कोल इण्डिया
Coal India

सीएमपीडीआई
मिनी रत्न
cmpdi
Mini Ratna

खण्ड 45 अंक 3 जुलाई-सितम्बर, 2024
Volume 45, No.3 July-September, 2024

ISSN 0970-7204

खनन विज्ञान
minetech

Special Issue
on
Environment and Sustainability
in
Coal Sector

ISSN 0970-7204

खनन विज्ञान minetech

सीएमपीडीआई प्रकाशन

वार्षिक शुल्क : ₹ 800 (Handling and postage charges ₹ 50 per copy extra)

A CMPDI PUBLICATION
Inland ₹ 800 (Annually) (Handling & postage charges ₹ 50 per copy extra)
Overseas US $ 200 (including airmail)

For free internal circulation within CIL Subsidiaries

खनन, गवेषण एवं सम्बन्धित विषयों का मुख्य भारतीय त्रैमासिक

कोड नं. 015 : 8/एमटी

खण्ड : **पैतालिस**

अंक : **तीन**

जुलाई-सितम्बर, 2024

India's premier quarterly journal of mining, exploration and allied subjects

Code No. 015 : 8 / MT

Volume : **Forty five**

Number : **Three**

July-September, 2024

प्रकाशक

सेन्ट्रल माइन प्लानिंग एंड डिजाइन इन्स्टीच्यूट लिमिटेड,
गोंडवाना प्लेस, काँके रोड,
राँची - 834 008

Published by

CENTRAL MINE PLANNING & DESIGN INSTITUTE LIMITED,
GONDWANA PLACE, KANKE, ROAD,
RANCHI - 834 008

मुद्रक :

कैलाश पेपर कन्वर्शन प्रा. लि.,
3 पार्ट कोकर इण्डस्ट्रियल एरिया, राँची-834001

Printed at

Kailash Paper Conversion Pvt. Ltd.
3rd Part, Kokar Industrial Area, Ranchi-834001

मनोज कुमार
अध्यक्ष-सह-प्रबंध निदेशक

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सेंट्रल माईन प्लानिंग एण्ड डिजाईन इंस्टीच्यूट लिमिटेड
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गोन्डवाना प्लेस, काँके रोड, राँची-834031, झारखण्ड (भारत)
Central Mine Planning & Design Institute Limited
(A Subsidiary of Coal India Limited / Govt. of India Public Sector Undertaking)
Gondwana Place, Kanke Road, Ranchi-834031, Jharkhand (INDIA)
CORPORATE IDENTITY NUMBER - U14292JH1975GOI001223

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Message

In the midst of an ever-changing global landscape, the theme of environment and sustainability has never been more pertinent. India is leading the way in showcasing an ambitious path balancing economic and social development along with its commitment towards environmental protection and sustainability.

As we grapple with the growing challenges of a growing economy and social aspirations, clubbed with the threat of climate change, biodiversity loss, and resource depletion, the need for sustainable and environmentally conscious development is paramount.

The coal sector is mindful of the same, and there is an increasing thrust towards sustainable coal mining and efforts to reduce the emission intensity from mining operations. The Indian coal sector has been making concerted efforts to bridge the demand-supply gap and ensure uninterrupted coal availability while at the same time promoting responsible mining practices.

In this context, I'm happy to note that CMPDIL is publishing this special issue of "MineTech" magazine with an aim to present themes from the domain of "Environment and Sustainability in the Coal Sector". I sincerely hope that the knowledge and ideas presented in this compilation serve as a beacon of hope, guiding us towards a future where coal mining and environmental sustainability are not mutually exclusive but can coexist harmoniously.

I extend my greetings and best wishes to the authors, officials of Environment Division as well as IMS Department of CMPDI for their dedication and hard work put in to bring out this special edition on Environmental Sustainability in the coal sector.

(Manoj Kumar)

शंकर नागाचारी
निदेशक तकनीकी (सी.आर.डी.)

Shankar Nagachari
Director Technical (CRD)

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Message

The coal sector in India has long been a cornerstone of the nation's energy security, driving industrial growth and economic development. However, the environmental impact of coal mining and usage has raised significant concerns, necessitating a shift towards more sustainable coal mining practices.

In line with India's Panchamrit Commitments announced at COP26, the coal sector is also exploring the potential of integrating renewable energy sources and increasing thrust on cleaner coal technologies apart from focus on reduction in emission intensity & compliance of regulatory prescriptions for coal mining operations. Through policy reforms, technological advancements, and collaborative initiatives, the industry is striving to minimize its environmental impact while continuing to meet the nation's energy demands.

CMPDIL, being a premier consulting organisation, plays a crucial role in promoting sustainable coal mining practices in India through planning and design of environmentally sustainable mining operations, undertaking environmental impact assessments, and developing effective mitigation strategies to minimize the adverse effects of mining activities.

For the same reason, I'm truly glad that CMPDI is bringing out this special edition of our in-house magazine, "MineTech" along the theme of "Environment & Sustainability in the Coal Sector". It is my sincere hope that this compilation will not only inform and educate but also inspire a sense of urgency and responsibility in addressing the environmental challenges we face in coal sector.

Together, through informed action and collaborative efforts, we can build a sustainable future for all.

(Shankar Nagachari)

अजय कुमार
निदेशक तकनीकी (पीएंडडी/आरडीएण्डटी)

Ajay Kumar
Director Technical (P&D/RD&T)

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Message

India's coal mining sector has been a vital contributor to the country's industrial and economic growth, providing essential energy resources that have fuelled national development and uplifting standard of living. However, given the advent of challenges of climate change and environmental degradation, it is imperative for the coal sector to balance the need for coal production with environmentally conscious mining operations.

The transition to more sustainable practices within this industry is not only necessary but also achievable through innovative approaches, technological advancements, and unwavering commitment from all stakeholders involved. The Indian coal sector has made significant progress in adopting eco-friendly mining technologies and implementing sustainable projects involving afforestation and eco-restoration of mined out areas with an aim to restore the ecological balance in mining-affected areas.

I am pleased to learn that CMPDI is bringing out a special edition of "Minetech" on "Environment & Sustainability in the Coal Sector". I hope that this edition of magazine will not only inform and educate but also inspire meaningful action and collaboration among all stakeholders.

My best wishes to the entire team of Environment Department and Publication Departments of CMPDI for bringing out this special edition.

18/03/2025

(Ajay Kumar)

इंदर पाल सिंह मथारू
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Ministry of Environment, Forest and Climate Change

Message

It is undeniable that coal has been a cornerstone of India's energy needs and economic growth. At the same time, it is equally essential to recognize our responsibility toward conserving the environment and safeguarding our invaluable forests.

The relationship between coal mining and environmental impact has been a subject of scrutiny, urging us to adopt innovative approaches that strike a balance between resource extraction and ecological conservation.

The preservation of forests is of utmost importance for India and this requires a paradigm shift in how we plan, execute, and monitor coal-related projects. It is imperative to promote practices that ensure minimal disruption to forest ecosystems, protect biodiversity, and prioritize afforestation efforts that compensate for any ecological loss.

In this context, I would like to express my pleasure at this special issue of "MineTech" magazine being published by CMPDIL along the theme of "Environment and Sustainability in the Coal Sector".

I sincerely hope that the coal sector continues to imbibe environmental sustainability in its operations and implements latest developments in this area in order to preserve and protect our environment & forest assets.

(Inder Pal Singh Matharu)

MINETECH

Volume 45, No. 3 July-September, 2024, ISSN-0970-7204

Assessment of Ecological indicators in reclaimed sites of Open Cast Coal Mining Site

Abhisht Raj[1], Nirbhay Bhatnagar[2]

Abstract

India's dependence on coal, fuelled by its plentiful reserves and widespread availability, has led to extensive mining operations, primarily through surface mining techniques. While these activities contribute significantly to the country's energy needs, they come at a considerable environmental cost. Surface mining, accounting for over 90% of mining operations, inflicts substantial damage to the natural landscape. These widespread environmental consequences necessitate a shift towards sustainable practices in India's coal mining industry. This includes actively restoring mined land to a functional ecosystem through re-vegetation, soil amendment, and habitat reconstruction. Utilizing technologies that minimize land disturbance, reduce waste generation, and facilitate efficient resource extraction. Diversifying India's energy portfolio by promoting renewable energy sources like solar and wind power to reduce reliance on coal.

By adopting these sustainable practices, India can mitigate the environmental damage caused by coal mining while ensuring its energy security for the future. A case study of ecological restoration in open cast coal mining in India is presented in this paper.

Background:

Extensive coal mining operations, driven by its abundance and widespread distribution, have resulted in significant environmental impacts, particularly in India. Surface mining techniques, employed for the extraction of coal and other minerals, account for over 90% of mining activities, causing substantial alterations to the natural landscape. These disturbances often lead to soil erosion, biodiversity loss, soil fertility decline, and ecosystem carbon (C) pool depletion.

In alignment with the United Nations' Decade of Ecosystem Restoration, reforestation initiatives have gained global attention, particularly for their potential to mitigate global warming and enhance carbon sequestration. Afforestation, when implemented with appropriate plant species, serves as a viable approach to restore mine-degraded ecosystems and generate socioeconomic benefits for stakeholders. Reclamation, an essential practice in geotechnical stabilization of

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overburden dumps, plays a crucial role in 'C' and nutrient stock recovery, aesthetic improvement, resistance to mine fire hazards, ecosystem service generation, sustainable land utilization, and partial mitigation of global warming through enhanced CO_2 sequestration.

Benefits and Challenges of Ecological Restoration in Coal Mines:

Ecological restoration in coal mines offers a range of environmental and economic advantages. Vegetation planted during the process can filter pollutants from the air and water, improving environmental quality. Plant cover also stabilizes the soil, preventing erosion and preserving fertility. This, in turn, leads to increased biodiversity as restored landscapes offer new habitats for wildlife. Additionally, trees and other plants absorb carbon dioxide from the atmosphere, mitigating climate change. Moreover, reclaimed land can be used for various purposes, including agriculture, forestry, or recreation, boosting land productivity and economic opportunities. Finally, restoration efforts can create a more aesthetically pleasing landscape, enhancing the local environment and attracting tourism.

Despite these significant benefits, challenges remain in implementing successful restoration projects. One key hurdle is funding, as these initiatives require substantial financial resources. Additionally, technological limitations often hinder effective and efficient restoration processes, necessitating further research and development. Furthermore, a lack of awareness often leads to limited public support for restoration projects. Finally, strengthening laws and regulations is crucial to ensure the effective implementation and enforcement of restoration plans. Addressing these challenges will require collaboration between government agencies, mining companies, environmental NGOs, and local communities. By working together, stakeholders can develop and implement effective restoration strategies that secure a sustainable future for India's coal mines and their surrounding environment.

A Case Study of Ananta OCP Mines for ecological monitoring:

A study on long term ecological restoration due to progressive mine closure and plantation activities in one of the mines of Talcher Coalfield has been taken up for 3 years. Continuous permanent ecological monitoring stations were used to collect soil and ecological data in the varied seasons. The research work was jointly taken up by CMPDI, Ranchi and IIT (ISM), Dhanbad. The young, intermediate and older ecosystem were assessed in terms of soil nutrients, organic matter, vegetation composition, biomass enhancement and Carbon sequestration potential. The ecosystem C- pool study showed the improvement in carbon accumulation potential of reclaimed ecosystems.

About Study area :

The study was carried out in the Ananta open cast project (20.95489 to 20.98256 N and 85.14562 to 85.14814 E), Angul district located in Talcher Coalfield, MCL, Odisha, India. For continuous monitoring of ecological changes due to open cast coal mine five reclaimed sites were taken named as ecological monitoring station (EMS) and one 'Sal Forest' was also taken as a control site. Talcher coalfields represent the south eastern part of Gondwana basin surrounded by igneous and metamorphic rocks, and produce non-coking coal (sub-bituminous to high-volatile bituminous type). The method of mining is opencast mining by shovel-dumper combination for the OB removal and dumping, while surface-miner, loader and tipper were used for excavation and loading of coal. The average stripping ratio is 1:2.2 (Coal:OB) and average gradient is 2^o-4^o. External OB dumps and back-filled areas are technically reclaimed (like, regarding slope formation and digging of plantation pits filled with topsoil) and planted with saplings of fast growing tree species.

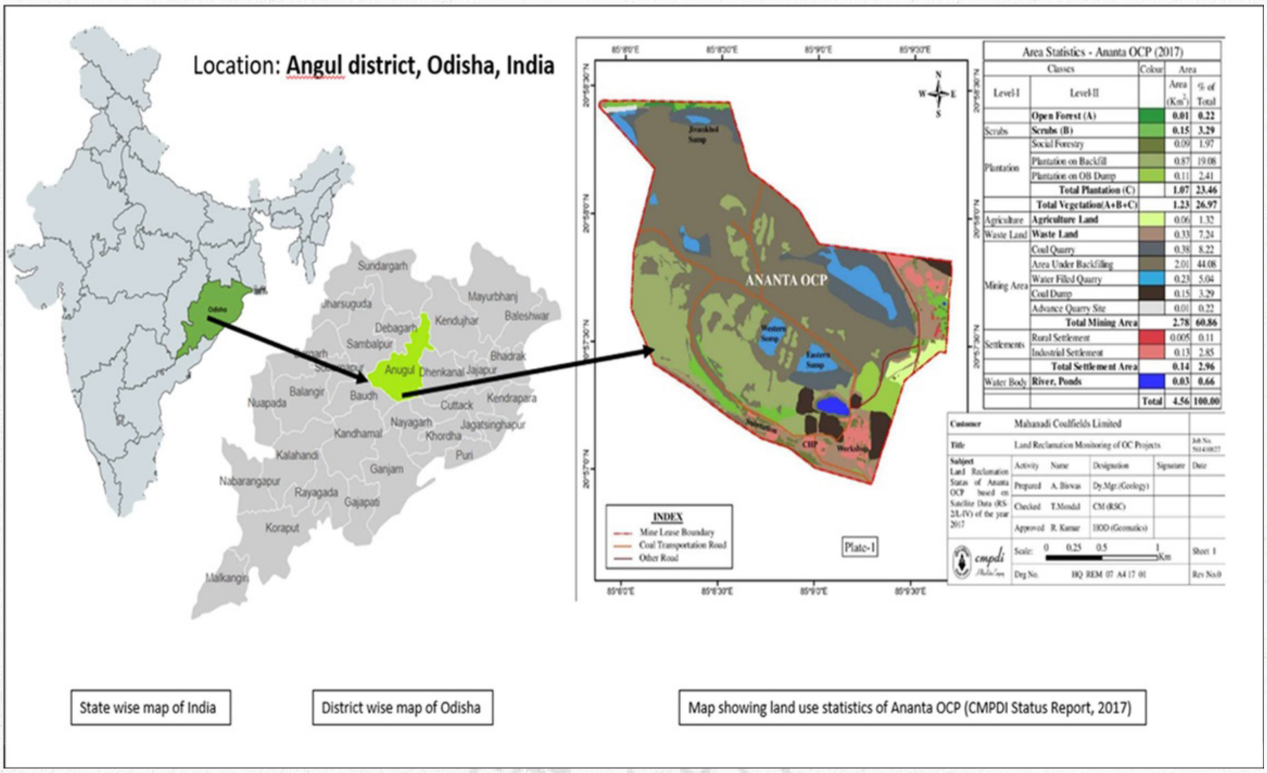


Figure 1: Location of Study Area

Methodology adopted for Study:

Six Ecological Monitoring Sites (EMSs) were selected on the basis of age of reclamation and vegetation cover. The age of reclamation found from 5years to 30 years old. Soil Samples have been collected from the sampling plots during the field visit on Sep' 2021 to Dec' 2022.

Sl No.	Study site	Location
1	Ecological Monitoring Site – 1 (EMS – 1)	20.95875N, 85.14814E
2	Ecological Monitoring Site – 2 (EMS – 2)	20.95571N, 85.14562E
3	Ecological Monitoring Site – 3 (EMS – 3)	20.95572N, 85.14679E
4	Ecological Monitoring Site – 4 (EMS – 4)	20.95489N, 85.14792E
5	Medicinal Garden	20.95496N, 85.14765E
6	Control Forest	20.98256N, 85.12690E

Following procedures were used during the survey:

i. The sampling has been done by 10 m × 10 m quadrates at different sites.

ii. The details of vegetation (types of plant, DBH, and height of plant) has been collected during sampling at site of study area.

iii. Soil sample were also collected from all sites.

iv. Soil sampling was carried out by standard methods (Maiti 2013) and samples were collected on profile basis (0-15 cm, 15-30 cm).

v. Soil was transported to Ecological Restoration Laboratory, IIT (ISM), Dhanbad and allowed to be air dried for 7 days and prepared for analysis of physical and chemical soil quality parameters.

vi. Soil was transported to Ecological Restoration Laboratory, IIT (ISM), Dhanbad and allowed to be air dried for 7 days and prepared for analysis of physical and chemical soil quality parameters.

Biodiversity analysis:

A diversity index is a quantitative measure that reflects how many different types (such as species) there are in a dataset (a community), and that can simultaneously take into account the phylogenetic relations among the individuals distributed among those types, such as richness, divergence or evenness. These indices are statistical representations of biodiversity in different aspects (richness, evenness, and dominance). The Shannon-weiner diversity index, Simpson's dominance index, Margalef's richness index have been used to assess the biodiversity in each reclaimed sites.

Estimation of SOC stock

Soil contains approximately 75% of the terrestrial 'C' pool, which is three times more than the amount stored in living plants and hence it plays a vital role in global 'C' cycling. Corrected bulk density was taken into account to determine 'C' stored in EMS to overcome the interferences due to non-soil fraction and determined as follows:

$$\text{Corrected bulk density}(\text{mg m}^{-3}) = \frac{\text{Soil mass (mg) X fine earth fraction (\%)}}{\text{Volume of core (m}^3\text{) X 100}} \quad \text{Eq. 1}$$

SOC stock of the revegetated sites was calculated by considering SOC concentration, corrected bulk density, fine earth fraction and thickness of the soil layer:

$$\text{SOC stock (t ha}^{-1}\text{)} = \frac{[\text{SOC\% X BD}_{corr}\text{ (g cc}^{-1}\text{) X T (m) X }10^4\text{ (m}^2\text{ha}^{-1}\text{)}}{100} \quad \text{Eq. 2}$$

where SOC = soil organic carbon concentration;
BD_{cor} = corrected bulk density,
T = soil profile.

Estimation of tree biomass, litter biomass and associated carbon stock:

Terrestrial ecosystems are the third largest global carbon pool only after the ocean and geological carbon pool. Estimation of vegetation carbon stock emphasize the magnitude and direction of changes in the terrestrial carbon pool of reclaimed site. The above ground biomass (AGB) C-stock consists of all living vegetation above the soil, inclusive of stems, branches, bark, seeds and foliage, while the below ground biomass (BGB) C-stock consists of the biomass contained within live roots. Several allometric equations were used to estimate the tree above ground biomass (AGB), however, most of them were species-specific. Usually, the allometric equation for AGB estimation is reported as a function of DBH (diameter at breast height), wood density and tree height, but this often differs for a wide range of forest type and climatic conditions. For the present study, a local empirical equation, developed by Brown et al. (1989) was employed to estimate tree biomass (Eq. 3)

The contribution of root 'C' stock (BGB) depends on root productivity, turnover rates, exudation, mycorrhizal colonization, and soil characteristics, that vary with vegetation species, environmental condition and reclamation age. Santantonio et al. (1977) suggest that the root biomass (BGB) is close to 20% of the total AGB that indicates the presence of heavy root architecture (> 2mm diameter) in majority of root biomass of the forest species. However, in present study, BGB was calculated by assuming that it contributes 20% of total AGB.

