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Physico-Chemical Characterization of Mine Water Produced During Various Mining Activities, Treatment and Possible Usage

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ABSTRACT

Investment plays a vital role in a developing country such as India, as it provides the necessary funds for undertaking productive activities to be circulated in the economy. Savings are our country's largest source of investment. Investments are assume they control their own destiny, whereas individuals with external LOC relate their experiences to destiny, luck or chance. Consequently, LOC has a great influence on an individual's investment decision-making behaviour. As a result, this study attempts to assess the LOC of an individual and segment the investors based on their level of internal and external LOC.

Keywords: Locus of control, Individual investor, Segmentation of investors.

I. INTRODUCTION

To estimate the Physico-chemical characterization of mine water produced during various mining activities, treatment and possible usage

II. OBJECTIVES

The mining industries are discharging millions of litres of water every day to the adjacent water courses creating water pollution problems in and around the mining area. Therefore it becomes essential to first assess the mine water quality and based on characteristics put it for beneficial usages (recycle and reuse), so as to avoid the mine water for its beneficiary use discharge pattern creating water pollution problems rather use it in the industry itself to save the fresh water requirement.

III. MATERIAL AND METHODS

i) **Sampling Site:** Mine water samples were collected phase wise (extractions) from ponds where the mine water was stored. Mine water samples were collected in polyethylene bottles of 1 litre capacity.

ii) **Analysis of mine water:** All the parameters reflecting mine water quality were analyzed as per the standard method (WHO standards).

IV. RESULTS AND DISCUSSION:

1. Mine water quality Assessment:

A classification of mine water is made based on the characteristics of mine waters from coal and non-coal mines i.e. alkaline mine water (A1, A2 and A3) and acidic mine water (B1 and B2). The characteristics of these mine waters are summarized in different categories as shown in **Table 1.**

The characteristics and the levels of concentration are shown in **Tables 2 to 5**. The characteristics of mine water collected from different mines are compared with water quality Standards (WHO, 2008 and IS 10500).

The results of analysis of collected mine waters in different seasons are depicted in **Tables 3, 4, and 5**. The pH of all mine water samples were found to be alkaline in nature, pH ranged from 7.2 to 8.2 with dissolved solids in the range of 83-301 mg/l, buffering capacity in the form of alkalinity ranged from 111-145 mg/l, turbidity in the range of 27-198 NTU with hardness in the range of 45-80 mg/l. Further, the organic content was also estimated in the mine water and expressed in terms of BOD and COD. The DO levels were also significant and recorded. The concentration level of demand parameters in the form of DO, BOD and COD ranged from 4.8-5.3 mg/l, < 3 mg/l and 6.8-11.3 mg/l respectively. It was observed that concentration levels of several metals like iron, zinc, chromium and cadmium ranged from 0.34 – 0.52 mg/l, 0.21-0.28 mg/l, 0.01-0.09 mg/l, and 0.2-0.3 mg/l respectively, whereas acidic mine water had pH in the range of 3.8-4.6, total dissolved solids 356-421 mg/l with hardness 78-102 mg/l. The demand parameters in the form of DO, BOD and COD ranged from 3.8-4.2 mg/l, ND and 30-56 mg/l respectively. From the characteristics of coal mine water, it was observed that the mine water was contributed by minerals with higher concentration levels of dissolved solids, however pH was found to be alkaline in nature. The organic load in terms of BOD was found to be less whereas COD was found to be in higher side might be due to the contamination of oil and grease and phenolic compounds.

This acidic mine water creates harmful effects on aquatic flora and fauna if discharged in water bodies and also to human beings if used for domestic purposes. Based on water quality characteristics, the acid mine water quality is categorized as B1 and B2 and shown in **Table 6**.

The overall characteristics of coal mine water was found to be alkaline in nature with permissible dissolved solids. However turbidity in the form of suspended load was found to be high dissolved oxygen was favorable to aquatic flora and fauna. Organic load observed was also not much and heavy metals content were in less concentration. Whereas the non-coal mine water quality was found to be acidic in nature, contains high dissolved solids due to the dissolution of minerals during mining process. The mine water was highly turbid in nature however levels of metal concentration were found to be low except iron content. It is mentioned that the alkaline mine water can be put in to use for domestic or irrigation purposes, whereas acidic mine water can-not be used for the same purposes unless treatment is given.

V. TREATMENT OF MINE WATER

Considering the mine water quality of both coal and non-coal mines, it becomes necessary to give treatment to the storage water in ponds or pits before put it into use. Alkaline mine water should be neutralized first and treated by applying coagulation and flocculation technique for the removal of suspended load or turbidity

followed by pressure filtration with disinfection treatment alongwith polishing with activated carbon. The acidic mine water, should be neutralized first with lime followed by sedimentation, filtration and polishing with activated carbon.

