



**ANALYSIS OF POLLUTANTS IN ABANDONED OCP WATER AND ITS IMPACT:
SPECIAL REFERENCE TO DAMALIA OCP IN RANIGANJ COAL FIELD, WEST
BENGAL**

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ABSTRACT

The stored wastes and extracted heap of materials are the major concern in abandoned open cast pits (OCP) of coal mine area. They adversely affect the pit water and surrounding mining areas. Due to oxidation of pyrites in deep coal layers and debris stored on the surrounding surface areas, in presence of air and water directs to very low pH, heavy and rare earth metals dissolved into the pit water. In the present study, the Physico-chemical features in respect of different pollutants and that correlate in-between different parameters considering three seasons of abandoned Damalia OCP have been investigated. Pollutant contamination in the pit is mainly due to the drainage of mine water. Nutrient pollutant level is within the permissible limits, like NO₃-N, dissolved phosphate. Water samples were analysed and it is found that total hardness as CaCO₃, total alkalinity as CaCO₃, TSS, dissolved oxygen (DO), BOD, COD, Cl are within permissible limit, whereas TDS, HCO₃⁻ value exceeds the standard limit. It is also seen that level of nitrate pollutants, i.e. NH₃-N, Cl₂, FA-NH₃, S²⁻, TKN, are under permissible limit but TKN percentage is higher than other pollutants. The results indicate highly acidic condition of the drain-water with low DO, high rate of TDS and HCO₃⁻, high hardness and higher concentrations of CaCO₃ and may be usable after proper treatment.

Keyword: Abandoned OCP, BOD, COD, DO, TSS, TDS

INTRODUCTION

Coal mining activity may create several harmful effects on the environment. It causes huge amount of ecological imbalance like landscape reforms, alteration of surface areas, and destruction of biodiversity [1-3]. On the other hand, huge quantity of removal waste materials is stored on the surrounding surface area which contains different toxic metals or pollutants. Generally these metals are harmful for the surface area as well as for the adjacent atmospheric layers. Rain water is directly come into interaction with the rocks, heavy metals, pollutants etc. These spoilings are percolated into the sub surface through precipitated water [4-6]. This event creates bio-accumulation as well as bio-magnifications in this aquatic food chain. In the Raniganj coalfield, a number of abandoned open cast coal mine pits have been identified where such kind of negative environmental alteration was reported [7, 8]. Anthropogenic landforms like quarries and dump of mine tailings due to open cast mining have made an impact to the geo environment of the area [9-11]. The key objectives of the present study are i) toxicity analysis and comparative study between different mine spoils and nearby

soil in various season, ii) statistical representation of the toxicity in the pit water with different indices, iii) identify the mitigation methods to minimize the adverse impact on the environment, iv) to search the alternative livelihood for sustainable development of that area.

Study Area:

Geographically Raniganj coalfield is encircle with Ajoy, Damodar and Barakar River. It spreads over 1900 km² area in the state of West Bengal and Jharkhand [9]. The coal field is encircled with Archean rock system in West, South & North side, but in east side the coal field surrounded by Gondwana Shield. There is an alluvium stratum beneath the coal field area. Our present study site, Damalia OCP is now abandoned in nature since 1989, situated in this coalfield near the South of Harabanga Village. Location of this OCP is 23°36' 32" N Lat and 87° 04' 00" E Long. The altitude of this site is 88.45 mt. from MSL. The length of this reverse "L" shaped OCP is 650 mt. where the width of this OCP is 710 mt. The average depth of this OCP is 220 mt.