Where, Y = AGB in kg, DBH = diameter at breast height in cm.

$$Y = \exp[-1.996+2.32 \times \ln(DBH) \quad \textbf{Eq. 3}$$

$$\text{Root biomass (BGB,Kg)} = \text{AGB} \times 0.2 \quad \textbf{Eq. 4}$$

$$\text{Total Tree biomass (AGB+BGB) Carbon content (C)} = \text{Total biomass} \times 0.5 \quad \textbf{Eq. 5}$$

Estimation of C sequestration:

Across the globe, studies on 'C' sequestration through reclaimed coal mine soils have received considerable attention. The equivalent CO_2 sequestration in reclaimed mine soil is calculated by estimating C-stock of biomass (above ground and below ground), litter and reclaimed mines soils. Carbon pools play an important role in the global carbon cycle and climate change. They act as both a source and sink of atmospheric carbon, meaning they can take in carbon from the atmosphere and release it back into the atmosphere. The ecosystem carbon pool (ECP) was estimated by accumulation of C-stock present in different ecosystem component (tree biomass carbon, SOC for present study) with the following equation (Eq. 6):

$$\text{Ecosystem Carbon Pool} = \text{Tree biomass C+SOC}_{(0\text{-}30\ cm)}\text{+litter biomass c} \quad \textbf{Eq. 6}$$

The equivalent amount of CO_2 sequestered in revegetated sites was calculated by the factor of 3.66 (Molecular Weight of CO_2: Molecular Weight of C) with the following equation (Eq. 7):

$$\text{Equivalent } CO_2 = \text{Ecosystem carbon pool} \times 3.66 \quad \textbf{Eq. 7}$$

Details of soil samples collected from the study area:

Size of Ecological sampling Quadrate: 100 m^2 (10 m ×10 m) was laid down in each EMS and reference forest site (Control). From each quadrate, 5 soil samples were collected on profile basis (0-15 cm and 15-30 cm

Figure 2: Field Photographs of quadrate sampling and soil sampling protocol (EMS)

Soil Sample Protocol

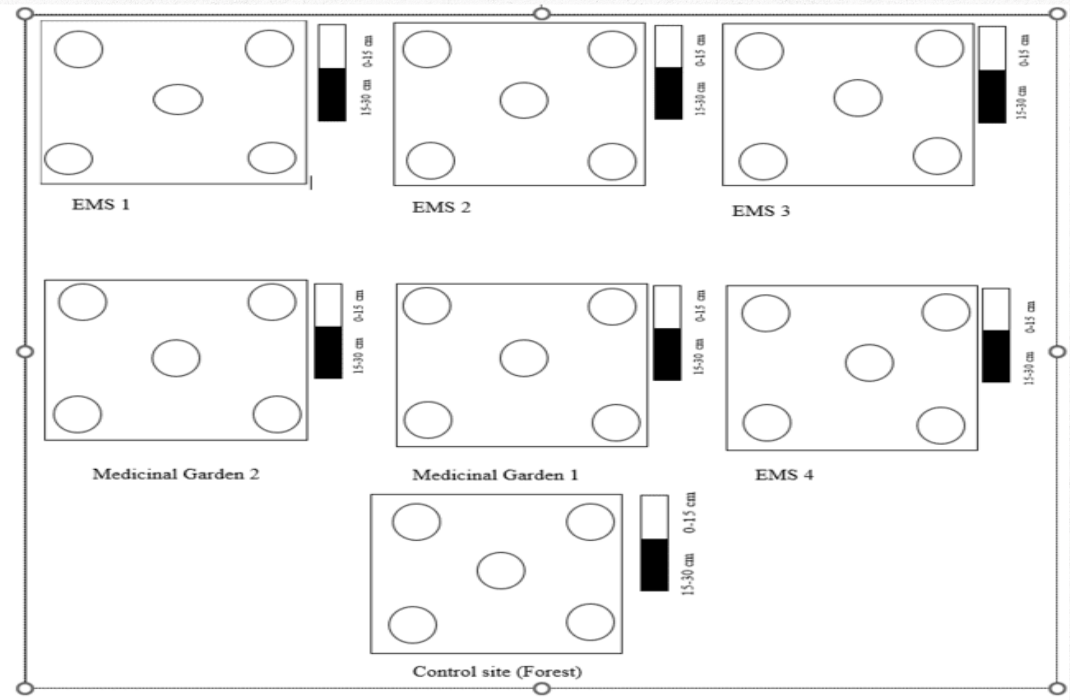
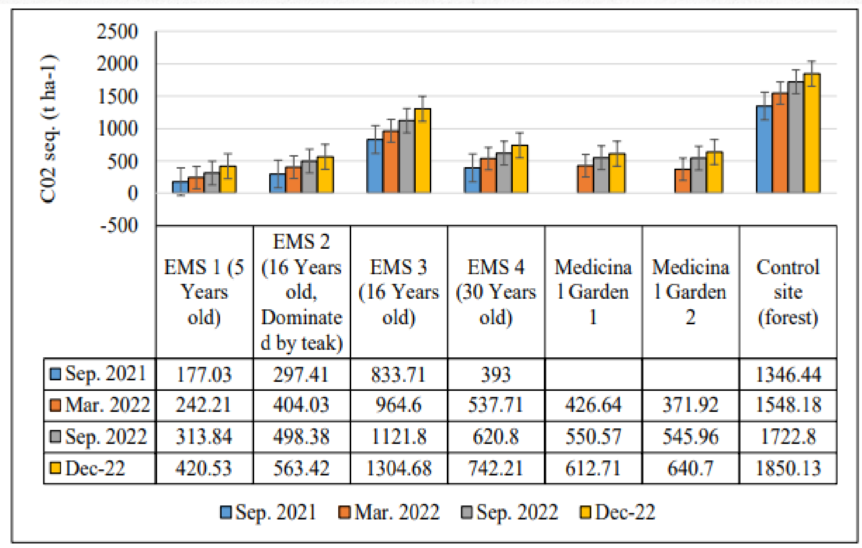


Figure 3: Schematic diagram of soil sampling protocol of Ecological Monitoring site (EMS)

Outcome of the study:

The ecosystem C- pool study showed the improvement in carbon accumulation potential of reclaimed ecosystems. Improvement in soil characteristics (physical changes – like moisture retention capacity, bulk density, infiltration rate etc.) and accretion of humus and soil organic carbon, NPK, cation exchange capacity has been found to be improved. Accretion of important micronutrients (Cu, Mn and Zn) were found in increasing trend with increasing age of reclamation and will not pose any deficiency problem for the plant growth. This study found the abundance of microbial populations related to technosol 'C' metabolism and nitrogen fixation increased with re-vegetation age.



	EMS 1 (5 Years old)	EMS 2 (16 Years old, Dominated by teak)	EMS 3 (16 Years old)	EMS 4 (30 Years old)	Medicinal Garden 1	Medicinal Garden 2	Control site (forest)
Sep. 2021	177.03	297.41	833.71	393			1346.44
Mar. 2022	242.21	404.03	964.6	537.71	426.64	371.92	1548.18
Sep. 2022	313.84	498.38	1121.8	620.8	550.57	545.96	1722.8
Dec-22	420.53	563.42	1304.68	742.21	612.71	640.7	1850.13

Figure 4: Comparison of CO_2 sequestration of different aged EMS with control forest

The solid analysis revealed that water samples, collected from mine pit of Ananta OCP, showed the increasing value, which could be due to the presence of higher total suspended solid (TSS). Similarly, the TDS content of mine pit water of Anata OCP also found in little bit higher that also collaborate with presence of high EC. The COD values of mine pit (Anata OCP) was found approximately 450 mg/L, which is normal. Similarly moderate TKN value was observed in central sump. The more abundance of Diatom (phytoplankton) in water indicates that the water is not so polluted, because of growth of Diatoms is potential bio-indicators of less polluted water. In some samples, presence of other blue green algae also noticed, which indicated presence of more organic nitrogen in water body.

Way Forward:

Restoring mine degraded lands is crucial for environmental protection and economic benefits. Here are the key recommendations:

1. **Topsoil Application:** Topsoil, the most fertile layer of soil, provides essential nutrients and organic matter for plant growth. Applying good quality topsoil creates a favorable substratum for vegetation establishment.
2. **Fencing for Protection:** Fencing helps safeguard vegetation from anthropogenic disturbances like grazing, trampling, and off-road vehicle usage. These disturbances can hinder vegetation growth and regeneration.
3. **Native and Bio-economic Tree Plantations:** Native tree species are well-adapted to local conditions and have a higher chance of thriving in mine degraded lands. Bio-economic tree species, such as medicinal, timber, or fruit-yielding varieties, offer economic returns to stakeholders.
4. **Bamboo Plantations for Abatement and Rehandling:** Bamboo plantations serve multiple purposes. Bamboo's rapid growth helps control air and noise pollution. Its ease of rehandling makes it suitable for re-handling sites used for coal evacuation or infrastructure projects.
5. **Site-specific Soil Moisture Conservation:** Site-specific soil moisture conservation measures are essential to prevent soil erosion and promote plant growth in mine degraded lands. The specific measures vary depending on site conditions.

These measures, when implemented effectively, can transform mine degraded lands into thriving ecosystems, contributing to environmental restoration and economic benefits.

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Coal Bed Methane Harnessing in Coal India Limited: Energy Alternative to Environmental Concerns

Gargi Pandey[1], P.C. Jha[2.]

Abstract

Coal India Limited (CIL) has a total number of 352 mines and 12 coal washeries located in 84 coal mining areas which is spread over eight states of the country. Coal production during the fiscal year 2022-23 was 703.21 MT and it has planned to produce 1 Billion tonne by the year 2024-25. Acknowledging the escalating energy demands of the country, Coalbed Methane (CBM) emerges as an environment friendly energy alternative.

Coalbed Methane (CBM) gas resembles natural gas and is a by-product formed during the coalification process. It typically contains 80 - 98% methane, along with other gases such as carbon dioxide, nitrogen, and traces of higher hydrocarbons and is recognized as a clean and environmentally friendly fuel. CBM exhibits 28-30 times the Global Warming Potential (GWP) of carbon dioxide for 100 years time period and 80-82 times the Global Warming Potential (GWP) of carbon dioxide for 20 years time period (IPCC, Sixth Assessment Report). The cumulative resource potential of CBM Blocks in CIL is estimated to be 27.73 billion cubic meter (BCM), which when not extracted can escape into the atmosphere leading to an elevation in greenhouse gas emissions.

To establish a sustainable equilibrium between the environment and production, it is imperative to devise and implement an effective management plan for harnessing CBM. The details of the various aspects of the alternative energy option and its environmental concerns have been discussed in this paper.

1. Introduction:

Coal mining plays a crucial role in sustaining the energy demand of the country as a significant economic activity. Coal India Limited (CIL) has a total number of 352 mines and 12 coal washeries located in 84 coal mining areas which is spread over eight states of the country. Coal production during the fiscal year 2022-23 was 703.21 MT and it has planned to produce 1 Billion tonne by the year 2024-25. Acknowledging the escalating energy demands of the country, Coalbed Methane (CBM) emerges as an environment friendly energy alternative.

Coalbed Methane (CBM) gas resembles natural gas and is a by-product formed during the coalification process. It typically contains 80-98% methane, along with other gases such

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as carbon dioxide, nitrogen, and traces of higher hydrocarbons and is recognized as a clean and environmentally friendly fuel. Coal serves a dual role as both the source rock and reservoir for CBM, primarily existing in an adsorbed state within the internal surfaces of the coal matrix. CBM is characterized as a low-risk, low-pressure gas, often associated with sub-hydrostatic conditions, making its operation considerably safer in comparison to the traditional Oil & Gas Drilling and Completion activities.

The details and resources of CBM Blocks in CIL areas are depicted in Table 1:

S.No.	Block	Coalfield	Area (sq. km)	Resource (BCM)
1.	Jharia CBM Block-I	Jharia	26.55	25.0
2.	Raniganj CBM Block	Raniganj	32.74	2.2
3.	Sohagpur CBM Block-I	Sohagpur	51	0.53

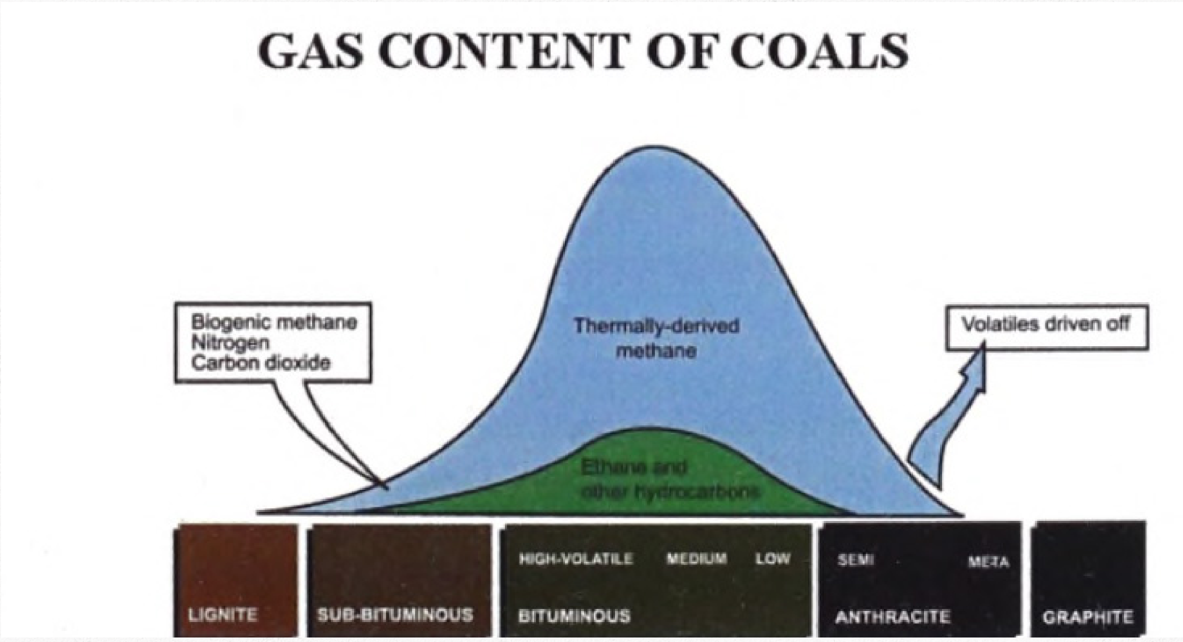

Figure 1: Gas Contents of Coal

(Source:NRLC Coal Bed Methane Conference, April 4-5, 2002)

2. Coal Bed Methane: Importance to the nation

In recent times, the natural gas demand in India has experienced a substantial increase, attributed to factors such as increased availability, the expansion of transmission and distribution infrastructure, cost savings associated with using natural gas instead of alternative fuels, the environmentally friendly nature of natural gas as a fuel, and the overall favorable economic considerations of providing gas at reasonable prices to end consumers. The CBM gas finds its use in various industries such as steel plants, rolling mills, cement-producing and methanol producing industries. It can also be used as a feedstock for fertilisers. CIL is actively seeking to diversify its business and is committed to clean energy initiatives, aligning with the Government of India's goal of achieving Net Zero Emissions by 2070.

The historical context of coalfield mining in India reveals a diverse range in the gassiness of seams, with certain mines experiencing accidents or fires linked to coal extraction activities. Methane within coal seams poses a safety risk due to its explosive nature when concentrations range between 5 to 15%. The Director General of Mines Safety (DGMS) has classified mines based on methane emissions during the mining process. The mines are predominantly categorized into Degree I, characterized by producing less than 1 m^3/tonne of coal. Additionally, there are Degree II mines emitting 1-10 m^3/tonne. Notably, only 21 underground mines in Damodar Valley, specifically in Jharia, Raniganj, and Bokaro coalfields, fall under the Degree III classification, indicating emission rates surpassing 10 m^3/tonne of coal output, which also include a few mines in Assam associated with tertiary deposits.

Approaches for managing methane in mines have varied, from traditional methods like having canaries in cages to detect oxygen-poor atmospheres, to the use of large ventilation fans aimed at replacing methane-rich environments with external air. A few efforts have also involved drilling CBM wells ahead of the coal face to degasify the coal before exposing the mine to CBM. While each of these techniques has achieved varying degrees of success, it's essential to note that none have proven entirely foolproof in preventing CBM from affecting the air quality within an underground mine.

Additionally, CBM functions as a potent greenhouse gas, exhibiting 28-30 times the Global Warming Potential (GWP) of carbon dioxide for 100 years time period and 80-82 times the Global Warming Potential (GWP) of carbon dioxide for 20 years time period (IPCC, Sixth Assessment Report). As it can be seen from Table 1, the cumulative resource potential of CBM Blocks in Coal India Limited (CIL) is estimated to be around 27.73 billion cubic meters (BCM). The efficiency of CBM extraction from coal seams varies between 30% and 50%, depending upon the coal seam permeability, with rare instances reaching up to 80% extraction. Assuming a 50% extraction efficiency in CIL blocks, approximately 13.87 BCM of CBM can be extracted, equivalent to 374.5 BCM of CO_2 (assuming 90% methane content in CBM). Considering that the combustion of 1 unit of CH4 results in the emission of 1 unit of CO_2, approximately 12.5 BCM of CO_2 would be emitted after the combustion of the extracted CBM. Therefore, through the effective utilization of CBM from CIL blocks alone, there is a potential to reduce emissions by up to 362 BCM of carbon dioxide.

The emerging focus on harnessing and utilizing Coal Bed Methane (CBM) represents a crucial environmentally friendly, unconventional, and alternative clean energy resource. The extraction of CBM holds significant promise in creating a safer and more environmentally friendly future for mining operations. This approach not only optimizes the utilization of both CBM and coal resources but also addresses the energy needs of the country.

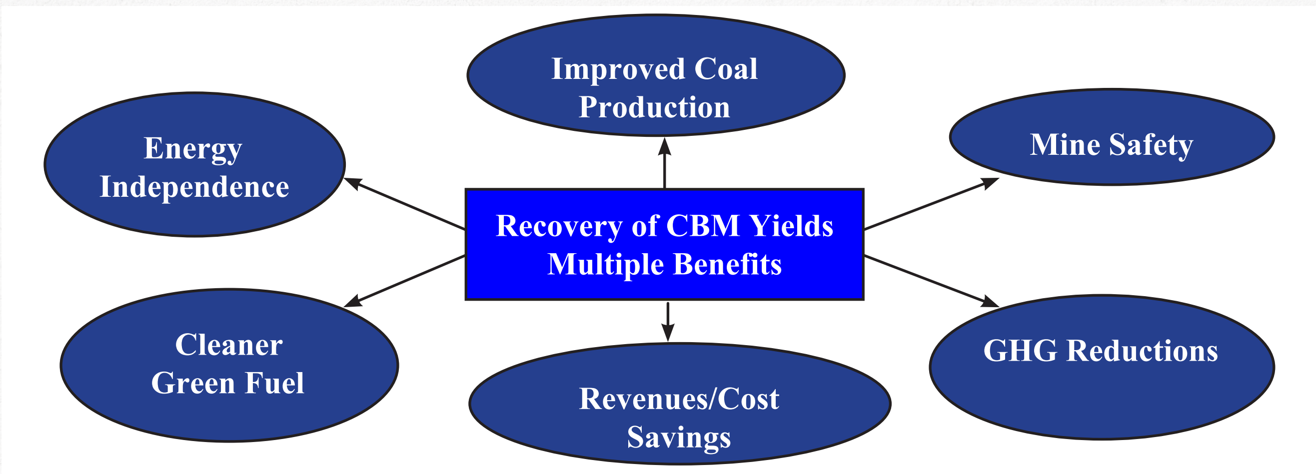

Figure 2: Benefits of CBM

3. Coal Bed Methane: Operation and methodology

In coalbed methane (CBM) production, operations are quite similar to other gas wells. However, conventional wells usually initiate production with high gas/water ratios (GWR) that decrease over time, while CBM wells commence with low GWRs i.e. low gas and high water ratio that increases with time. Consequently, the early construction of equipment and facilities for water handling and disposal at the project's outset is required initially which demands substantial lead time and capital.

- **Coreholes**

A Corehole is a specialized borehole where coring activities extend to the ultimate depth, allowing for a meticulous examination of diverse rock, coal, or lignite samples. This boring technique is employed to precisely determine the depths at which various geological formations, coal seams, and mineralized zones exist below the Earth's surface. Cores are extracted from the entire borehole length using either wireline or conventional drilling methods.

