In the present work, the main emphasis has been laid on the chemical and mineralogical aspects. The proximate analysis involves the study of moisture, ash, VM, and fixed carbon, and the ultimate analysis measures the elemental composition of coal. In addition to X-ray diffraction and Fourier Transmission Infrared Radiation, XPS, SEM and Raman spectroscopy were used, and an attempt was made to determine the quantitative distribution of each organic and inorganic constituent of coal. Finally, the present study aims to classify the Singrauli coal according to available Indian classification schemes and to focus on the chemical beneficiation and potential utilization of this coal and derived fly ash with less harm to the environment. The entire work has been divided into nine chapters.

Chapter 1 Provides an introduction of the available literature on the Gondwana coal with a description of the other coals in India.

Chapter 2 deals with the exhaustive literature review of past studied in chemical quality of coal and its chemical beneficiation.

Chapter 3 The geological setting and geography has been presented in this section with the description of the mode of occurrence of coal seams in Singrauli Basins.

Chapter 4 includes the detail of sample collection procedure and various methodologies adopted to study coal and fly ash.

Chapter 5 The Experimental study and results of analyzed data have been presented in this section.

Chapter 6 gives an insight into the beneficiation of coal using choline, chloride, and urea-based deep eutectic solvent.

Chapter 7 the discussion of the entire analytical results has been presented in this chapter.

Chapter 8 reports the conclusion based on the research work. The entire work has been summarized. Finally, some recommendations for future work have also been incorporated in this chapter of the thesis.