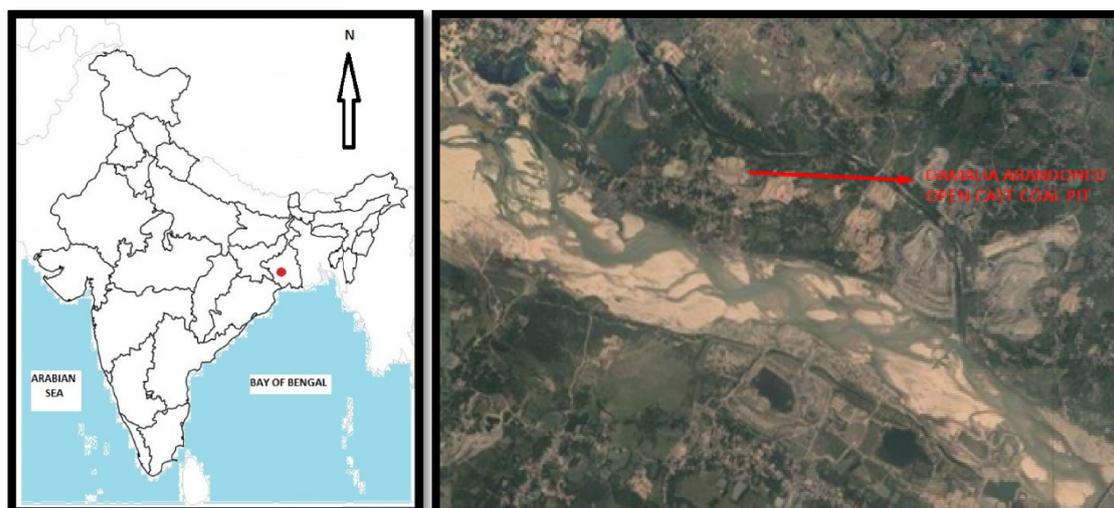


Figure 1 & 2: Location of Damalia OCP

METHODOLOGY:

The present work carried out on the basis of primary data, which get through sample collection directly from Damalia OCP. Sampling was undertaken in three seasonal phases, these are pre monsoon, monsoon and post monsoon season. Pit surface water was collected from five points and followed mixed it thoroughly. After that samples

were brought to the laboratory for estimate the concentration of Nitrate Pollutants, Organic Pollutants, Metal Pollutants and Nutrient type Pollutants, using APHA 23rd Edition, 1060 method. After testing the water quality, correlation has been done between different parameters considering three seasons [12, 13].



Figure 3: Abandoned Damalia OCP

RESULTS/ DATA ANALYSIS:

Samples collected from the given study sites were analyse through various statistical techniques to get better result. In

this purpose, SPSS techniques have been used to compute the data set. We have used different frequency distribution and

representation techniques to show the result prominently.

Season wise deviation of all nitrates has been given in the **Table 1**. Beside this, permissible standard as per MoEF has been included with this data set.

Data given in **Table 1** represents it on comparative bar diagram (**Figure 4**) to get the comparative structure of different variables as per permissible standard.

In **Table 2**, shows the seasonal variation of organic pollutants on the basis of permissible standard. Ministry of Environment and Forest has set a critical value in scheduled VI to characterise level of occurrence of pollutants in the environment.

The diagram in **Figure 5** represents the data set (**Table 2**) and it will be able to find out comparative study between the seasons.

Metal pollution level in different season has also given in tabular form and with permissible limit (**Table 3**).

Figure 6 represents comparative bar. The method is normally used to signify the magnitude between several variable. Season wise permissible standard of different metals are also plotted separately.

Table 4 showing the variation of nutrient based pollutants in three seasons. To know the seasonal impact on these pollutants, comparative bar has been made to identify the dominant season and its direct or indirect relationships on concentration.

Table 1: Season wise variation of Nitrate Pollutants as per standard limit

PROPERTISE	PRE MONSOON	MONSOON	POST MONSOON	Limit as per MoEF Schedule-VI Standard
Ammoniacal Nitrogen (NH ₃ -N)(mg/l)	2.72	2.98	2.77	50
Total Kjeldahl Nitrogen (TKN) (mg/l)	5.54	6.12	5.92	100
Free Ammonia (FA, NH ₃) (mg/l)	0.1	0.2	0.1	5
Sulphide (S ²⁻) (mg/l)	0.01	0.02	0.01	2
Total Residual Chlorine (Cl ₂) (mg/l)	0	0	0	1