In CBM, a corehole is drilled to acquire detailed subsurface lithological information about different geological formations and to pinpoint the exact depth at which coal seams are located. Cores obtained from the entire depth of the hole are then subjected to comprehensive geological analyses, including desorption, coal analysis, and adsorption studies. These studies aim to derive essential CBM related parameters, such as gas content in coal seams, coal seam thickness, coal quality, and other reservoir characteristics. The ultimate goal is to assess the coal reserve and evaluate the CBM potentiality of the specified block.

- **Assessment of Gas Reserve**

The assessment of gas resource of the CBM block helps to have a broad idea of the prospectivity of the block and is taken as an approximate estimate that is subject to modification with generation of reservoir data from the block.

To assess the gas storage capacity and maximum gas retention under various reservoir pressures, coal samples undergo an adsorption isotherm analysis. Prior to initiating the experiment, essential data such as reservoir temperature, pressure, gas composition, ash content, and equilibrated moisture content, is gathered. These parameters are critical for the isotherm testing process.

The determination of a coal seam's gas content involves measuring the gas released from a coal sample extracted from the reservoir. To facilitate this, recovered coal samples from coreholes are placed in sealed canisters. The study employs a direct method for assessing the methane content of coal core samples, involving a three-stage measurement process. Desorbed gas, collected at different time intervals, undergoes analysis using gas chromatography to quantify C1 and higher hydrocarbons, N_2, CO_2 and O_2.

- **Analysis of Coal**

The strategy for coal analysis encompasses detailed logging, laboratory analyses, determination of coal grade and thermal maturity, petrographic studies, and cleat analysis. The logging of cores is done on a specified computerised format incorporating details on run length, recovered length, lithology, colour, texture, structural features and cleat description for subsequent processing and integration with other data. A representative sample is then taken for proximate, ultimate and other analysis. Parameters for analysis in the laboratories include Ash, Moisture (M), Volatile Matter (VM) and Fixed Carbon (FC), C, H_2 , S , N, P, O, CO_2, Calorific Value (CV) and Mechanical properties. The coal grade and thermal maturity/rank of the coal is then determined based on the Proximate and Ultimate analysis and Vitrinite Reflectance. The petrographic study of representative coal core samples from each seam is done to gain insights on the composition of the coal seams and VR_0 along with the various maceral assemblages distributed throughout the gross coal interval that controls the coal reservoir heterogeneity, fluid storage and movement characteristics. Cleat morphology and aperture width is determined by optical microscope and SEM.

- **Production Potential**

The injection/fall-off test, a form of single-well pressure transient test conducted in core holes, provides crucial insights into the production potential and viability of coalbed methane wells. This test yields estimations of reservoir pressure, permeability, borehole damage, and the product of storage and porosity compressibility. During the test, water is injected into the well at a consistent low rate for a specified duration, followed by shutting in the well. Throughout the injection and shut-in phases, downhole electronic memory pressure gauges measure bottom hole pressure.

The key considerations in the test design include maintaining the injection pressure as low as possible. In cases where permeability data is unavailable, a slug test is conducted to estimate permeability, allowing for the computation of the maximum injection rate.

The advanced automated well test interpretation software is employed for the well test analysis, facilitating swift data input and manipulation. The software supports various analyses, including linear and bilinear flow analysis for fractured wells, naturally fractured reservoir analysis, type curve matching, variable rate analysis, and other capabilities.

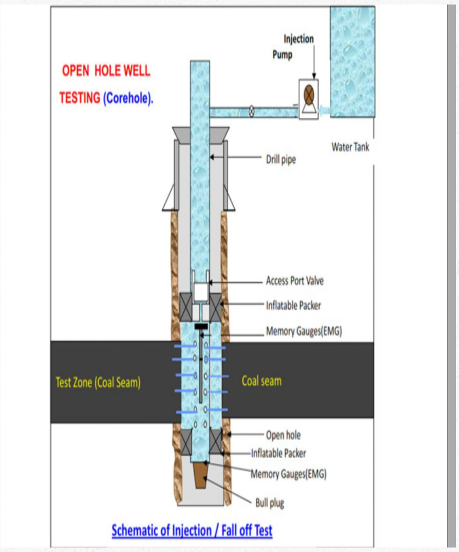

Figure 3: Schematic of Injection/Fall off Test

- **Hydro-fracturing**

Hydro-fracturing is the predominant stimulation technique employed in the CBM extraction. This method involves applying pressure through a fluid column to a reservoir face at a rate surpassing the formation's acceptance capacity, thereby inducing the fracturing of the formation rock. The pumping process is sustained to elongate, widen, and elevate the fracture. Subsequently, proppants, typically sand, are introduced to the fluid and pushed into the formation to maintain the openness of the fractures. The primary goal is to establish a broad vertical fracture of substantial length, creating a conduit that connects the intricate cleat system to the wellbore. A commonly used stimulation approach involves utilizing water at elevated pumping rates (30 - 50 BPM) with 20/40 mesh sands serving as proppants. It is standard to place between 150,000 to 400,000 pounds of sand in thicker coal seams.

- **Test Wells and Pilot Wells**

A test well refers to an exploration borehole drilled specifically to conduct a variety of well tests aimed at evaluating the potential for CBM production from coal or lignite seams. These well tests encompass a range of examinations, including injection or fall-off tests, stress tests, dewatering tests for production assessment, and any other tests necessary for estimating CBM and water production rates. Successful outcomes from test wells may qualify them to be included as integral components within a cluster of wells.

Coal seams are particularly vulnerable to damage during drilling, a phenomenon which is observed in under-pressured coal seams, mostly in regions of the Damodar Valley coalfields such as Jharia Coalfield and Raniganj Coalfield. To mitigate formation damage during drilling and completion operations and control formation pressures, specific drilling fluids are carefully chosen.

Pilot wells, which are same as test and production wells, are strategically drilled in a pattern of either five or ten spots. This systematic approach aims to evaluate the coal reservoir by determining the permeability of coal seams, helping establish the optimal spacing for subsequent development or production wells. The ultimate objective is to enhance CBM gas production, both at the coal reservoir level and for the entire block. The selection of test and pilot well locations is guided by available geological and geophysical data. A drilling rig is installed at the chosen site after a comprehensive inspection to ensure its operational capability and adherence to quality standards.

- **Well Completion, Casing & Cementation**

In the extraction of CBM, water pumping is essential for lowering the well's water level, thereby reducing pressure against the formation. This process encourages methane gas to desorb from the coal and flow towards the wellbore, essentially necessitating the emptying of wells to facilitate the maximum release of methane gas adsorbed on the coal surface or seam.

The cased hole completion is employed to selectively complete and produce multiple coal seams. This method involves a smaller hole size, controlled perforations, and targeted stimulation to mitigate formation damage, minimize the production of coal fines, and facilitate moderate clean-out and workovers.

Figure 4: Drilling operation in Jharia CBM Block-I, CIL

Surface casing cementing plays a crucial role in isolating the water table and aquifers. It reduces hydrostatic pressure linked to the cement column, thus minimizing potential formation damage or cement invasion in the coal seams. The specific cementing approach is tailored to the actual hole conditions during and after drilling. A common practice in CBM operations worldwide involves the use of "Class G" cement slurry with lightweight additives. These additives effectively lower the slurry density to 11.5 lbs/gal.

4. Environmental Aspects of CBM

There are several environmental aspects which are needed to be considered in the exploration, exploitation and development of CBM. Some of these are highlighted below:

- **Dewatering of Aquifers**

Methane gas is securely trapped within coal seams due to the hydrostatic pressure from groundwater. The production of methane rises as the water content decreases. Consequently, to reduce pressure within coal bed reservoirs and encourage the release of methane from the seams, the initial phase of Coalbed Methane (CBM) production involves the extraction of billions of gallons of groundwater to the surface. This process leads to the de-pressurization of aquifers, creating a cone of depression and causing a significant decline in groundwater levels in nearby dug and borewells.

- **Management and disposal of produced water**

The water that accumulates within the fractures, cleats, and permeable zones of coal beds is typically saline and characterized by a high concentration of dissolved salts and solids, along with elevated levels of fluoride, ammonia, sulphate, and other elements. Frequently, this produced water is released onto the ground surface or discharged into nearby streams and rivers. The increased volume of surface flow not only impacts the water quality of the stream or river but also accelerates stream channel erosion, raises sediment load, and poses potential adverse effects on downstream irrigators, including flooding of agricultural land, and the aquatic organisms within the river ecosystem. Similarly, when these waters exhibit a high sodium-to-calcium and magnesium ratio (Sodium Adsorption Ratio/SAR), they can prove harmful to the soils and vegetation patterns of the area. Moreover, an elevated ratio of sodium to calcium and magnesium can alter the chemical composition of clays and diminish soil permeability.

- **Contamination of Aquifer**

The quantity of methane generated during the coalification process typically surpasses the gas-holding capacity of the coal seams. Consequently, the surplus gas migrates into the adjacent rock formations through natural conduits such as fissures, joints, and secondary openings. Additionally, uncemented annular spaces resulting from existing well casings, water wells, and improperly abandoned oil and gas wells facilitate the migration or seepage of methane gas. During this seepage, methane infiltrates overlying groundwater aquifers, posing a threat to their quality. This may create health hazards for numerous families.

- **Air pollution**

The preparation of drill sites, clearance of approach paths, operation of diesel-based power generators, and the movement of both light and heavy vehicles and machinery during construction and drilling activities generate air pollutants such as PM_{10}, $PM_{2.5}$ NO_2, and SO_2. This activity may lead to an elevated concentration of pollutants at ground level in the vicinity of drilling sites. The use of internal combustion engines for drilling and servicing wells, gas compression, and transportation results in the emission of various gases, including N_2O, CO, SO_2, CO_2, particulate matter, and toxic air pollutants. These emissions can have an adverse impact on the air quality in the surrounding area. Additionally, the establishment of additional processing plants to accommodate the large volume of extracted methane contributes to the release of CH_4 and CO_2 gases into the environment. The combination of fugitive dust and exhaust from construction activities, along with air pollutants emitted during various well operations, creates a non-conducive environment at the site.

- **Gas flaring**

A certain amount of gas production is expected from the wells while exploration of gas. The incidental gas generated from test wells is collected, processed, and compressed. Flaring this gas into the atmosphere is commonly deemed an acceptable disposal method. However, improper burning practices may lead to a situation resembling a fire at the well site.

- **Noise Pollution**

The operation of drill machines, generator sets, water and mud pumps, and certain vehicle movements contributes to an increase in noise levels. The most significant source of noise in Coalbed Methane development arises from compressing the gas in a compressor. While the noise from these activities is generally of low intensity, the continuous humming may pose an annoyance to individuals residing in the close proximity.

5. Preventive and Remedial Measures

- **Water Treatment and Management**

Every CBM wells need to be dewatered for lowering reservoir pressure to start CBM gas flow from the wells. Water production rates from CBM wells are variable and depend upon the geologic formation. The quantity of water produced initially, decreases substantially with time.

i. Reverse Osmosis

The process involves the extraction of total dissolved solids (TDS) and other components from the produced water. This is achieved by directing water from a solution containing dissolved solids through a semi-permeable membrane. Applying pressure allows water to pass through the membrane, while the dissolved solids are retained. Periodic cleaning of the membranes occurs through cross-flow, removing surface-retained molecules, which are then collected and concentrated for disposal. This method is effective in treating produced water, concentrating constituents into a smaller volume effluent for easier disposal. Following Reverse Osmosis (RO) treatment, the treated produced water can be transported for disposal at designated sites. The RO reject water, constituting 20% of the produced water to be treated, can be utilized for dust suppression.

iii. Solar drying in storage pit

A waste water storage pit of suitable size having lined with HDPE (High Density Poly Ethylene) Sheet can be provided to collect waste water generated from drilling operations. The waste pits collect drilling fluid from operations, and the content undergoes solar drying. It is essential to ensure that the HDPE lining covers the surrounding areas of the pit to prevent soil contamination.

iv. Atomization treatment

The technique of breaking down water particles into smaller droplets and dispersing them can be highly efficient in warm, dry climatic regions. In such areas, the smaller droplets facilitate

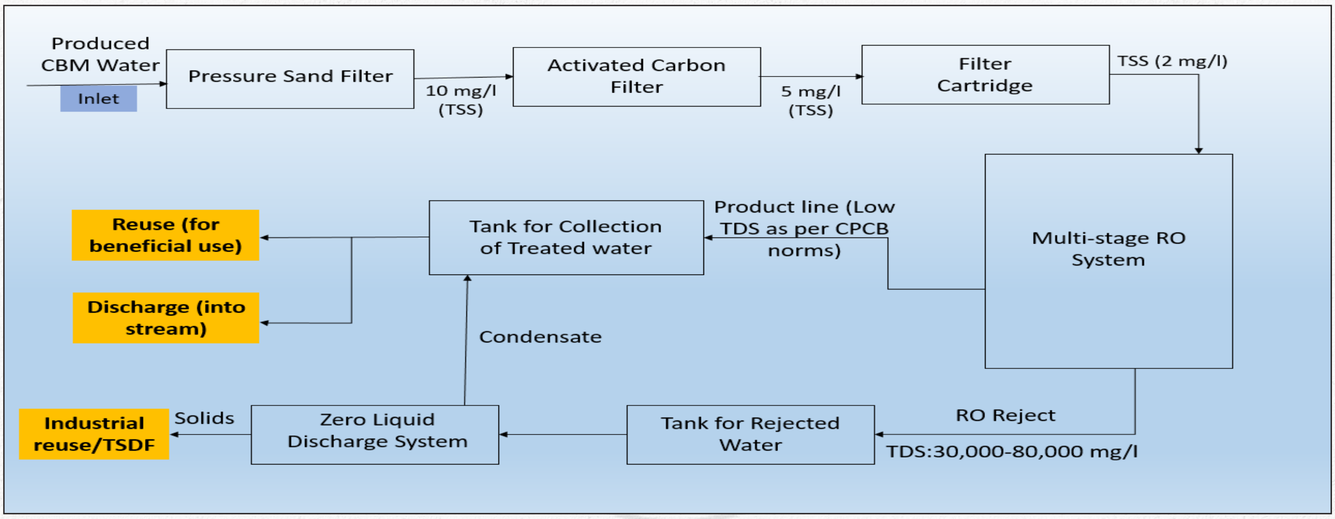

Figure 5: Schematic Diagram of Produced Water Treatment using RO

ii. Dilution of Produced Water with low SAR water

The dilution of high Sodium Adsorption Ratio (SAR) water with higher-quality, low SAR water, as a water management strategy, can significantly reduce soil damage. The utilization of water with lower Total Dissolved Solids (TDS) and Sodium content for mixing with CBM produced water helps in bringing the TDS and Sodium levels within acceptable discharge standards. After dilution, the produced water can be safely employed for irrigation or to supplement river discharge.

Figure 6: HDPE-Lined Water Disposal Pit

quicker evaporation compared to water stored in impoundments.

v. Application in drilling and stimulation

Produced water can be stored in the water pits at site and can be used for carrying out drilling and stimulation jobs in other wells.

vi. Industrial Applications

The CBM produced water can be used for industrial applications which includes dust suppression, fire-fighting, washing of machineries.

- **Management of Air Quality**

Water spraying along with suitable chemical surfactants can be done to supress fugitive dust generation, particularly on the approach road. The use of electrical compressors can significantly reduce the level of exhaust and emissions.

- **Management of Noise Quality**

The gas-powered compressors that move the gas along the transmission pipelines should be equipped with proper acoustic enclosures to reduce noise. The noise impacts can also be reduced by using the electrical compressors. A minimum distance of 100m between the operating sites and nearby habitation can be maintained to avoid continuous exposure of high noise to local residents.

6. Conclusion & Recommendations

In the present context, Coalbed Methane (CBM) has surfaced with multifold advantages and is poised to play a crucial role in fulfilling the growing energy demands of the country. The advancement of CBM represents a noteworthy stride toward sustainable and conscientious mining practices. The clean energy initiatives should be embraced in harmony with the Government of India's ambitious aim to attain Net Zero Emissions by 2070. Recognizing Coal Bed Methane (CBM) as a powerful greenhouse gas, there is a potential for significant emissions reduction and a consequent decrease in global warming through the efficient utilization of CBM extracted from its blocks. Nevertheless, the extraction of CBM from underground coal seams presents its own environmental challenges. To establish a sustainable equilibrium between the environment and production, it is imperative to devise and implement an effective strategy.

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ALTERNATE COAL LOADING SYSTEM FOR ROAD SALE THROUGH TRUCKS TO ELIMINATE PAY LOADER LOADING OF ROAD SALE TRUCKS: A CASE STUDY FOR CHP IN SECL

J. K. Dixit[1], Rajib Dutta[2]

Abstract

To meet the demand for high accuracy, and Rapid loading it has designed a simple and smart hydraulically operated pre-weigh truck loading system engineered to load various types of trucks. Coal can all be loaded into trucks using a variety of design and operating systems. Main feature of this truck loading is its operational advantage at less capital cost. Volumetric type loading structures can be converted in to pre-weigh type Rapid loading systems. This paper will study the existing truck loading system (TLS) and pre-weigh truck loading system for road sale. The handling capacity of this system has been designed as 500 tph as a module for approximately 2.0 Mty. The system will eliminate pay loader loading to road sale trucks in all mines of CIL.

Keywords: High accuracy, TLS, Rapid loading system, Volumetric type, pre-weigh hopper

1.0 INTRODUCTION

Various types of Electronic Rail/Road WBs and Belt weighers are used for the weighment of raw coal in SECL. The coal dispatch in the year 2022-23 through road is 62.01 Mty which is the second largest mode of dispatch after rail transport. So, the transportation of coal through road is a huge challenge in coal mining of SECL.

The mode wise dispatch system of SECL in the year 2022-23 is as shown in figure 1.

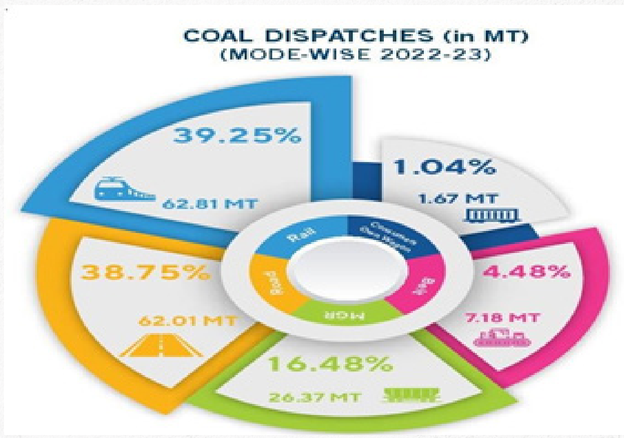

Figure 1. Mode wise dispatch of coal in SECL 22-23

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A circular has been issued by Director Technical, CIL vide. CIL/DT/069/17/492 dated 07.07.2017 regarding exploration of possibility of introducing truck loading system in the existing CHP of all the mines and in other cases where it is not possible, ensuring action for the installation of mini CHP near suitable places for truck loading system for road sale. Further, in the said letter it has also been suggested that coal loading by pay loaders should be stopped and necessary arrangement to be made as alternative loading system.

It has been proposed a module of 500 TPH (Peak) i.e around 5000te per day capacity consisting with Coal Receiving by truck receiving hopper from the stockpile located on surface and feeding to a conveyor and subsequently feed to surge bin (120te) with pre-weigh hopper for truck loading system. The number of module will be selected based on the capacity of respective project/mine.

The special feature of alternative truck loading system is following.

- Truck loading system consists of sub-assemblies like Top Discharge Gates, Telescopic Chute, Hydraulic power pack, Pre-Weigh Bin, Traffic signal and Dedicated loading controller, Software, etc.
- Main feature of this truck loading is its operational advantage at less capital cost.
- High capacity loading rates upto 1000TPH.
- Loading with +0.05% weighing accuracy
- Loading accuracy +/- 0.5% of target load.
- Highly cost effective solution.
- Makes uniform loading profile.
- Robust construction of equipment.
- Overall PLC Control and Automation of the system.

2.0 EXISTING COAL TRANSPORT SYSTEM IN SECL

The existing truck loading station (TLS) for road sale has been installed in SECL. Coal of (-) 100 mm size won by surface miners will be fed into the hoppers of Truck Receiving Station (TRS). Coal from the hopper, will be reclaimed by vibratory feeders and loaded onto reclaim belt conveyor of the truck receiving station. The coal from the reclaim conveyor of TRS will be transferred through series of conveyors to the tripper conveyors for spreading coal into the O/H RCC Bunker. The coal from bunker will be reclaimed through vibratory feeders onto the elevating belt conveyors for feeding into the Silo for wagon loading.

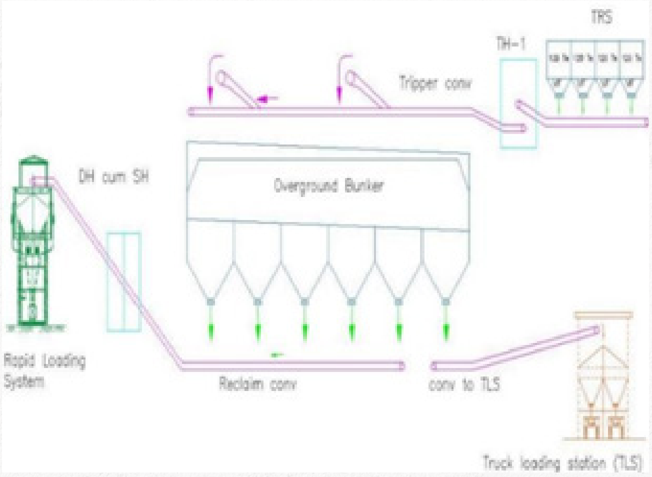

Figure 1. Schematic diagram of CHP with truck loading station

Also, there will be one more reclaim circuit from bunker for truck loading station. One road weigh bridge of 100T capacity has been proposed for weighment of coal. The schematic diagram of coal handling plant (CHP) with truck loading station (TLS) is shown in the figure 1.

FEATURES OF EXISTING SYSTEM

- Truck receiving station (TRS) of capacity 2 X120t for surface miner coal. Below the truck receiving hopper vibro feeder of capacity 200tph has been installed.
- Truck loading station (TLS) of capacity 2X 200t with vibro feeder capacity of 200tph.

3.0 PROPOSED COAL TRANSPORT SYSTEM IN SECL

The system shall be designed to load the Truck of capacity up to 40te carrying capacity. The system shall have the capacity to load number of trucks continuously. Coal received through truck receiving hoppers at TRS shall be distributed in two directions viz. one will be transported to the silo through bunker circuit for loading of Railway wagons and another will be transported to TLS for loading of trucks for road sale. There will be one number truck loading station. Truck Loading Station shall consist of steel surge hoppers and pre-weigh hopper with rapid loading system along with telescopic chutes at bottom for and all associated equipment for successful loading of trucks.

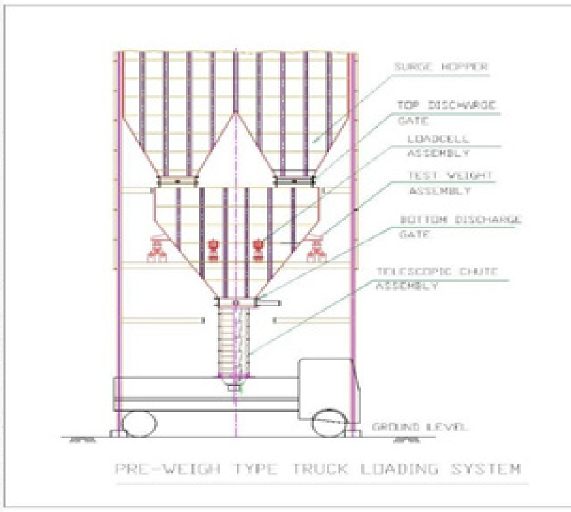

Figure 2. schematic diagram of TLS

The details of the truck loading station are followings.

- Lump Size: (-)100 mm
- Receiving hoppers: 100T x 2 nos.
- Vibro feeder capacity: 500 tph x 2 nos.
- Feed conveyor: 500 tph – 150 Mtr length
- Surge hopper: 120 T capacity
- Pre weigh hopper capacity: 40T
- Mode of Loading: Pre Weigh Batch
- Rate of Truck Loading: 600 - 900 TPH

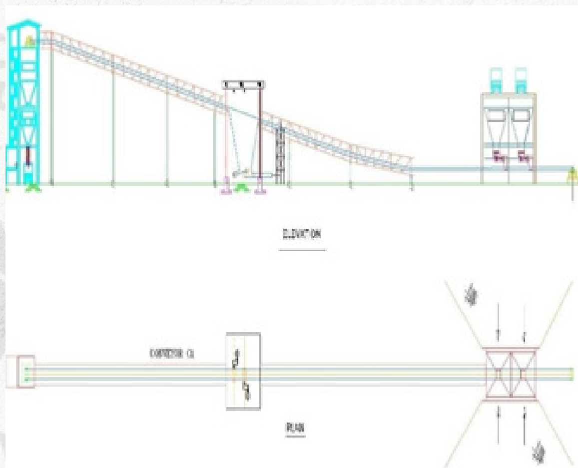

Figure 3. GA diagram of TLS

The schematic diagram and GA diagram of truck loading system with pre-weigh hopper is shown in figure 2 and figure 3.

SPECIAL FEATURES OF PROPOSED SYSTEM

- Highly cost effective solution.
- Robust construction of equipment.
- Overall PLC Control and Automation of the system.
- Visual monitoring of operations through SCADA applications.
- Windows based software is used to control the system.
- The system provides the proper dust control system.

The pictorial view of truck loading system is shown in figure 4.

Figure 4. The pictorial view of TLS

4.0 COMPARASION BETWEEN TWO TRUCK LOADING SYSTEM

The techno economical study has been between two TLS system as shown in table 1 and figure 5.

Table 1. Comparison between two truck loading system (TLS)

Sl. No.	Particulars	Conventional TLS	Alternative TLS
1	Receiving pit	TRS	TRS
2	Capacity of TRS	2X100 t	2X100 t
3	Vibro feeder capacity	2X500 tph	2X500 tph
4	Conveyor capacity	500 tph	500 tph
5	Types of truck loading station	2X100t capacity TLS, below this 2 X200 tph vibro feeder	Surge hopper of 120t capacity, below this 40t (approx.) pre-weigh installed
6	Type of weighment	Through weighbridge	Through pre-weigh hopper
7	Camera device	No camera	CCTV camera
8	Manpower	13	9
9	Capital cost(Including DLP, GST	20.50 crore (Approx.)	19.0 crore (Approx.)
10	Software	No software used	Capturing data from Pre-weigh bin should be automated and flow to central server at SAP automatically.

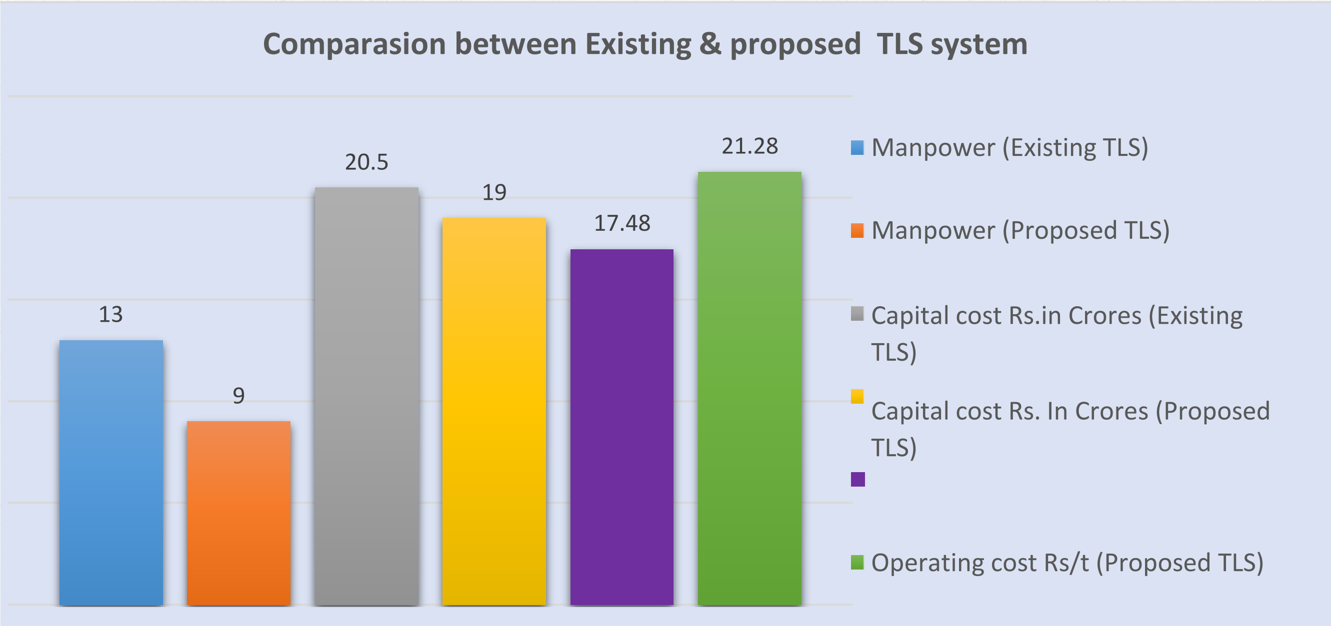

Figure 5. Comparison of truck loading system (TLS)

5.0 CONCLUSIONS

The total operating cost is less as compared to conventional system. The total operating cost of proposed CHP is 17.48 Rs/t.and the total operating cost of Existing CHP is 21.28 Rs/t. The weighment and target load accuracy is comparatively better than existing system.

Manpower is also less as compared to existing system.

In view of the above case study report, the proposed system may be justified and feasible and may be considered for implementation.

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IMPORTANCE OF COMMUNITY PARTICIPATION IN MINE CLOSURE PLANNING

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Abstract

Community Participation is the most important aspect of Mine Closure Planning. This paper comprehensively discusses the role of Community Participation and highlights the importance of Community Participation in finalising the Mine Closure Plan. The paper also highlights the need of community participation in respect of Paschim Bardhman District, West Bengal where coal mining plays an important role in livelihood.

INTRODUCTION

Mining is a temporary business and is closed after exhaustion of the reserves. Most of the mines are located in the remote areas and surrounded by villages of economically and opportunity deprived community. Mines bring numerous changes in the area and generally have a huge impact on the socio-economic fabric of the area. These changes get inculcated in the lifestyle of the local populace and they become dependent on the mining operations and the allied activities. As the mine approaches closure, the facilities like hospital/dispensary, schools, community parks, playgrounds, etc., provided and maintained by the mine operators are also removed gradually. This can induce social anxiety and stress on the community that can lead to unrest and agitation if not adequately addressed in time. Thus, mine closure has to be undertaken in a planned and effective manner to reduce post closure liabilities and to avoid social risks. This will also help the local government in managing the people and other facilities in an effective way after closure (Rao & Pathak, 2009, p. 10).

The other most important aspect of mine closure is the loss of livelihood of a large section of the population resulting in a drastic decline in their standard of living (Rao & Pathak, 2009, p. 11). This also has an impact on the education of the children as they are forced to move out of the area in search of earnings.

In many cases, illegal mining become the major source of income to the local communities. However, these illegal pits are dangerous and can lead to death of the mine workers due to unscientific method of mining. Such illegal mining cases are observed frequently in Raniganj Coalfield, West Bengal. Thus, scientific closure of mines incorporating the requirements of the local populace can stop such dangerous mining practices and can lead to a better post-closure area. The local community can have a say in the matter and has a potentially very important role to play in protecting the environment after the mine is closed (Research on Mine Closure Policy, January, 2002, p. 65).

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"Mine closure is the process of planning and managing the decommissioning of a mine, mitigating impacts, undertaking environmental rehabilitation and relinquishing the leases. It is a continuous process" (The Social Aspects of Mine Closure: A Global Literature Review). Closure Planning should be carried out since the earliest stages of mine planning, including exploration, to capture the risks and opportunities from the start and can be proactively managed. This is required so that closure aspect is fully considered in the mine design and business plan (ICMM (Mining with Principles), February, 2019, pp. 10-14).

Mining lifecycle comprises of different stages shown as under:

Exploration → Planning → Construction → Operation → Closure → Post-Closure

Mine Closure should be part of every stage of mining lifecycle

RELUGATIONS REALTED TO MINE CLOSURE PLANNING: INDIAN CONTEXT

Mine Closure Plan is governed by following guidelines / rules issued by Govt. of India:

1. "Guidelines for Preparation, Formulation, Submission, Processing, Scrutiny, Approval and Revision of Mining Plan for the coal and lignite blocks" issued by Ministry of Coal, Government of India, 2020 which is applicable specifically to coal and lignite mines
2. Mineral Conservation and Development Rules (MCDR), 1988 and its subsequent amendments issued as per section 18 of the Mines and Minerals (Regulation and Development) Act, 1957 (67 of 1957). These rules are applicable to all the minerals except petroleum and natural gas; coal, lignite and sand for stowing; any mineral declared as prescribed substance for the purpose of the Atomic Energy Act, 1962 (33 of 1962) and minor minerals.

These guidelines / rules explicitly deal with closure planning and the liability of closure has been fixed on the mining lessees. As per these guidelines, there are two stages of Mine Closure Planning:

a. Progressive or Concurrent Mine Closure Planning as part of ongoing planning process

b. Final Mine Closure Planning before 2/5 years of the planned closure of the mine (Ministry of Coal, Govt. of India, May, 2020) (IBM, Ministry of Mines, Govt. of India, 1988).

These guidelines / rules have emphasised on the inclusion of closure plan as part of overall planning process. However, the major focus is on physical and environmental issues such as topsoil management, rehabilitation of quarry voids, management of subsided land (in underground mines), air and water quality management, restoration of drainage pattern, vegetation management, physical removal of the mining infrastructure (which cannot be put to other productive/community uses) and biological reclamation of spaces thus freed-up.

As per the Guidelines issued by Ministry of Coal, Government of India, 2020, social activities to be included in the Closure Plan are:

- Entrepreneurship Development (vocational/ skill development training for sustainable income of affected people),
- golden handshake/retrenchment benefits to 100 employees of OC mine and 200 employees of UG mine,
- onetime financial grant to societies/ institutions/ organisations which is dependent on the project,
- provide jobs in other mines of the company and continuation of other services like running of schools, etc.

The share of fund to be allocated for these activities are very low.

Social dimensions are not discussed in Mineral Conservation and Development Rules (MCDR), 1988 and subsequent amendments.

Apart from the above rules, EIA Notification, 2006 and subsequent amendments issued under the relevant provisions of Environment (Protection) Act, 1986 have provisions for Mine Closure Plan in the EIA & EMP Report on the basis of which public hearing is conducted and subsequently EC is granted. However, this report is required prior to mining operations and mostly contains closure provisions related to Progressive Mine Closure Planning (MoEF&CC, New Delhi, Govt. of India, September, 2006).

Government of India through NITI Aayog has published a "Report of the Inter- Ministerial Committee on Just Transition from Coal under the Sustainable Growth Pillar of the India-US Strategic Clean Energy Partnership" for proposed action and implementation framework to address the key issues, enable the closure of coalmines, both in short, and long term on just transition principles. In this report, it has been established that coal based assets are deeply interlinked with local communities which particularly impact them, strategies for project closure, and the way forward, must include perspectives from community stakeholders. For this purpose, following frameworks have been adopted in the report:

1. Prepare and publish an annual report on planned coal-based asset closures
2. Prepare an asset-specific redevelopment and repurposing plan based on wide- spread consultations
3. Prepare an annual monitoring and oversight report after closure (Report of the Inter-Ministerial Committee on Just Transition

NEED FOR COMMUNITY PARTICIPATION

Participation is the way through which communities and individuals within communities are engaged with decisions that affect them including mine closure. The decommissioning/ closure process should include the expectations of the local communities and major focus should be on the sustainability of the area in context of their expectations. Thus, to uphold equity and inclusiveness and to ensure that the interests and views of all affected communities are considered at appropriate levels, participatory processes are as important at this phase of mine life as at any other time.

There is influx of people from different aspects of life during the course of mining. To make their lives better and providing them with basic amenities, mine operators invest heavily in that area. These amenities also benefit the local population during the course of mining operations. However, after the closure of the mine, these amenities either are gradually decommissioned or are poorly maintained which directly affects the lives of these local people. This lead to deterioration of the social life quality. Thus, their participation during the closure planning and post closure become significantly important.

Community participation can provide greater transparency in decision-making, improve quality of decision-making processes, improve relationship between communities and mining companies, local diverse knowledge and more post-closure options, enhance alignment of closure outcomes with community aspirations and to improve the understanding of evolution of social systems and community life during the mine-life.

Mines (mostly opencast) require rehabilitation and resettlement of local population due to mining. They have to leave their land to be settled to some other place as decided by the mine management during planning. This also possess issues like loss of employment, adjustment to new place, etc. Opinions of these displaced people are also important during the closure of the mine.

As per the report published by the University of Queensland, Australia under "Participatory processes, mine closure and social transitions", communities could include:

- ❖ Communities of interest: people who share a common interest or goal
- ❖ Communities of affiliation: people who are connected through their affiliation with a social network or institution– such as a workers' union
- ❖ Communities of standing: people who have legal or formally recognised rights
- ❖ Communities of place: people who live, work, access, use, depend on, or otherwise have ties to a particular location (The University of Queensland, Australia, February, 2020).

Individuals often belong to more than one community simultaneously. Vulnerable groups mostly contain children and elder peoples whose voice are generally left out during the process.

ROLE OF COMMUNITY PARTICIPATION

Local communities have vast knowledge regarding the project area and their knowledge can be beneficial during the operation as well as closure of the mines. Thus, community participation is an important aspect at each stage of the mining lifecycle and it becomes all-important at the time of closure as they are impacted the most post-closure. Mining companies can utilise their knowledge to give better shape to the closure activities and can make post-closure activities more sustainable.

UNITED NATIONS DECLARATION ON THE RIGHTS OF INDIGENOUS PEOPLES

People who are impacted by projects have the right to be involved in decision-making process. It becomes more important as these decisions will later have a bigger impact on their lives and surroundings. This right applies to all stages of the mining lifecycle, including closure.

Indigenous peoples including tribals have special rights. They are mostly dependent on the local resources, which are available in the area prior to commencement of mining. Their free, prior and informed consent (FPIC) must be obtained for projects that affect their lands, territories and other resources. These rights are also captured in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)".

Article 10

> "Indigenous peoples shall not be forcibly removed from their lands or territories. No relocation shall take place without the free, prior and informed consent of the indigenous peoples concerned and after agreement on just and fair compensation and, where possible, with the option of return".

Article 18

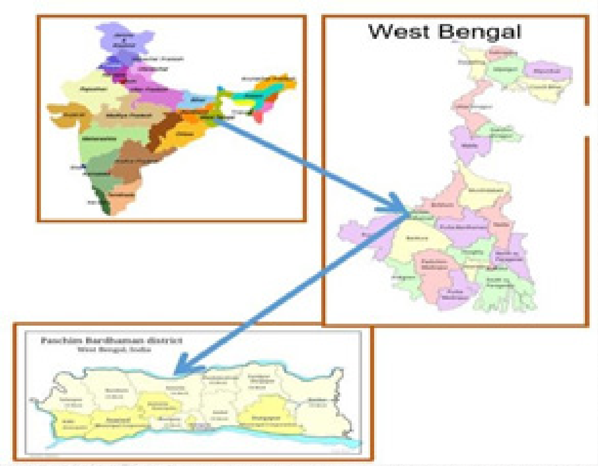
> "Indigenous peoples have the right to participate in decision-making in matters which would affect their rights, through representatives chosen by themselves in accordance with their own procedures, as well as to maintain and develop their own indigenous decision-making institutions" (UNDRIP, September, 2007, pp. 11-15).