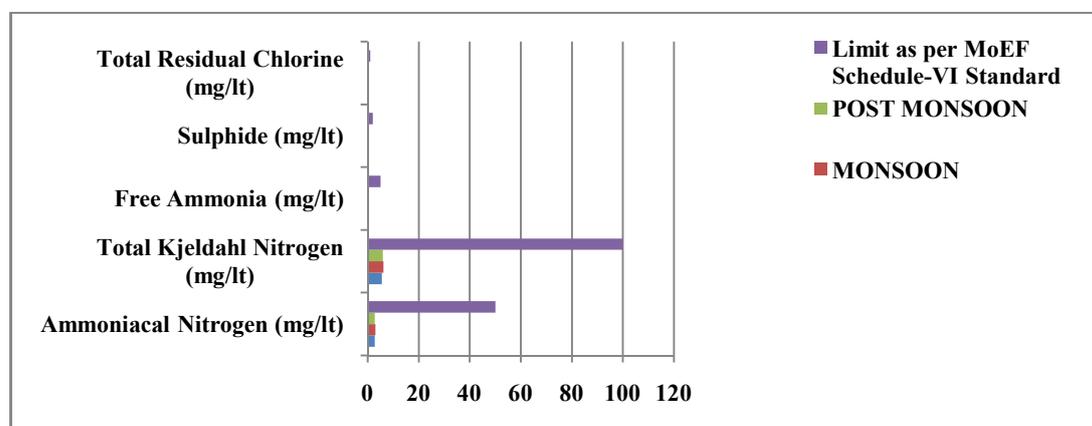


Figure 4: Comparative bar showing seasonal Nitrate Pollutants level

Table 2: Season wise variation of Organic Pollutants as per standard limit

PROPERTY	PRE MONSOON	MONSOON	POST MONSOON	Limit as per MoEF Schedule-VI Standard
Oil & Grease (mg/l)	1.9	2.2	1.9	10
Phenolic Compounds (mg/l)	0.088	0.102	0.084	1

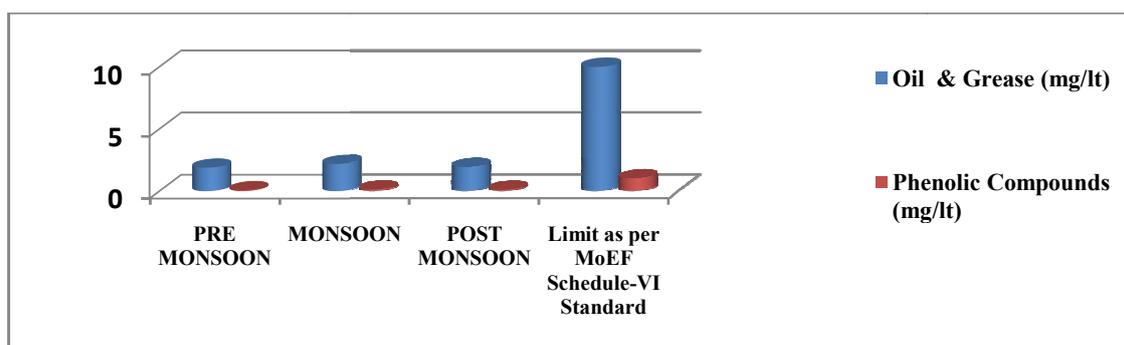


Figure 5: Comparative bar showing seasonal Organic Pollutants level

Table 3: Season wise nature of Metal Pollution as per standard limit

PROPERTY	PRE MONSOON	MONSOON	POST MONSOON	Limit as per MoEF Schedule-VI Standard
Nickel (Ni) (mg/l)	0.02	0.04	0.02	3
Iron (Fe) (mg/l)	0.3	0.35	0.3	3
Fluoride (F) (mg/l)	0.89	0.98	0.39	1.5

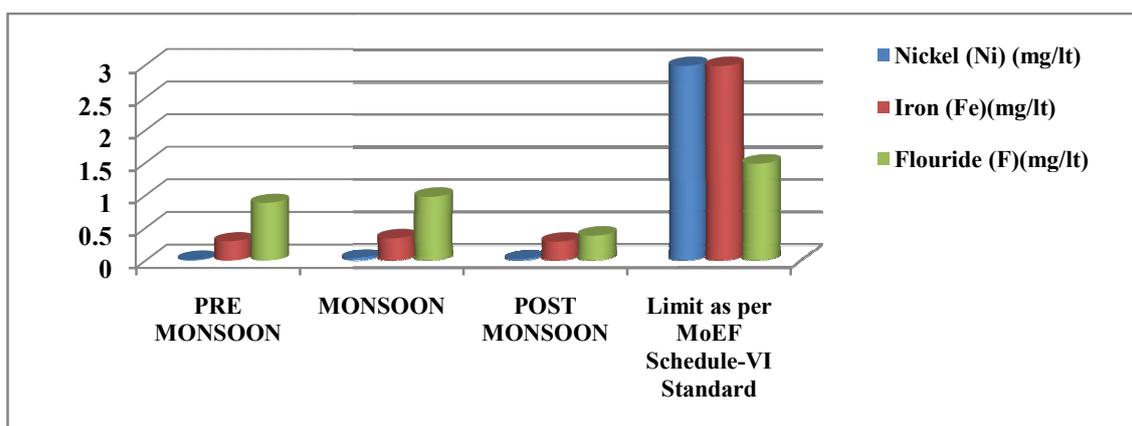


Figure 6: Comparative bar showing seasonal Metal Pollution level

Table 4: Season wise Nutrient type Pollutants level as per standard limit

PROPERTY	PRE MONSOON	MONSOON	POST MONSOON	Limit as per MoEF Schedule-VI Standard
Nitrate Nitrogen (mg/l)	1.2	1.4	1.2	10
Dissolved Phosphate (mg/l)	0.01	0.02	0.01	5