CASE STUDY

Raniganj Coalfield is the birthplace of coal mining in the country. The first mining operation in the country was started in this Coalfield by Sumner & Healy in 1774. The first Coal Company, M/s. Alexander & Company was established in 1820. The first Indian Enterprise, M/s. Carr & Tagore Company was formed in 1835. In 1843, the first joint stock Coal Company, M/s. Bengal Coal Company was formed. Numerous small mine owners were also in this business (CMPDI, RI-I, Asansol, May, 2014, p. 1).

Coal of this coalfield is non-coking in nature with high calorific value and hence, demand of this coal is high in thermal power plants. Majority of this coalfield falls in Paschim Bardhaman District and small portion falls in Bankura District, Birbhum District, Purulia District and Dhanbad District (Jharkhand).

Paschim Bardhaman district is a predominantly urban mining-industrial district in West Bengal. It is densely populated with 2,882,031 population (as per Census, 2011) living in the district out of which around 81.61% (as per Census, 2011) living in urban areas. Around 30% population is either below 6 years or above 60 years, which comprise the most vulnerable group. Asansol and Durgapur are the major industrial cities in the district. Most of the mines surround these two cities.



Location map of the study area

Since, most of the coalmines in this region are nationalised and comes under the administrative control of Eastern Coalfields Limited (a subsidiary of Coal India Limited, a Maharatna Public Sector Undertaking), the demography of the area has changed due to influx of people from different parts of the country. Around 52935 employees work in ECL (as on 31.03.2022). Apart from these permanent employees, the local population are heavily dependent on coalmines and the attached facilities like hospitals / dispensaries, playgrounds, schools, etc. provided by the mine authorities (either Eastern Coalfields Limited or private entities). Activities carried out under Corporate Social Responsibility like drinking water supply, road construction, beautification of the area, repair and maintenance of schools or classrooms, rural development, etc. also have huge impact on the social lives of the local people in this region. Amount spent of CSR activities during the last four FYs is given below:

Sl. No.	FY	Amount spent on CSR (in Rs Lakh)
1	2019-20	1147.25
2	2020-21	1155.58
3	2021-22	1385.73

(Source: Annual Expenditure Report, ECL)

These mines also provide huge indirect employment in the region. Similarly, numerous old mines are also present in the region which have been abandoned unscientifically leading to illegal mining pits spread all over the coalfield. Many lives have lost due to illegal mining. Thus, in this region, it becomes all more important to incorporate community participation in mine closure planning as in future, the coal reserves are going to be exhausted and there should be mature transition to avoid any conflicts.

WAY OUT

Community participation can be ensured in mine closure planning by adopting options given below:

#	Way-out	Details	Methodology to be adopted	Expected Outcome
1	Community Consultative Committee	Group of volunteers (no. may depend on the size and quantity of the communities) from the host community representing the community and familiar with the aspirations of the community. It will work as a liasoning body between communities and company.	Periodic meeting amongst the volunteers to discuss community expectations, issues of concern and options for their resolution. Annual meeting with mine authorities to discuss the implementation status	Open dialogue forum between company and community representatives to assess the current and future options and to give input on risks and opportunities arising from various closure aspects
2	Public Consultation / Public Hearing before implementation of final mine closure	One time meeting of all stakeholders (directly or indirectly involved) in the presence of mine authorities and representatives from local governments.	The methodology described in EIA Notification, 2006 and its subsequent amendments issued by Ministry of Environment, Forest & Climate Change, Govt. of India is to be utilised	The discussions during the meeting to be noted in minutes along with commitments given by the mine authorities to be completed in a time bound manner. Fulfilment of commitment may go beyond final closure of the mine.
3	Social Impact Assessment	Social impact assessment (SIA) is a tool for the identification, analysis, assessment, management and monitoring of the potential social impacts of a project, both positive and negative by reputed institutes / organisations.	SIA is prepared on the basis of inputs received for: people to be impacted and how the affected communities potential social impacts developing management measures to mitigate adverse impacts and enhance benefits monitoring and reporting	On the basis of the submitted report, the mine authority can better assess the likely impact of closure on local communities and can make informed decisions. SIA tool has many advantages as it gives a broader picture of the actual social impact due to closure and can be utilised for monitoring the post- closure implementation status
4	Continued evaluation of participation throughout the closure process	Collaborative process of collecting and analysing data, and communicating the results, in an attempt to solve the problem.	Periodic review of the participation by the mine authority. This can be done by: • gathering and analysing data, • sharing and discussing data with a planning team (stakeholders and the company), • building a plan of appropriate actions and • agreeing on a timeline and milestones, ensuring all stakeholders understand the timeframes involved	The company, stakeholders and communities can easily review progress of mine closure, gain information and insights and act on these. Problems and their causes related to mine closure and mine rehabilitation can be identified early. Alternate solutions to problems can be developed and are supported by the community and more likely more effective.

#	Way-out	Details	Methodology to be adopted	Expected Outcome
5	Inclusion of social dimensions apart from physical parameters (air, water, groundwater, drainage patterns, etc.) in post-closure monitoring	Social dimensions like social sustainability, economic sustainability apart from environment sustainability to be included in the post-closure monitoring.	As per the guidelines issued by Ministry of Coal, Govt. of India, post-closure monitoring of air quality and water quality is to be carried out for next 3 years. This monitoring can be extended to social dimensions so that many civic facilities, such as educational facilities, health facilities, and drinking water provided by the mine management do not get discontinued after the mine closure. Few years prior to intended closure, the local body, in consultation with State Government agencies, would be trained and given hands on experience in management of the above mentioned basic facilities so that they could efficiently manage the affairs in the post closure period. For the first 3 years, the mine management would help the entrusted body in the management of such facilities. Thereafter final transition shall be made. Some skill development programmes under guidance of dedicated NGOs would be conducted at regular intervals as part of mine closure plan activities.	It will assist the mine authority to better assess the socio-economic conditions of the area post-closure. After assessment, if needed, a lump sum amount would also be paid to the local bodies/ Trust of local people/State bodies for proper upkeep and maintenance of various community facilities.
6	Introducing the social aspects of closure in the relevant acts or guidelines issued by national governments	Equal focus on environmental sustainability and social sustainability of the area post closure.	Necessary amendments can be made in the relevant acts to incorporate the social aspects of closure	This will assist the government in fixing the liabilities as per the rules and regulations and will improve the monitoring mechanism of the government agencies.

CONCLUSION

Community Participation is an important aspect of Mine Closure Planning. Mining companies and government agencies particularly in India need to make more focus on social aspects of the Closure Planning so that the reclaimed mining area after closure can be utilised sustainably by the local populace. This will bring more confidence among the local communities and the mining companies. It will also help in achieving Goal No. 11 of Sustainable Development Goals (SDGS) adopted by United Nations in 2015 that sets a target of sustainable cities and communities. Goal No. 11 states "Making cities sustainable means creating career and business opportunities, safe and affordable housing, and building resilient societies and economies. It involves investment in public transport, creating green public spaces, and improving urban planning and management in participatory and inclusive ways" (UNGA, 2015).

Thus, it can be safely concluded that mine closure must incorporate the following principles:

1. No compromise on Health and safety of public in future
2. No further physical and chemical deterioration of the local environment after closure
3. The after-use of the site is beneficial and sustainable in long term
4. Minimisation of any adverse impact on socio-economic fabric
5. Maximisation of all the benefits towards socio-economic aspects (Organization for Security and Co-operation in Europe, 2005).

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Air quality assessment during the COVID-19 lockdown period at Talcher Coalfield of Odisha

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Abstract

On a global scale, the COVID-19 pandemic has profoundly impacted various facets of human society, encompassing healthcare, economic structures, and social dynamics. The implementation of widespread measures, such as business closures and social distancing, has yielded unprecedented regional consequences. In mining regions, the heightened concern revolves around particulate pollution, a consequence of diverse mining activities that generate dust, adversely affecting the health of both workers and residents in nearby areas.

The primary objective of this study is to assess the air quality during the COVID-19 lockdown period, considering that coal mining, categorized as an essential service, continued unabated. The investigation was carried out in the Talcher Coalfield, where compliance with established standards was consistently excellent. Notably, PM_{10} levels remained below 100 µg/m^3 for more than 90% of the time. Comparative analysis with data from previous years revealed a substantial reduction in pollution levels, with values decreasing by approximately two-fold for both SPM and PM_{10}.

Keywords: Coal Mining, COVID-19, Air Pollution, PM_{10},

1.0 Introduction

Globally, COVID-19 pandemic has substantially affected human society, including health care, economic structures, and social relationships (Kaye at el., 2021). A global response that includes closures of businesses and social distancing has wrought unprecedented regional consequences (Berman at el., 2020). While the severe health impacts of the COVID-19 emergence remain the top priority, it is still unknown how the pandemic may impact other factors, notably the hazard of air pollution (Sharifi at el., 2020). In the past decade, the impact of air pollution on public health, particularly concerning airborne particulate matter (PM), has garnered significant attention from both the air quality management community and regulatory authorities (Almetwally, al el, 2020). In India, the

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National Ambient Air Quality Standards of 2009 (NAAQS-2009) establishes a comprehensive legislative framework for regulating air quality in populated areas and GSR 742(E) 2001 for the coal mines (Kumar at el., 2022). Within this framework, specific target values have been recommended for pollutants known to pose threats to public health, environmental well-being, and the integrity of built infrastructure. Notable among these pollutants are particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), among others (WHO, 2006). Poor air quality has come to be recognized as a serious health risk and drag on economic development in India. Though there are many types of air pollutants, these small particulates in the air, about one-thirtieth the width of a human hair, are the most harmful to human health (Chang at el., 2016). They can penetrate deep into the lungs, enter the bloodstream and cause deadly illnesses such as lung cancer, stroke, and heart disease. Air pollution exposure is an important and persistent risk factor for cardiovascular and respiratory health outcomes (Artíñano et al., 2007). With rapid economic growth and increases in energy consumption, India has suffered serious air pollution in recent decades, especially high levels of particulate matter in Industrial zones (Sekar at el., 2021). The development of effective remedies for the air pollution problems will require a thorough understanding of the chemical composition, sources, and formation of aerosols (Pöschl 2005). Due to COVID-19, nation-wide lockdown was declared from 25th March 2020 to 14th April (21 days) which will further be extended for the period of 19 days till 3rd May-2020 which again extended in form third phase and forth phase till 31st May-2020 (Yadav at el., 2023). Since only essential services were allowed during the lockdown period and all other non-essential services are stopped so this allow us to conduct a special study in coalfield region that how much air pollution is caused due to the coal production. Coal industry is always held responsible by different regulatory bodies and public for the high particulate pollution in the region (Yadav at el., 2023). So, this real-time study in coalfield region will provide the insight regarding the dispersion of air pollution in region. The only activity was allowed in region was related to coal mining and power production to meet the energy demand during lockdown period.

This pioneering study aims to elucidate the distribution of particulate concentration in the coalfield region during the lockdown period. By doing so, it will contribute to our understanding of how the air quality in the study area is influenced by the nationwide lockdown. The insights gained from this study will be instrumental in discerning the extent of coal mining's impact on air quality in the coalfield region.

2.0 Material and Method

2.1 Study Area

This study was conducted in Talcher coalfield which is in command area of MCL. Four sampling location were identified in Talcher Coalfield (shown in figure 1). In this study only Particulate Matters which included SPM, PM_{10} and $PM_{2.5}$ has been monitored as these are considered as major source of pollution in Coalfield region. The frequency of monitoring at each station was weekly 5-6 times. The study period was from 03.04.2020 to 06.06.2020. Monitoring was done as per CPCB and NABL requirement. All the filter papers are kept in the field in desiccator and finally analysis has been done in REC lab, CMPDI RI-VII, Bhubaneswar.

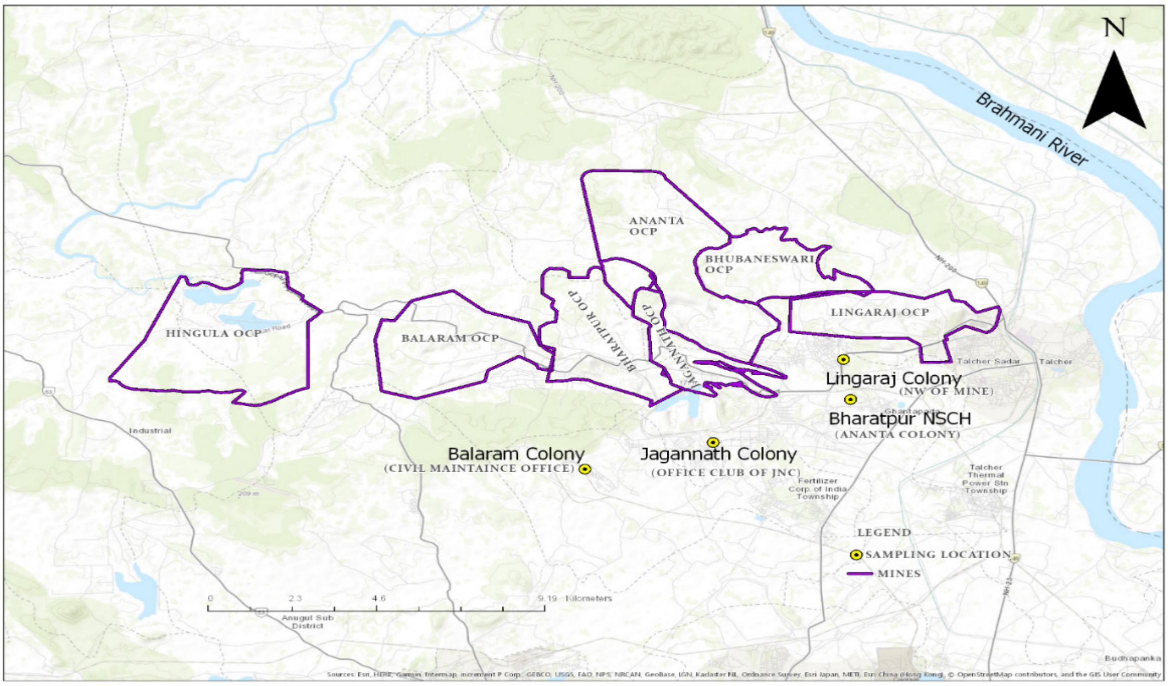

Figure-1: Study area of Talcher Coalfield showing monitoring location

2.2 Sampling and Instrumentation

Sampling methodology and Instrument used in this study is shown in Table 1. RDS were used for SPM and PM_{10} while FDS were used for $PM_{2.5}$ sample collection. For analysis of SPM and PM_{10}, electronic balance was used while 6 digit micro-balance was used for $PM_{2.5}$ analysis.

Sl No.	Parameters	Method	Instruments
1.	SPM and PM_{10}	IS:5182 (Part-23):2006 Cyclonic Flow Technique, Gravimetric Method	Respirable Dust Sampler, Electronic Balance
2.	$PM_{2.5}$	Guideline for the measurement of Ambient Air Pollutants, Volume –I, May 2011	$PM_{2.5}$ Sampler, Micro Balance

3.0 Result and Discussion

3.1 Scenario in Talcher Coalfield

3.1.1 SPM/TPM

In the Talcher Coalfield, throughout the lockdown period, the Suspended Particulate Matter (SPM) exhibits a range of concentrations, ranging from 85 µg/m^3 at Lingaraj OCP to 220 µg/m3 at Lingaraj Colony. The average SPM values range between 127 µg/m^3 (Lingaraj Colony) and 138 µg/m3 (Balaram Colony). Remarkably, a consistent distribution of SPM concentrations is evident across all four locations, as illustrated in Figure 2. The upper line in the figure represents the maximum value, the lower line corresponds to the minimum value, the lower part of the box indicates the 25th percentile, the upper box denotes the 75th percentile, the middle line signifies the 50th percentile, and the red dot pinpointed on the figure represents the mean value.

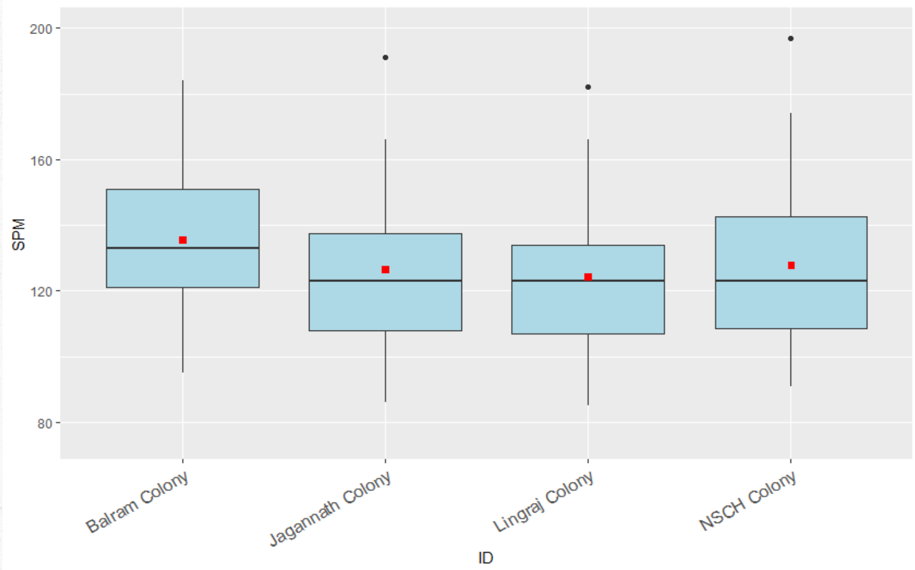

Figure:2 Box Plot of SPM in Talcher Coalfield

3.1.2 PM_{10}

The maximum concentration of PM_{10} was recorded at NSCH (Bharatpur), reaching 148 µg/m³, whereas the minimum was observed at Jagannath Colony with a value of 52 µg/m³. The average PM_{10} values range from 79 µg/m³ (Lingaraj Colony) to 85 µg/m³ (Balaram Colony). In parallel with the observations for SPM, the PM_{10} values did not exhibit significant variation, and a consistent distribution pattern was observed at all four locations, as depicted in Figure 3.

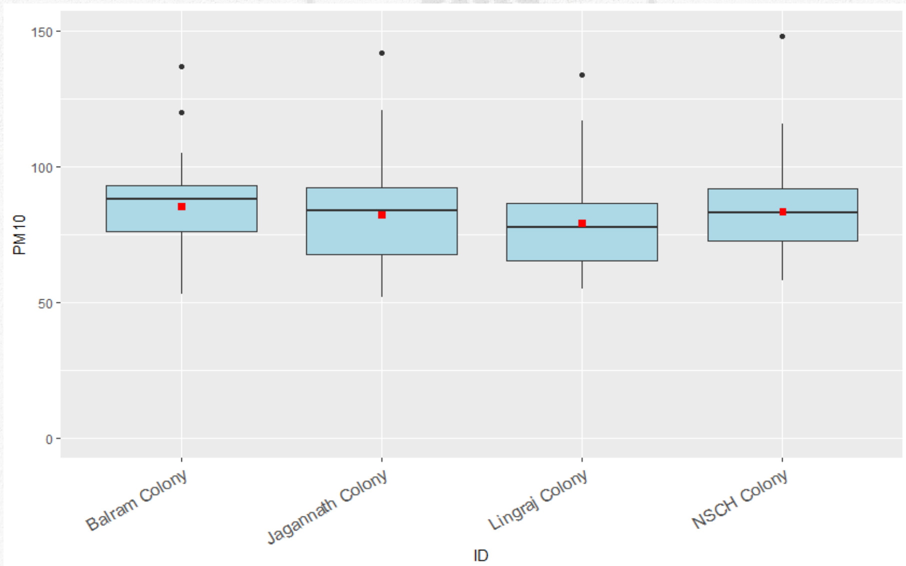

Figure:3 Box Plot of PM10 in Talcher Coalfield

3.1.3 $PM_{2.5}$

The highest concentration of $PM_{2.5}$ was noted at Jagannath Colony, registering 65 µg/m³, while the lowest values were observed at both Jagannath and Lingaraj Colony, each recording 20 µg/m³. Average $PM_{2.5}$ values range from 32 µg/m³ at NSCH (Bharatpur) to 33 µg/m³ at Lingaraj, Balaram, and Jagannath Colony. Consistent with the patterns observed for SPM and PM_{10}, the distribution of $PM_{2.5}$ values follows a similar trend across different locations, as illustrated in Figure 4

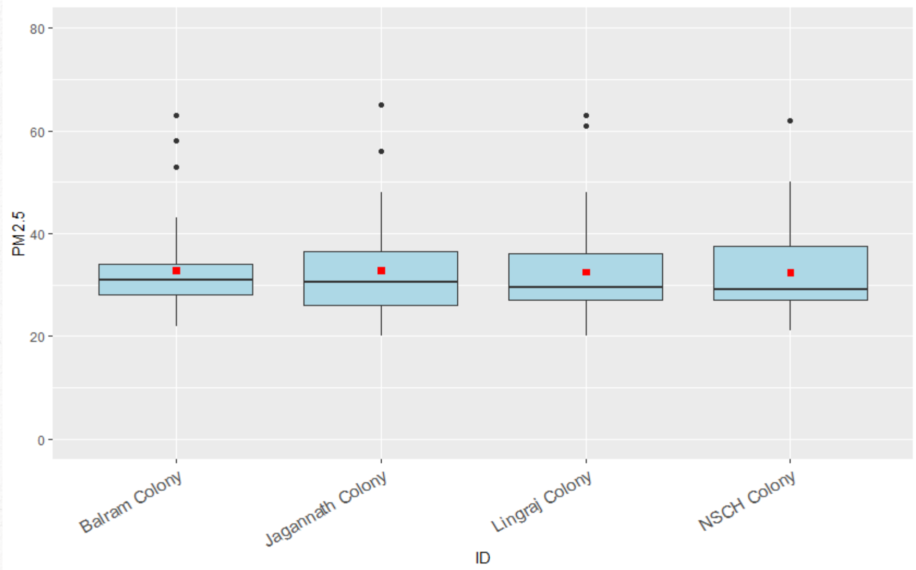

Figure:4 Box Plot of PM2.5 in Talcher Coalfield

3.2 Temporal Variation in Talcher Coalfield

3.2.1 SPM/TPM

Figure-5 shows the temporal variation of SPM at all four location during the lockdown period. Initial value at location shows the maximum spike after which it declines at all location. Since the monitoring has been done in residential area for which no standard has been prescribed by CPCB for the SPM while for core zone as per GSR(742), 2001, it is 250 µg/m^3 for new mines and 300 µg/m^3 for old mines. Concentration of SPM is lower to 250 µg/m3 throughout the study period.

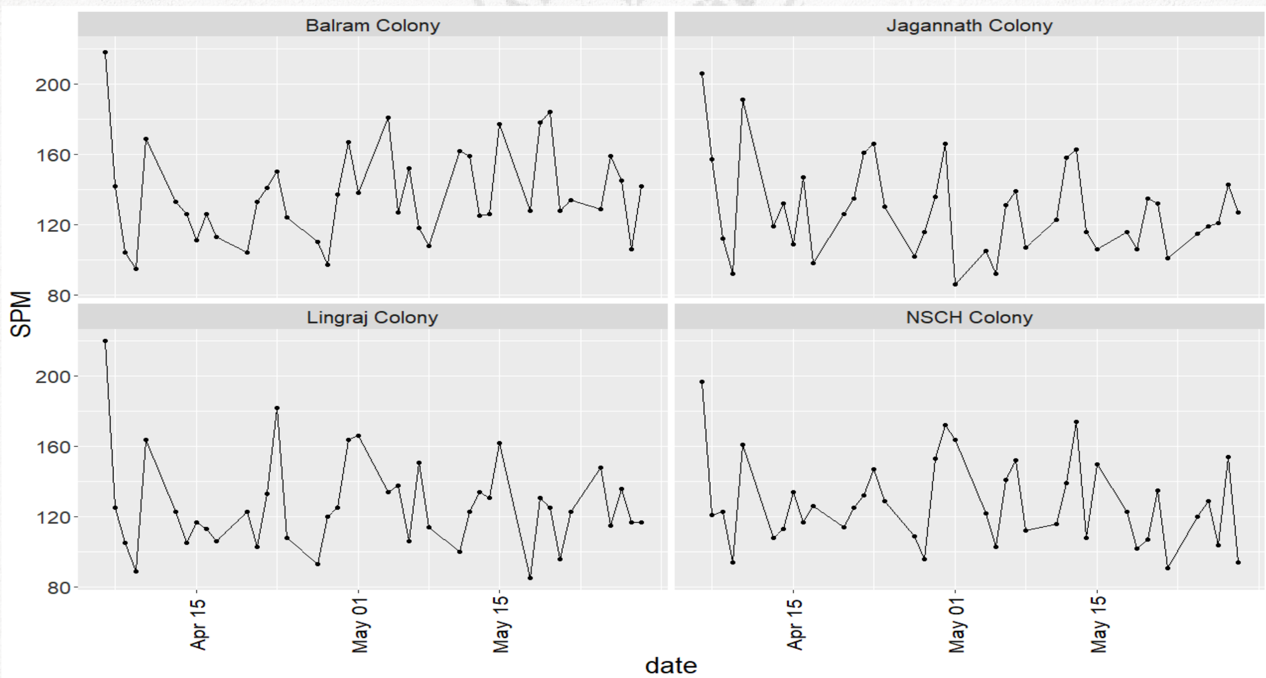

Figure:5 Temporal variation of SPM in Talcher Coalfield

3.2.2 PM_{10}

Figure-6, shows the trend of PM_{10}. Similar to SPM values of PM_{10} was spiked during initial days of monitoring campaign. CPCB standard for PM_{10} is 100 µg/m^3, comparing to standards 92.5% of times values are complied to standards at Balaram Colony and NSCH (Bharatpur) while at Jagannath OCP and Lingaraj Colony compliance rate was 90% of time. The values show that there has been good compliance to standard in coalfield region as the values of particulate matter are high in general at coalfields. It shows that there has been some effect of lockdown due to which such good results obtained.

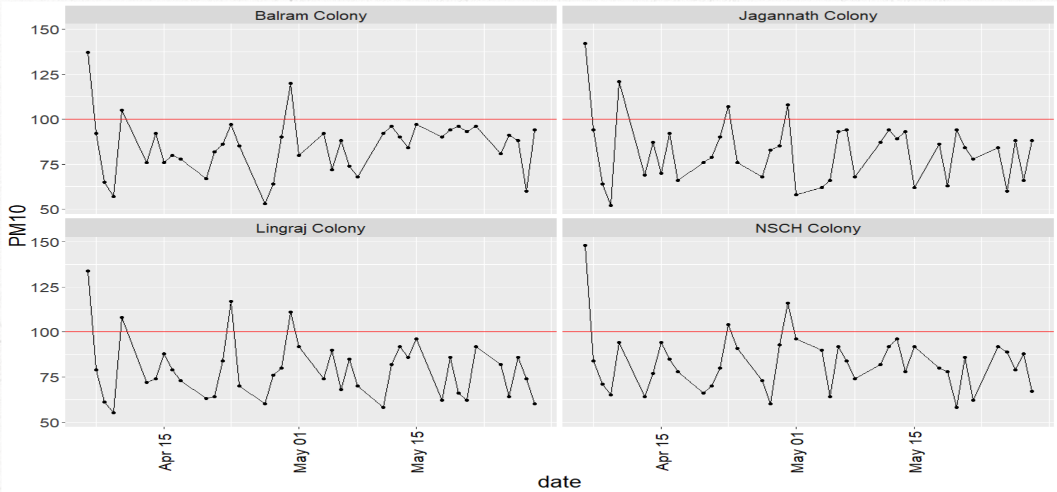

Figure:6 Temporal variation of PM10 in Talcher Coalfield

3.2.3 $PM_{2.5}$

Trends of are also similar to SPM and PM_{10} for in case of $PM_{2.5}$. Initial value shows highest peaks then after is reduces (Fig-7). CPCB standard for $PM_{2.5}$ is 60 µg/m^3. Compare to standards 97.5% of times values of $PM_{2.5}$ was in compliance to standard at Balaram, Jagannath and NSCH (Bharatpur) colony while at Lingaraj 95% of times compliance was observed. Such good compliance to standards in coalfield region is definitely due to the lockdown when non-essential services were completed stopped.

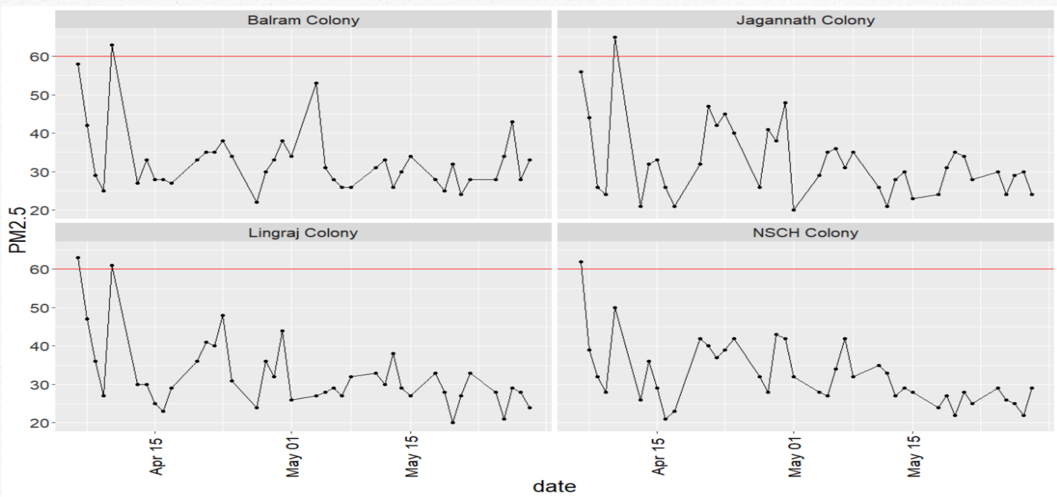

Figure:7 Temporal variation of PM2.5 in Talcher Coalfield

3.3 Effect of Lockdown

To assess the impact of the lockdown on pollution reduction, a comparative analysis was conducted between 2019 and 2020 data for the same period. The average values of 2019 data are represented by green bars, while the values for 2020 are depicted by blue bars. Due to the stringent nature of the lockdown, selecting identical locations for Routine Environmental Monitoring (REM) in both years proved challenging. However, the closest available monitoring locations from the 2019 REM sites were chosen for comparison with the current monitoring locations. Fortunately, in the Talcher coalfield, all the current monitoring locations align with the previous REM locations, albeit with different names in the REM records.

3.3.1 Lingaraj & Jagannath Colony

In Lingaraj Colony, there has been a notable decrease in the concentrations of SPM and PM_{10}. Specifically, the reduction in SPM levels was 2.5 times in April, as illustrated in Figure 8, while the reduction in PM_{10} levels during the same month was 3.4 times. Subsequently, in May, the reduction in SPM levels further decreased to 3.4 times, and for PM_{10}, the reduction was 4.6 times. Regarding $PM_{2.5}$, there was a 3.3 times increase in April, which remained consistent in May. It's worth noting that the absolute value of $PM_{2.5}$ remained relatively low.

Similar trends were observed in Jagannath Colony, where the reduction in SPM levels was 1.6 and 2.4 times in April and May, respectively. Likewise, for PM_{10}, reductions of 2.24 and 3.24 times were observed in April and May. In the case of $PM_{2.5}$, the values decreased from 45 µg/m^3 in April 2019 to 37 µg/m^3 in April 2020, and a 1.7 times reduction was observed in May compared to the previous year.

Figure:8 Comparison of 2019 and 2020 pollution level in Talcher Coalfield

3.3.2 Balaram and NSCH (Bharatpur) Colony

Similar to Lingaraj and Jagannath Colony, NSCH (Bharatpur) exhibits a noteworthy reduction in SPM and PM_{10}. In April, the SPM values decreased by 2.2 times, and in May, the reduction was 1.3 times compared to the previous year's data. The PM_{10} values showed a reduction of 2.4 and 1.5 times in April and May, respectively. Although there was a slight increase in $PM_{2.5}$ values in April, a subsequent reduction to 1.7 times compared to the previous year was observed. It's important to note that the absolute values of $PM_{2.5}$ remained consistently low for both years.

In Balaram Colony, reductions in pollutant values were also evident. SPM levels decreased by 1.5 and 1.94 times in April and May, respectively. Similarly, for PM_{10}, reductions of 1.7 and 2 times were observed in April and May. However, the values of $PM_{2.5}$ increased compared to the previous year, rising from 28 $\mu g/m^3$ to 35 $\mu g/m^3$ in April. Subsequently, a reduction of 1.77 times was noted in May, as depicted in Figure 9.

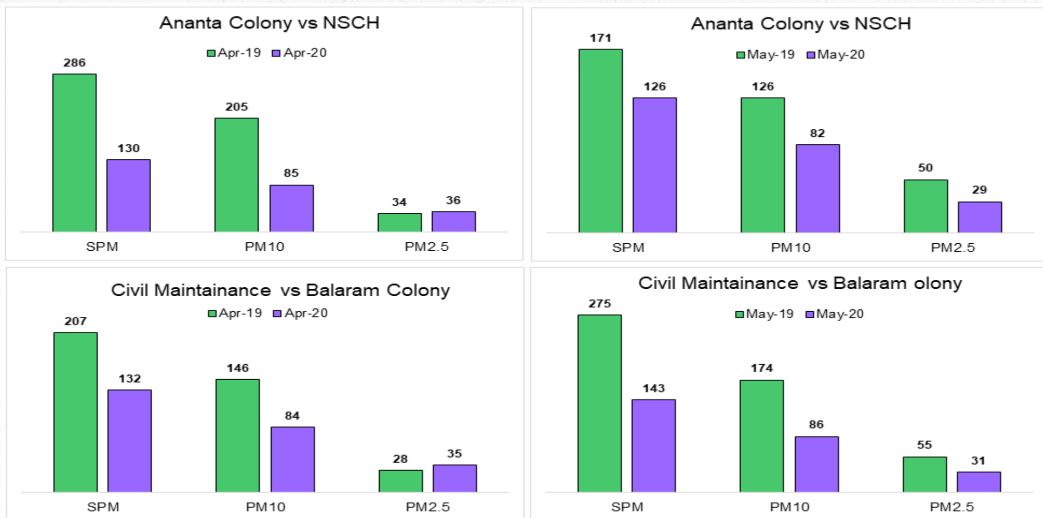

Figure:9 Comparison of 2019 and 2020 pollution level in Talcher Coalfield

3.4 Discussion

Upon comparing the current data from Talcher Coalfield during the lockdown period with data from previous years, a notable reduction in particulate matter is evident, especially for SPM and PM_{10} - two major pollutants in the coalfield region. The reduction in pollution levels coincides with the lockdown restrictions that led to the cessation of non-essential activities, allowing only coal mining to continue. Compliance with environmental standards was consistently good during the study period.

While the values of $PM_{2.5}$ exhibited some variability, with occasional increases observed in April followed by reductions in May, the overall values remained low compared to the established standards. The compliance with $PM_{2.5}$ standards was also consistently good. This observation underscores that in mining areas, various associated activities, such as public transport, operation of local eateries, and domestic activities, contribute to elevated pollution levels. The reduction in pollution during the lockdown, with only essential coal mining operations ongoing, highlights the impact of these ancillary activities on the overall pollution levels in the region.

Additionally, the significant reduction in SPM and PM_{10} levels during the lockdown period in Talcher Coalfield suggests that the restrictions imposed on non-essential activities had a tangible impact on air quality. The focus on coal mining, as the primary ongoing activity, played a pivotal role in curbing emissions from major pollutants. This reduction not only aligns with environmental goals but also indicates the potential effectiveness of targeted interventions in mitigating pollution in industrial regions.

The compliance with environmental standards throughout the study period further underscores the success of regulatory measures in maintaining air quality within acceptable limits. This positive outcome suggests that adherence to strict lockdown measures can result in immediate improvements in air quality, particularly in areas with industrial activities.

Despite the overall reduction in pollution, the varying behavior of $PM_{2.5}$ values in April and May raises interesting questions. The observed fluctuations may be attributed to multiple factors, including local meteorological conditions, changes in coal mining activities, or the influence of other anthropogenic sources. Further investigation into these dynamics could provide valuable insights into the specific factors influencing $PM_{2.5}$ concentrations and help refine strategies for sustained pollution control.

The consistently low absolute values of $PM_{2.5}$ compared to standards, along with good compliance, indicate that this fine particulate matter remained relatively well-controlled even during the lockdown. This suggests that the coal mining operations, while contributing to overall pollution reduction, may not be a primary source of $PM_{2.5}$ in the region. The broader implication of these findings is that addressing pollution in mining areas requires a comprehensive approach that goes beyond the mining activities themselves. Understanding and managing the associated factors, such as public transport, local businesses (like desi dhabas), and domestic activities, are crucial for achieving sustained improvements in air quality.

In conclusion, the observed reduction in pollution levels during the lockdown period in Talcher Coalfield reflects the immediate impact of targeted restrictions on non-essential activities. Further research and ongoing monitoring are essential to unravel the complexities of pollution dynamics in mining areas, allowing for the development of holistic strategies that address the multifaceted sources of pollution in these regions.

4.0 Conclusion

1. In Talcher Coalfield, there is reduction in particulate pollution due to the lockdown.
2. Compliance against the standards has been observed very good and for more than 90% of time PM_{10} was below the 100 µg/m^3.
3. Compared to previous years data, there has been significant reduction in pollution level. Values are reduced approximately 2 times or more of earlier values for SPM and PM_{10}.
4. In May month more reduction is observed, the probable reason for that is, upto May month, more than 1 month has been completed for lockdown and due to which in this time period, background values get time to settle. So, better results obtained in May month.
5. Overall, due to lockdown air quality is increased in coalfield region. High pollution level in usual time indicate that other anthropogenic sources are also associated for high particulate values in these regions.
6. The observed reduction in pollution levels during the lockdown period in Talcher Coalfield reflects the immediate impact of targeted restrictions on non-essential activities.
7. Further research and ongoing monitoring are essential to unravel the complexities of pollution dynamics in mining areas, allowing for the development of holistic strategies that address the multifaceted sources of pollution in these regions.

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DRY BENEFICIATION OF COAL AND ITS RELEVANCE TO ENVIRONMENTAL SUSTAINABILITY

Abha Prasad [1], Charu Oberoi [2]

Abstract

Coal accounts for about 55% of the country's energy need and its usage for power generation is expected to rise in the coming years. Indian coal is characterized by high ash content. Combustion of high ash coal for electricity generation is a major source of emission of particulate matter, oxides of sulphur (SOx) and hazardous trace elements such as mercury and arsenic. These environmental issues can be mitigated by employing efficient coal beneficiation methods. Mostly upgradation of coal is carried out using conventional wet processes. However, many regions experience water scarcity, hence, upgrading coal using wet processes is not always possible. Dry beneficiation of coal is an alternative to the current wet processes and has received a lot of attention over the past decade not only due to the scarcity of fresh water in coal-producing countries but also due to process benefits in downstream utilization.

This paper presents a summary assessment of different dry beneficiation technologies for processing of coal. CIL initiatives in the field of dry beneficiation has also been dealt. Dry beneficiation of coal is a step towards conservation of water, one of the most precious natural resource apart from harnessing the benefits of using cleaner coal for power generation.

1.0 BACKGROUND

Coal is the most important and abundant fossil fuel, accounting for 55% of the country's energy need. Driven by the rising population, expanding economy and a quest for improved quality of life, energy usage in India is expected to rise in the coming years though India, at the 26th session of the United Nations Framework Convention on Climate Change (COP 26) in November, 2021, announced its target to achieve net zero by 2070.