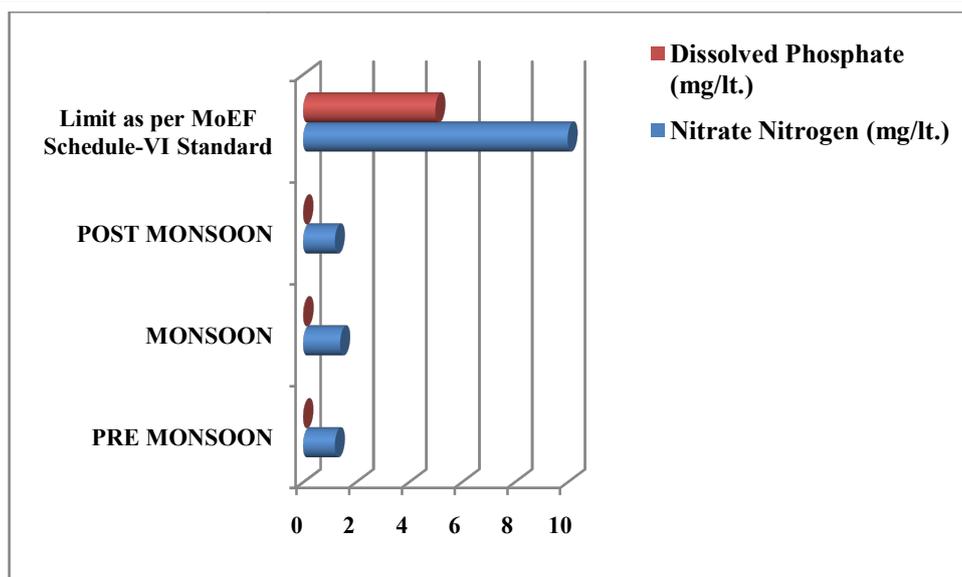


Figure 7: Comparative bar showing seasonal Nutrient type Pollutants level

Table 5: Season wise Water Quality Parameter as per Pollution level

	Total Suspended Solid (TSS) i.e. Pollutants (mg/Lt)	Dissolved Oxygen (DO) (mg/Lt)	BOD (mg/Lt)	COD (mg/Lt)	Total Hardness as CaCO ₃ (mg/Lt)	Total Alkalinity as CaCO ₃ (mg/Lt)	TDS (mg/Lt)	HCO ₃ (mg/Lt)	Cl (mg/Lt)
PRE MONSOON	2	5.5	10	52.57	109.43	198	830	430	95
POST MONSOON	3	5.18	10	59.52	110.43	204	690	250	58
MONSOON	3	6.22	8	49.48	117.43	182	910	525	120
Limit as per MoEF Schedule-VI Standard	100	-	30	250	-	-	500	500	600

Table 6: Correlation between different season and water quality parameters

Variables	1	2	3
1	1		
2	0.982270599	1	
3	0.997094269	0.965641101	1

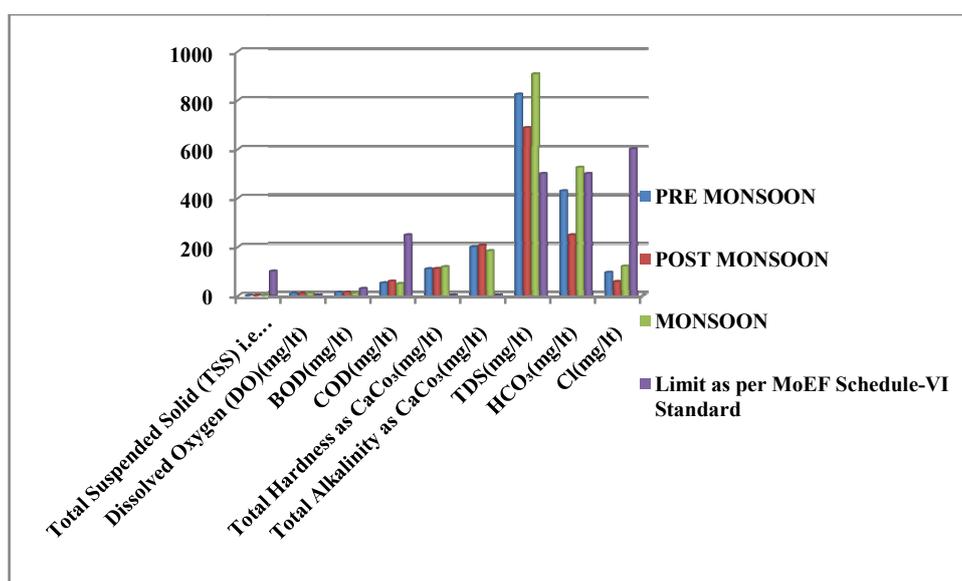


Figure 8: Comparative bar showing relative status of water quality parameter

DISCUSSION:

From **Table 1** it is shown that Nitrate Pollutant level is higher in monsoon season, but its value within permissible limit. Several parameters were taken into consideration to analyse the data set. It is found that $\text{NH}_3\text{-N}$, TKN, FA, NH_3 , S^2 values are higher in monsoon season in comparison to other two seasons and Cl_2 values are same in all three seasons. From **Figure 1**, this may be argued that TKN value is higher in context of permissible standard level at all three seasons and among all water parameters. Season wise organic pollutants were also analysed through statistical methods. Oil, Grease, Phenolic compounds are found within the permissible limit as per MoEF standard. It is shown that the concentration of organic compounds is comparatively high during monsoon season. These components are not properly mixed with rain water as the rate of ground water contamination is very low. But the rate of contamination is high in

surface run off. It is found that higher the rainfall, resulting higher rate of concentration in surface runoff. This polluted water came to the mine pit and contaminated the whole water bodies. From **Figure 3**, it may be pointed out that the presence of Fluoride is a great matter of concern for that the inhabitants of this area and as well as OCP ecosystem. As it is under permissible limit, but at certain time, the fluoride rate became so high in pit water as well as ground water. Pit water is highly contaminated by fluoride and it is associated with high rate of TDS, TH as CaCO_3 , COD. Previous studies showed that the rate of fluoride concentration is increases from east ward to west. It is observed that the existence of DO and Cl is low in pre and post monsoon, in comparison to monsoon season. Previous study revealed that the limnological variables may develop on the basis of water density gradients like alkalinity, DO, pH through the water profile, which gives rise to the stratification [14, 15].



Figure 9 & 10: Waste material deposit around the abandoned Damalia OCP

It is observed that the relationship between all variables in various season is positive as the value >0.5 . They are inter dependent in nature and directly varied with seasonal changes. From the data set of water quality analysis (**Figure 5**), we get that TDS value is an alarming in respect of permissible limit. In all season, over TDS rate recorded. It has observed that in Raniganj mine water, F^- and NO_3^- contribute minimum to the total anions and has high TDS, total hardness, and SO_4 concentrations [16, 17]. In monsoon season, TDS rate is very high due to massive volume of water discharge from surrounding areas. HCO_3^- value is also recorded above the permissible standard in monsoon and in pre monsoon where the observed value near about to critical limit. But in post monsoon season due to less rainfall and low rate of contamination, the HCO_3^- value is moderate. Chlorine touches the highest mark in monsoon season as a result of storage of sediments from surrounding areas through surface runoff. The values of TH and COD are maximal in monsoon season and showing their relative relationship to each other. On the other hand, the same relationship is found in between BOD and total alkalinity. As per results, it may be pointed out that both BOD and alkalinity level is low in monsoon season due to fresh water supply in to this ecosystem. Some of works established that the total hardness (TH) increased with

depth of OCP water in the monsoon season, being maximal in the post monsoon (196.0 mg L^{-1}). They also stated that BOD and COD increased with depth in the post monsoon [18, 19].

CONCLUSION

The present study has been carried out to explore the present status of water quality of Damalia OCP water bodies. Various water quality parameter like DO, TDS, TH, TSS Alkalinity, Cl were taken in observation. Beside this, various pollutants, like nitrate, organic, metals were also analysed to know about pollution level and their effectiveness. It is found that TKN rate is high among all types of nitrate pollutants, whereas oil and grease rate is high among organic pollutants. The major alarming fact is that the presence of Fluoride is near critical limit and in monsoon season the rate of concentration is high due to huge surface runoff and it will be more vulnerable regarding ground water contamination, through infiltration. Nutrient pollutants are not so matter of concern as these are under critical standard [20]. But the presence of dissolved solid, TH and HCO_3^- are very high as it will be very harmful factors for pit aquatic ecosystem, local inhabitants and local air-water-soil relationship. Surrounding animals are also affected to taking the water for drinking purpose. Various skin diseases are reported by local peoples. So, proper

water treatment is well needed for the betterment of the water quality as it is useable for all living being. Chemical treatment through periodic observation, like Ion exchange, sludge treatment, evaporation and crystallization, filtration may be used to pit water drinkable. Anaerobic sulphate-reducing bacteria (SRB) may also be applied as bioremediation method for the purification of acid mine runoff.

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