Indian coal is characterized by high ash content (incombustible mineral matters, mostly about 40-45% ash) due to its drift origin. Direct burning of high ash coal for energy affects efficiency of coal-fired electricity generation plants and is a major source of emission of particulate matter, oxides of sulphur (SOx) and hazardous trace elements such as mercury and arsenic. Most of these environmental issues can be mitigated by employing efficient coal beneficiation methods which are not widely

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practiced by power industry yet. This could result in smaller carbon footprint.

Coal preparation is an important means of clean and efficient utilisation of coal as it is not only more efficient in terms of combustion, but also more uniform in size, composition, calorific value and moisture content. The benefits of efficient beneficiation processes to the downstream industry and environment include more reliable and uniform operation, lower SOx emission (and consequently less flue gas desulfurization requirement). In addition, the transport of such high-ash coal across long distances is wasteful as it carries large quantities of ash-forming minerals that cause further congestion in already constrained rail transportation and port-handling systems. The transport of high ash coal across long distances also contributes to the emission of carbon dioxide (CO_2) and other greenhouse gases (GHG) from the mode of transport (rail and road).

Washing of coal helps in maintaining consistency in the quality of coal supplied. A number of studies carried out earlier on the use of washed coal for power generation have proved it to be beneficial from both environmental and economical points of view.

Mostly upgradation of coal is carried out using conventional wet processes. Wet beneficiation is well adopted mainly due to the sharper separation and higher separation efficiency achieved in modern wet processing techniques such as heavy media separation (dense medium vessel or dense medium cyclone), jigging, spirals and flotation. The wet process system, however, is complicated and the production cost is high due to the restriction of medium recovery, tailings water treatment, etc. However, many regions experience water scarcity, hence, upgrading coal using wet processes is not always possible, and in some cases, it is used in its natural state, leading to even more environmental pollution.

Dry beneficiation of coal is an alternative to the current wet processes and has received a lot of attention over the past decade not only due to the scarcity of fresh water in coal-producing countries but also due to process benefits in downstream utilization. The economic consideration of dry beneficiation is obvious as coal is mainly used as a fuel and no energy is expended in drying the coal. Compared to wet separation, dry coal preparation, without water, medium, and tailings, has the advantages of less investment in infrastructure, low operating cost, energy conservation, etc.

2.0 DRY BENEFICIATION TECHNOLOGY

Dry beneficiation methods have been in use since the earliest days of the coal industry and are known to exist around 1910-1930 in the United States (USA) and were prevalent in the industry in the early to mid-1900s. Dry separation techniques provided low capital cost and maintenance operations. However, lower separation performance than water-based methods, sensitivity to variations in feed moisture and the inability to treat fine coal limited the applicability of the technology. By 1990 many of the dry-cleaning plants were closed due to dust exposure regulations and the demand for higher quality requiring more efficient low-density separations.

Recent renewed interest in dry beneficiation methods has been largely driven by shortages of water in arid and permafrost areas, recent improvements in separation efficiency, and also environmental concerns over tailings disposal. However, there are also many other significant potential benefits, including the increased product calorific value and reduced haulage cost of a dryer product, reduced energy use during processing, and plant simplification by the elimination of dewatering and tailings circuits. Even when wet processing is subsequently used, there may still be benefit in using dry processing in an initial de-stoning/deshaling step. This approach reduces the load in the subsequent water-based circuit. Dry processing is well suited to this de-stoning step as dry processes are most effective on large particles and are also relatively unaffected by feed moisture for coarser particles.

The dry processes for coal are based on the physical properties of coal and its associated mineral matters. Different types of equipment for dry beneficiation have been developed, based on the exploitation of physical properties such as density, size, shape, friction, electrical conductivity and magnetic susceptibility.

Dry coal beneficiation is mainly classified into the following five categories according to different beneficiating mechanisms:

i. Air table/ Air fluidized vibrating deck separation
ii. Air jigs based on stratification
iii. Air dense medium fluidized bed separation
iv. Tribo-electrostatic separation
v. Magnetic separation

These five categories of technologies have their own advantages respectively in processing certain coal or yielding clean coal product with certain quality. Generally speaking, air tables and air jigs do not need additional dense medium and usually have larger capacities and lower processing cost, but lower separation efficiency due to the original limitation of separation mechanism. These technologies are suitable for thermal coal. In contrast, air dense medium fluidized bed separation, tribo-electrostatic separation and magnetic separation usually have high separation efficiency but high operational cost, which are suitable for producing high quality clean coal. Besides, the electrostatic separation technologies and the magnetic separation technologies have high requirements for coal properties and certain degree of dissociation, thus, the handling capacities are limited. Considering these limitations, these two types of beneficiation technologies are only used in very special purpose.

Air tables, air jigs and air dense medium fluidized bed separators are more widely used for dry separation to upgrade coal quality. Brief description of these are given hereafter:

2.1 Air Table

Air table technologies have seen a re-emergence with modern technology upgrades including automation to provide a more efficient separation performance. An example of a modern air table is the Air Fluidized Vibrating Deck Separator (AFVDS) eg. FGX Dry Separator. This unit consists of a perforated table surface with riffles. The table is suspended in an inclined position both in the longitudinal and transverse directions as shown. Air blown up through the perforations partially suspends the material and the vibrations move particles towards the refuse end. The vibration causes coarser particles to rise above the fine particles (the Brazil nut effect), with lower density particles tending to lie above high-density particles of the same size. The fluidising air tends to stratify the fine low-density particles above the coarse dense particles. Hence with suitable choice of vibration and airflow, mainly density-based stratification results. An air collection system is employed to clean the recycled air and to remove the dust from air being emitted into the atmosphere.

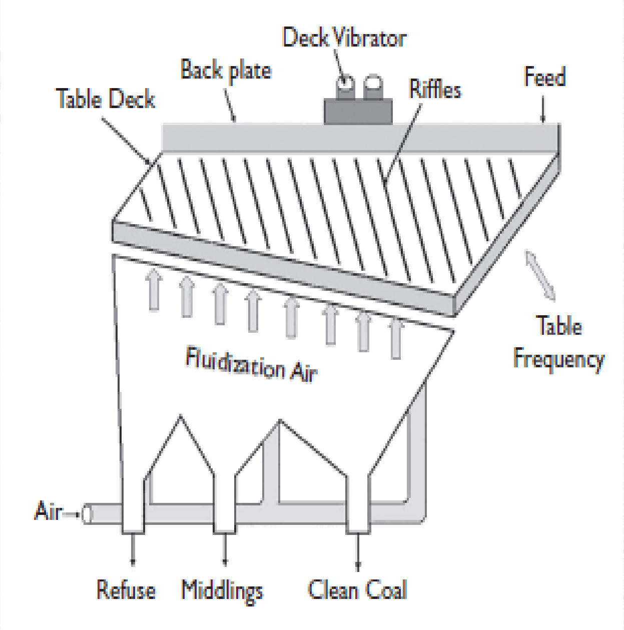

Figure 1: Air fluidized vibrating deck separator

The first commercial installation of FGX technology took place in the United States in the year 2009. More than 1500 FGX units have been installed in various coal operations around the world, with unit capacities ranging from 10 t/h to 500 t/h. High separation efficiency along with low cleaning costs has resulted in the widespread application of the FGX Dry Separator in China. The largest current commercial unit, the 25×20 m FGX 48A, processes coal from 6 up to 80 mm in size at a rate of 480 tph (FGX SepTech). They achieve Ep values in the range 0.20-0.30 and density cut points from 1.8 to 2.2. Hence, they are particularly well suited to de-stoning applications, and have even been adopted in that role in locations where water is plentiful. Also, 2 nos. of plant of capacity 30 tph each are operating in Poland for dry deshaling of thermal coal using air vibrating separators of FGX type. The size of coal processed is 50-0 mm. In USA, an installation of 500 tph dry deshaling plant with FGX Technology in West Virginia Underground coal mine is operating profitably. However, there is no plant installed with FGX technology at commercial level in India.

2.2 Air Jigs

Air jigs operate based on similar principals to the conventional jig but utilise air rather than water for stratification to affect the density separation. The first-generation air jigs operated in the USA from the 1930s to 1990 before being phased out. In the late 1990s all mineral developed next generation air jigs with improved air fluidisation and distribution systems and more advanced instrumentation and control systems and these have been installed in the USA, Colombia, Spain, Ukraine, and India. The nominal capacity is 30 to 60 tph for a 1.2 m x 2.4 m unit or up to 100 tph for a 2.4 m x 2.7 m unit dependent on feed size range with the lower capacities on the finer by zero feed types. In India, eight small capacity (mostly 50 tph) All air jig plants are operational for dry coal beneficiation.

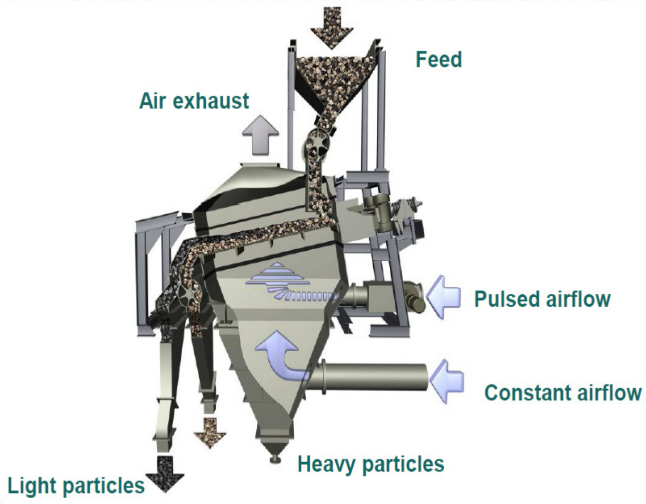

Figure 2: Schematic Sketch of allair®-air jig (all mineral)

The separation efficiencies are lower than conventional wet jigging. Middlings/reject ordinarily contains substantial misplaced material and is either retreated through a wet processing plant or blended for utilisation in fluidised bed boilers. These operational limitations reduce air jigging attractiveness to most coal applications. These air jigs can adequately treat particles in the size range 50-6mm, with the largest 2 m wide units able to handle 100 tph with Ep in the range 0.16 to 0.27 and density cut points from 1.8 to 2.2. Some air jigs are used to upgrade 6-0.5 mm coal at lower specific capacities and somewhat higher Ep values.

Overall, air jigs are well-suited for coal separation due to their ability to effectively separate coal particles based on density, their flexibility, and their relatively low operating costs.

2.3 Air Dense Medium Fluidised Bed Separators

Air Dense Medium Fluidised Bed Separators were tested using fluidising medium comprised of limestone, hematite and/or magnetite in the 1980s. The unit was tested across a wide range of raw coal sizes (-20 mm to 0.8 mm). The resultant separation provided Ep values of 0.25 to 0.24, aligned with those achieved by the conventional Baum Jig, but better than previous air jigs.

In recent decades, numerous small-scale successes have been documented using air dense medium fluidised beds. These tests used magnetite only as the medium and have recorded Ep values as low as 0.06 for -50 +6 mm fractions and 0.10 for -1 +0.42 mm fractions.

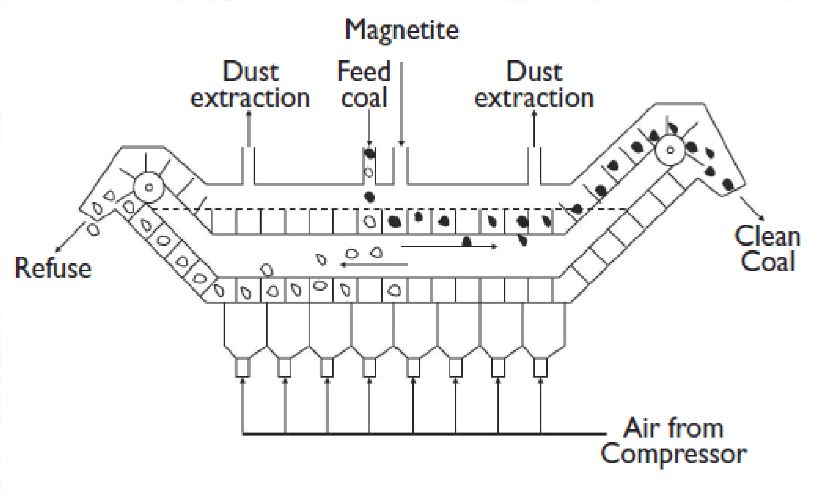

Figure 3: Air Dense Medium Fluidised Bed Separators

The ADMFB technique offers several advantages for coal separation:

1. Dry Operation: The process does not require water, eliminating the need for dewatering and reducing water consumption.
2. High Efficiency: The dense media particles provide excellent separation efficiency, resulting in high-quality coal products.
3. Wide Applicability: The ADMFB technique can be used for a wide range of coal sizes and types, accommodating various coal characteristics.

There is a restriction on the top size of the feed coal (i.e. below 50 mm). Also, limiting surface moisture (below 5%) required for the feed coal may restrict its applicability to some high moisture non-coking coals.

3.0 DRY BENEFICIATION TECHNOLOGY INITIATIVES IN CIL

Internationally, the coal produced from the mines (Run of Mine Coal) is generally prepared after crushing, sizing and washing before dispatching the same to the consumers. However, in India less than 10% of the non-coking coal produced is washed. As mentioned earlier, Indian coal has high ash content. More than 80% of non-coking coal produced is utilized for power generation, out of which about 70% is of Grade G11 or inferior. This high ash content coal leads to erosion in the power plant components, difficulty in pulverisation, poor emissivity and flame temperature, low radiative transfer, generation of excessive amounts of fly ash containing large amounts of unburnt carbon, etc. at user end.

Washing of coal by wet processes leads to addition of moisture which decreases the GCV. This issue can be addressing by resorting to dry beneficiation technologies. Dry beneficiation techniques are gaining attention in the coal industry due to their potential to reduce water consumption, eliminate the need for dewatering processes, and minimize environmental impacts associated with traditional wet beneficiation methods. While wet deshaling is prevalent in India, dry deshaling is of recent origin and being carried out on small scale or are still under R&D stage. Keeping this in view, Coal India Limited (CIL) is taking efforts in this direction.

3.1 R&D project on Air Fluidized Vibrating Deck Separator (NML, CMPDI and MCL)

An R&D project viz. dry processing of high ash indigenous thermal coal, sponsored by CIL was undertaken with joint collaboration of CSIR-NML, CMPDI and MCL with an objective to explore the possibility of dry beneficiation of non-coking coals from Hingula mine of Talcher coalfield and Lakhanpur mine of IB Valley coalfield by air-fluidization technique (Air Fluidized Vibrating Deck Separator) and to develop a technology for producing clean coal with 34% ash for application in thermal power plants. The detailed experimental work was carried out at CSIR-NML, Jamshedpur at laboratory scale of 10 tph. The project was successfully completed in June 2020. The results of coal from Hingula mine were found to be encouraging with organic efficiency of about 91 %.

3.2 R&D project on air dense medium fluidized bed separator (IIT KGP, CMPDI, MCL & BCCL)

An R&D Project titled Upgradation of low-grade Indian coals through dry and chemical beneficiation with Indian Institute of Technology Kharagpur (IIT KGP), CMPDIL, Ranchi; Mahanadi Coalfields Limited (MCL), Sambalpur, Odisha & Bharat Coking Coal Limited, Dhanbad is in progress. The main objective of this project is to develop a process for dry beneficiation of coal in air dense medium fluidized bed separator for coarser size fraction (50-6mm). This separator technology is an emerging trend which is more promising compared to other dry beneficiation technologies.

Non-coking coal samples from Samleshwari, Garjanbahal and Bhubaneshwari OCPs (MCL) and coking coal samples from Ena, Kuya & Bastacolla OCPs (BCCL) have been considered for the study. The project is scheduled to be completed by September 2024.

3.3 Setting up of deshaling plants in various subsidiaries of CIL

A technical committee has been constituted by CIL in April 2023 to identify mines in subsidiaries of CIL for setting up of non-coking coal washery/ deshaling plant to improve coal quality. Prima facie, five mines have been identified for setting up of deshaling plants in various subsidiaries. In one of the mines of ECL, due to scarcity of water in that region, dry technology has been envisaged for deshaling of coarse coal fraction i.e. 50-6mm and mixing of natural -6mm coal fraction with deshaled coal to give washed coal. Air Fluidized Vibrating-Desk Separator (AFVDS) has been considered for dry deshaling as this equipment has been found to give encouraging results in the R&D project carried out at CSIR-NML, Jamshedpur.

4.0 CONCLUSION

Dry coal beneficiation has an inherent advantage since it uses no process water and reduces the costs that are associated with process water, fines dewatering and slurry confinement. Dry coal beneficiation is more suitable for coal cleaning in dry regions that lack available processing water. As India relies heavily on coal for energy supply, efforts should be made to utilize non-coking coal to meet the increasing required energy consumption and protect the coking coal resource. Thus, it is imperative to develop high-efficiency dry coal beneficiation to support the utilization of non-coking coal. Advanced dry separation technology that has low dust emission and saves water and electricity should be envisaged to improve the quality of thermal coal for power generation. The investment in dry coal preparation plant is generally $1/3^{rd}$-$1/4^{th}$ of that of wet process plants, and the operating cost is almost half or less than of that of wet processing plants.

R&D initiatives should be undertaken for improving the separation stability and the separation efficiency of dry coal beneficiation technologies. Furthermore, some demonstration plants based on dry coal beneficiation systems should be established for research and academic studies for providing an advanced research platform. The significance of developing dry coal beneficiation should be paid sufficient attention and the policy support and adequate financial support are required to facilitate the considerable progress in coal dry cleaning.

Dry beneficiation of coal will be a step towards conservation of water, one of the most precious natural resource apart from harnessing the benefits of using cleaner coal for power generation.

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Report on "Setting up of deshaling plants in various Subsidiaries of CIL" (2023) by technical committee has been constituted by CIL

Accredited Compensatory Afforestation – Considerations and Opportunities for Responsible Diversion of Forest Land for coal mining Projects

Dr Manoj Kumar[1]

Abstract

The paper will explore ways to effectuate robust governance system ensuring application of effective diversion of forest land with focus on Just Transition and focusing repurposing activities being sensed beyond mine closure. Diversion of forests land for non forest use is one of the contentious area having varied dimensions including environment, social and development challenges. Identification of land for Compensatory afforestation (CA) and preparation of schemes are causing delay in processing of proposals.

This paper further examines all equivocal issue and elaborates the concept of Accredited Compensatory Afforestation (ACA) as per FCR-2022, its provision, eligibility, criteria, and mechanism of raising ACA through development of a portal. Formulating proposals under FCA-1980 has been made available in flow sheet developed under this research work. Proactive afforestation, obviate delays, flow of ESG in advance, investment in forest sector, meeting NDCs targets, cost saving etc. are some of the benefits flagged for User Agency (UA) & community in and around the forest area. Issues to be addressed have been pin pointed in this paper which will help the coal mines managers in considering the CA aspects as an opportunity for responsible diversion of forest land for coal mining projects through social, environment & developmental challenges in addressing forest clearance process in their mining complexes.

Keywords: Accredited Compensatory afforestation, Just Transition, Portal, Transparency.

1.0 Introduction

While it is convenient to set avowed goals to achieve sustainable development objectives, it is challenging to implement and achieve these targets. The fine balance between development and environment has to be maintained while ensuring climate justice. Compensatory afforestation is one of the pivotal element in diversion of forests land for non forest use and is one of the contentious area having varied dimensions including environment, social and development challenges. Union

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Government had earlier provided a framework for compensatory afforestation, wherein afforestation was done on another land in lieu of the loss of forest cover due to the use of forest land for non-forest purposes. The mechanism involved inter alia payment of compensatory afforestation levies by the person making such proposals and handing over of another land identified for compensatory afforestation to the relevant forest department. The size of the land to be handed over was determined as per the Rules. The Union Government was not expected to grant final approval for the use of forest land unless the requirement for compensatory afforestation was fulfilled.

Compensatory Afforestation means that when the forest land is utilized for non-forest purposes. The company/ User Agency (UA) have to provide alternate land as compensation for the occupied one. The area of forest land lost is compensated with an equal area of non-forest land. If non-forest land is not available, degraded forest land that is double the area of cleared forest land has to be afforested to recompense.

2.0 Forest Conservation Rules 2022 and Accredited Compensatory Afforestation

The Ministry of Environment, Forest and Climate Change has notified the Forest (Conservation) Rules, 2022 (FCR-22) in supersession of Forest (Conservation) Rules, 2003. The focus on accredited compensatory afforestation in these Rules indicates that it is a critical area of concern for the Union Government, which is mindful that there is a need for improving the mechanism. However, it remains to be seen as to how the Rules are implemented to remove the challenges and shortcomings in the earlier process to improve the forest cover in the country through compensatory afforestation. Accredited compensatory afforestation means a system of proactive afforestation which can be used instead of fulfilling obligations for compensatory afforestation. To avail this, a person should have:

(a) Established afforestation over land on which the Act is not applicable and is free from all encumbrances;
(b) Planted trees having canopy density of 0.4 or more and those trees are at least five years old; and
(c) Afforested over one-hectare area with 0.4 or more canopy density.

The Rules permit accredited compensatory afforestation to be used in lieu of CA involves various steps including handing over of land to forest department and payment of levies) if it:

- Cover a block of minimum 10 Ha and has been fenced as per norms of CA.
- Is situated Over land of any size situated in the continuity of land declared or notified as forest under any law, Protected Area, Tiger Reserve or within a designated or identified tiger or wildlife corridor.
- Is earned out of vacation of non-forest lands on account of voluntary relocation of a village from a National Park, Wildlife Sanctuary or Tiger Reserve and designated or identified tiger or wildlife corridors.

The Rules further provide that such area shall be handed over to the forest department of the relevant State Government or Union Territory Administration free from all encumbrances. It should also be notified as protected forest under Indian Forest Act, 1927 before the final approval is granted under the Act.

2.1 Provisions for the requirement of land related to CA and also include ACA

CA land and some of the provisions of ACA are given in schedule I as per rule 11 (1) and rule 11 (3) of FCR-2022.

2.2 Criteria of raising ACA:

i. Lands on which the provisions of Forest (Conservation) Act, 1980 are not applicable and are free from all encumbrances should be considered for ACA;

ii. Land considered for raising afforestation should be properly demarcated and adequately protected to ensure its protection from various biotic factors.

iii. Afforestation shall be counted towards ACA if such land covers an area of minimum of ten hectares.

iv. Afforestation over land of any size situated in the continuity of land declared or notified as forest under any law, Protected Area, Tiger Reserve or within a designated or identified tiger or wildlife corridor, may be considered for ACA.

v. One-hectare area under Accredited Compensatory Afforestation with 0.4 or more canopy density will be counted as 1 ACA unit for further evaluation, grading and utilisation etc.

vi. An afforestation shall be counted towards ACA if such land has vegetation composed predominantly of trees having canopy density of 0.4 or more and the trees are at least five years old;

vii. Afforestation raised should preferably be heterogeneous in nature consisting of majority of indigenous species.

2.3 Eligibility for raising ACA

Persons or agencies from private as well as Govt. sector may register for ACA scheme.

2.4 Mechanism for the ACA:

The following procedure shall be adopted for effective implementation of the proposed ACA mechanism:

i. A centralized online portal will be developed for submission of online application, evaluation of proposal by the local Forest Department, access to database relating to persons/agencies and ACA availability in a particular State/UTs. Online portal shall maintain the State/UT wise record of such persons/agencies and their ACA who have submitted application on the online portal.

ii. State/UTs department will make available in public the model scheme for raising afforestation for different agro-climatic zones for its use by the aspiring persons/agencies to prepare their afforestation scheme for 5 years and schemes for existing afforestation to earn ACAs for the proposed afforestation, as the case may be.

iii. Any person or agency keen to register in the ACA Scheme may submit online application along with the details non-forest land and/or existing afforestation viz. maps, authenticated copies of revenue records, etc. and afforestation scheme and/or composition of existing afforestation, prepared on the basis of model scheme of the concerned State/UTs.

iv. The Forest Department or empanelled/ accredited agencies or individuals will examine the proposal for its completeness and fulfilment of relevant preconditions/criterion. Proposals qualifying the scrutiny of Local Forest department will be considered for final registration and proposed ACA scheme.

v. Persons/agencies registered with local Forest Department may raise afforestation as per the scheme prepared in consonance with the model scheme of the State/UTs for the concerned agro-climatic zone.

vi. Existing afforestation or afforestation raised afresh shall be eligible for ACA after attaining the age of 5 years, provided such plantation meet the preconditions specified hereinabove including predetermined success/survival criteria. Preconditions and criterion of a particular Afforestation/plantation will be evaluated by the local Forest Department by undertaking a visit to such site.

vii. The State Forest Department, based on their on site evaluation of afforestation and depending upon the extent of area qualifying under the ACA, will award ACAs to such Afforestation. Afforestation raised over 1 ha of land with 0.4 canopy density will be considered equivalent to 1 ACA. Detail of ACAs, awarded by the State Forest Department, will be updated in the online application by the concerned person/ agency.

viii. The person or agency may promote or publicise its credentials and availability of ACAs awards with it for its swapping in lieu of proposal relating to diversion of forest land.

ix. The persons or agencies registered with the Forest Department will be free to trade its asset i.e. its ACAs in parcels with user agency aspiring for non-forestry use of forest land. The User Agency, aspiring for non-forest use of forest land, may pay the amount to the registered agency, as may be agreed between them and swipe such ACAs in lieu of their proposal pertaining to diversion of forest land.

x. ACAs purchased by the user agency in lieu of diversion of forest land shall be transferred and mutated in favour of State Forest Department and subsequently notified as Protected Forest under Section 29 of the Indian Forest land or any other local Forest Act.

xi. Persons or agencies from private as well as Govt. sector may register for ACA scheme. ACAs earned by an agency/person will be transferable i.e. can be transferred to other agency under intimation to local Forest Department.

xii. The person or agency registered for ACA will be at liberty to deregistered its ACAs earned in part of full from the online portal at any point of time.

2.5 Formulating proposals under the FCA-80 using ACAs lands

ACA mechanism envisages the considerations to be taken while formulating proposals under FC Act 1980 using ACAs lands. It facilities entry of the private party as person or agency. One can develop ACA credit and can sell to the needy organization.

As per flow sheet at fig 1.:

i. The UA requiring forest land shall negotiate financial details with the person or agency holding ACA and enter into an agreement for required ACA area with the concerned agency.

ii. ACA area agreed for trading between the agency and UA will be surveyed by the UA using DGPS, Total Stations or like technology and detail of the area along with digital Differential GPS map (KML/shape files) and copy of agreement shall be submitted to the Forest Department along with application for diversion of forest land under the FCA-80.

iii. Afforestation scheme implemented by the agency for a period of 5 years or scheme for maintenance of existing afforestation, as the case may be, will be assessed by the State Forest Department (SFD) and if needed term of the scheme may be recommended to be increased to such duration as the Forest Department may deem fit.

iv. The forest department shall give priority to such proposals and on receipt of 'In-principle' approval said land parcel shall be transferred and mutated in favour of the SFD and declared as Protected Forest under Section 29 of the Indian Forest Act, 1927 (IFA-27) or any other law.

v. No cost of raising CA shall be charged from the UA by the SFD.

vi. As the afforestation so raised may be utilized in parts, therefore, until a patch of minimum size of 5 ha is transferred in lieu of diversion of forest land, the concerned agency, at the cost of user agency may manage the area till such time as required or till the entire patch is transferred to the Forest Department.

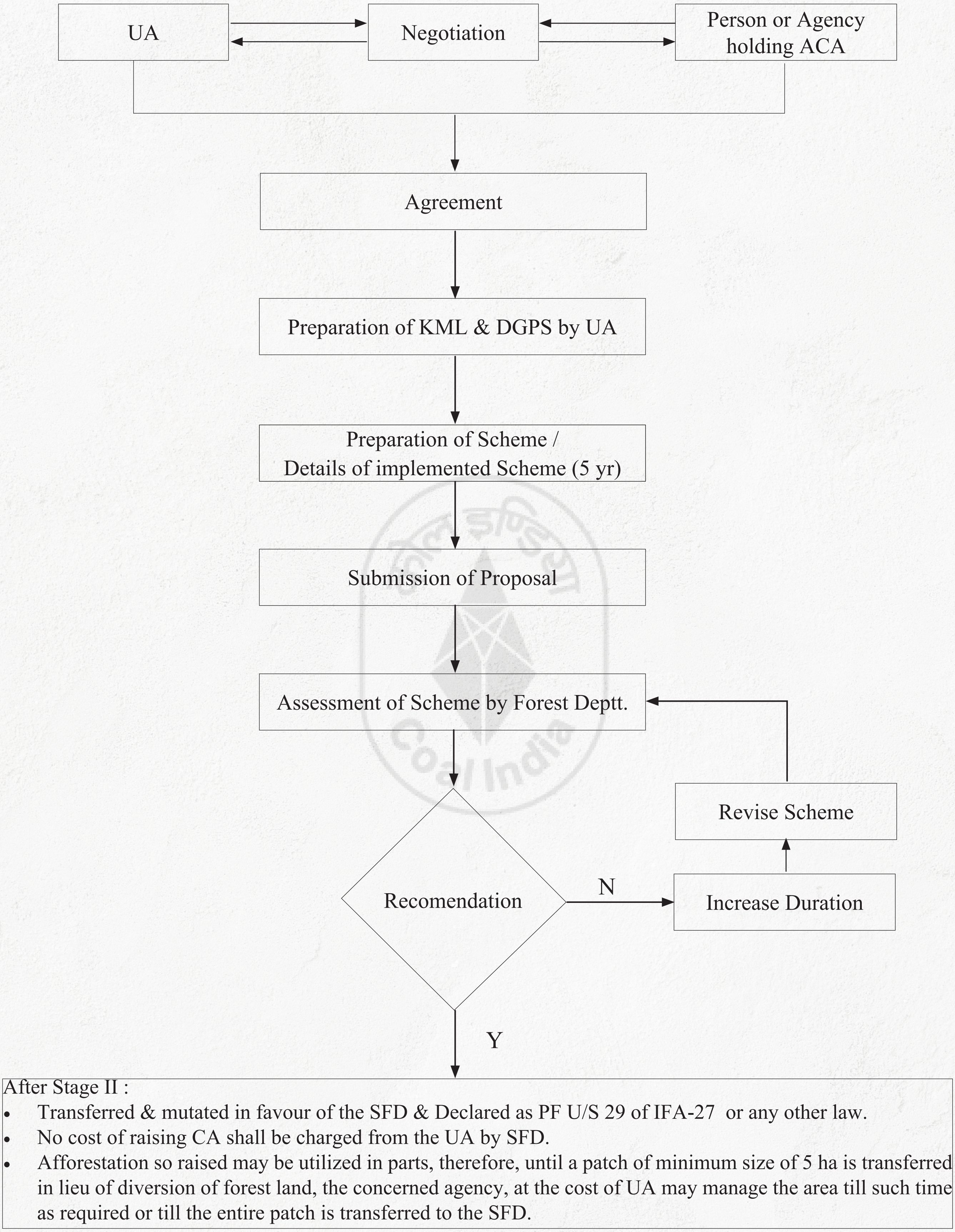

Fig 1: Flow chart for using ACA as per FCA-80

2.6 Benefits likely to be accrued from the ACA scheme:

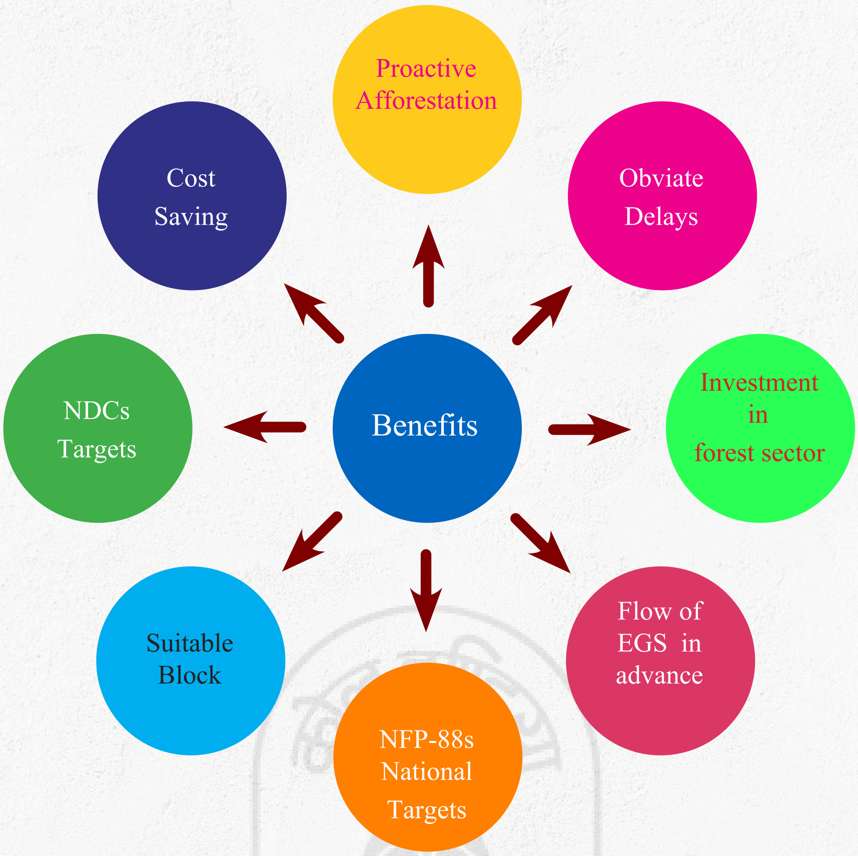

Fig 2: Benefits of ACA Scheme

a. **Proactive Afforestation:** ACA will develop a system of proactive afforestation to be used for obtaining prior approval under section 2 (ii) of the FCA-80 by way of raising advance afforestation over a non-forest land free from any encumbrance.

b. **Obviate Delays:** the system of consideration of ACA will facilitate the CA activities in advance, which will obviate any delays that could be caused due to fund flow or administrative/technical procedures.

c. **Flow of EGS in advance:** The introduction of ACA as per FC rule 2022 & ACA guide line will promote onset of flow of ecosystem goods and services in advance.

d. **Investment in forest sector:** The proposed scheme will open a new area for investment in forest sector for individual, agencies and others.

e. **National Forest Policy, 1988:** This proposed scheme will encourage afforestation over fallow lands thereby helping in achieving the national targets as envisaged in the National Forest Policy, 1988

f. **Suitable Block:** Alternative non-forest land that may be made available would be in a suitable block thereby facilitating appropriate protection measures.

g. **NDCs Targets:** ACA scheme will expedite afforestation works which will ultimately increase the total carbon sequestered thereby helping to achieve the NDCs targets.

h. **Cost Saving by UA:** No cost of raising CA shall be charged from the UA by the State Forest Department (SFD).

5.0 Efforts of CMPDI

MoC, GoI vide its letter dtd. 22.08.2024 requested CMPDIL to develop a portal for creation of a portal for creating land bank for Accredited Compensatory Afforestation (ACA). The portal is expected to be user-friendly to facilitate the smooth submission and evaluation of proposals as per guidelines of MoEFCC w.r.t. Accredited Compensatory Afforestation and green credit programme developed by MoEFCC. The objectives of the request from MoC includes Invitation of Proposals, Evaluation, Accreditation, Streamlined Communication, Transparency and Accountability. Invitation of Proposals is about to facilitate the submission of proposals from landholders or agencies interested in offering their land (not less than 10 Ha) for afforestation projects. Evaluation and Accreditation steps to include a rigorous evaluation process to ensure that the offered land meets the necessary criteria for being classified as ACA land. The portal should also serve as a platform for streamlined/seamless communication between CIL, CMPDIL, potential landholders, and other relevant stakeholders. The process for selecting and accrediting land should be transparent, with regular updates and information available to all involved parties with certain accountability.

Further CIL on dated, 05.09.2024 based on Secretary (Coal), GoI's advise on dtd. 25.06.2024 entrusted CMPDI to develop a portal for identifying and purchasing land from individuals for establishing a strong land bank for CA purposes. An SoP for creation of the Portal was also developed by duly constituted committee.

Accordingly, CMPDIL is set to develop the portal. This portal will include attracting awareness of portal amongst its user, its advertisement, framing query and dashboards over drawing eligibility as framed in SoP, requirements of list of documents, user interface for interaction for its scrutiny, verifying and uploading on portal.

Eligibility for application may include the land for CA can be procured from Private Land Owners/ Land Aggregator/ Registered Farmer Producer Organization / Entrepreneurs / Sole Proprietorships / Partnerships / Limited Liability Partnerships / Consortium / Companies / Cooperative Societies / Technology Providers / Registered NGO / Registered trust/ Government Agencies/Government Companies/ Public Sector Undertakings etc. The Applicant should have the legal title / ownership of the land in its favour OR Authorised persons on behalf of Organisations / Firms / Consortium / Companies / Registered Societies / NGOs / Trusts / Government Agencies/Government Companies/ Public Sector Undertakings. The land should be under the legal and physical possession of the Applicant or the selling party and to be free from encumbrance and encroachments on any part of it. There should not be any legal case pending / in-process involving the land being offered for sale in any Court of India. The applicant will sign-up in the portal with required details and upload the supporting documents with respect to eligibility criteria

6.0 Issues to address

Identification of land for CA and preparation of schemes are causing delay in processing of proposals. As per clause 2.5 (i)(f) – Special provisions for CA, of Handbook on guideline stipulates that "CA shall be raised and maintained at the cost of the user agency on degraded forest land twice in extent of the forest area diverted" and exemption from getting certificate from state Government to the effect that suitable land required for compensatory Afforestation under this clause is not available. [Clause 11-1(a)].

It is not clear whether in case of UA acquires any non forest land for the execution of the project, the exceptions in case of CG agencies, CPSUs and SPSUs as above shall not be applicable. Reclaimed non forest lands after completion of mining can be considered for CA and can be brought under clause 11(3) of FC Rules 2022. ie. Accredited Compensatory Afforestation without transferring to SFD. Such land may be demarcated as forest land for further records.

In respect of land acquired under CBA (A&D) Act 1957 issue of transferring the Biologically reclaimed non-forest land considered for CA to Forest Department, needs to be addressed.

Challenges required to combat are:

- Behavioural changes among public
- Fund challenge
- R&D locks
- Implementation issues
- Public distrust
- Lack of policy
- Initially unaffordable
- Identification and marking of PFA and social Economic indicator
- Inclusion in CSR, welfare and MCP
- Livelihood based transition which is acceptable by community CD plan inclusive with other planning & execution
- Regular social survey and economic development indicator
- Economic lossess
- Less employment
- Regional disparity
- Political instability
- Feedback
- Resolution
- Improvement
- Alternatives
- Digitisation & Transparency
- Single window approach
- Separate manpower
- Separate resource

7.0 Conclusion

The FCR-22 has introduced an accredited compensatory afforestation mechanism. The purpose is to encourage people to raise vegetation on its land and sell it to persons who need to meet compensatory afforestation targets under the Act. This policy is expected to act as an incentive for persons to develop plantations and undertake agro-forestry. Parivesh version 2.0 of MoEFCC is a good and favourable move by the government in favour of UA. Government and Inter ministerial intervention are explicitly required for transferring of land acquired under CBA (A&D) Act 1957.

The development of portal will help in resolving issues related to unions, local community protest, environment related protocol, local politics, theft / threatening, land related, DGMS & EC related, de-coaled area, environmental rehabilitation & restoration, waste management, water management, dismantling, financial provision, implementation and monitoring of projects. This inter alia will require improvement in support from local administration, cooperative models, public awareness, basic amenities for social people improvement, liniwnt policies and framework, Proper training & education about portal.

8.0 Acknowledgement

The author would like to acknowledge the expertise extended by coal mines officials, officials of Jharkhand State Forest Department at Ranchi. This article is based on presentation made during ICOMS 2022 and in national seminar on "Forest Clearance and Environmental Clearance: Issues Relating to Ease of Doing Business" by IE (2023). The views presented by author is solely his interpretation based on his day to day work and not necessarily be of the organization he belongs.

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