VI. RECYCLE AND REUSE

There is a plenty of scope for the application and reuse/recycle of mine water for the wastewater management in mining industry. The quality of the mine water whether it is alkaline or acidic should be neutralized and treated as mentioned above. The treated water further should stored in a mine out pits so that this will be the system of water harvesting and recharging of ground water also. This treated mine water could be used for water sprinkling for dust suppression during excavation and transportation activities. It could also be used for gardening depending on the soil quality and the characteristics of treated water to avoid any soil deterioration. Further, if the volume of mine water stored in mine out pits is in large quantity then, it is advisable to create a reservoir with plantation around for recreation and aesthetic point of view [17] (**Fig. 2-4**). This will provide a better and safer environment for future generation.

VII. CONCLUSION

Mine water sample were collected from coal and non-coal mine areas and analyzed with respect to quality parameters to assess the mine water quality. It was observed that there was variations in concentration levels of some quality parameters i.e. pH and total dissolved solids based on the composition of ores and mines. The mine water quality was compared with drinking water quality standards prescribed by WHO and CPCB. The mine water quality in both coal and non-coal areas was found to be much better, however, certain treatments for mine waters (both acid and alkaline) were suggested prior to put into use for domestic purposes.

Table 1: Characteristics of Alkaline Mine waters

	Unit	Category of the Alkaline Mine waters		
		A-1	A-2	A-3
Water Quality Parameters				
pH		7.7-8.5	7.0-8.5	6.0-8.0
Alkalinity	mg/l, as $CaCO_3$	200-7000	100-500	10-30
Hardness	mg/l, as $CaCO_3$	50-150	200-1500	1000
Total Dissolved Solids	mg/l	300-700	500-1500	1500-2500
ccTotal Suspended Solids	mg/l	5-30	12-50	10-50
Demand Parameters				
DO	mg/l	5.5-8.0	5.0-8.0	5.0-8.0
BOD	mg/l	<1	<1-2	<1-2
COD	mg/l	8-30	15-50	15-60
Element or Ion Content				
Calcium	mg/l, as Ca	10-50	50-200	100-150
Magnesium	mg/l, as Mg	10-30	40-180	80-100
Iron	mg/l	0-2	0-5	0-5

Sulphate	mg/l	10-100	100-800	1000 and above

Table 2: Characteristics of collected mine waters (post-monsoon) (Jharia coalfield)

Parameters	Unit	Phase I	Phase II
pH		7.2	8.27
EC	µS/cm	157	152
Turbidity	NTU	90	153
Total Dissolved Solids	mg/l	116	115
Total Alkalinity	mg/l as $CaCO_3$	128	133
Total Hardness	mg/l as $CaCO_3$	45	70
CO_3^{--}	mg/l	7.20	11.0
HCO_3^{-}	mg/l	180	210
Fe^{+3}	mg/l	0.60	0.40
Ca^{+2}	mg/l	30	40
Mg^{+2}	mg/l	15	30
Na^{+}	mg/l	7.7	5.40
K^{+}	mg/l	3.10	2.80
As^{---}	mg/l	0.01	0.01
SO_4^{--}	mg/l	1.33	1.70
PO_4^{---}	mg/l	1.20	1
SiO_2^{--}	mg/l	36	36
NO_3^{-}	mg/l	0.18	0.12
Cl^{-}	mg/l	5.32	5.96
NH_3	mg/l	ND	ND
DO	mg/l	5.10	4.80
BOD	mg/l	<3	<3
COD	mg/l	8.2	10.8
Cd^{+2}	mg/l	0.05	0.028
Zn^{+2}	mg/l	0.21	0.24
Cr^{+3}	mg/l	0.09	0.02

ND: Not detectable

Table 3: Characteristics of collected mine waters (water season)(Jharis coal field)

Parameters	Unit	Phase I	Phase II
pH		8.03	7.33
EC	µS/cm	91	174
Turbidity	NTU	28	34
Total Dissolved Solids	mg/l	83	127
Total Alkalinity	mg/l as $CaCO_3$	113	125

Total Hardness	mg/l as $CaCO_3$	80	71
CO_3^{--}	mg/l	9	6
HCO_3^{-}	mg/l	146	177
Fe^{+3}	mg/l	0.45	0.34
Ca^{+2}	mg/l	55	45
Mg^{+2}	mg/l	25	26
Na^{+}	mg/l	6.20	7.20
K^{+}	mg/l	2.80	3.30
As^{---}	mg/l	0.01	0.01
SO_4^{--}	mg/l	1.30	1.23
PO_4^{---}	mg/l	1.20	1.10
SiO_2^{--}	mg/l	35	35
NO_3^{-}	mg/l	0.13	0.17
Cl^{-}	mg/l	6.39	6.03
NH_3	mg/l	0.25	0.17
DO	mg/l	4.80	4.60
BOD	mg/l	<3	<3
COD	mg/l	6.80	8.50
Cd^{+2}	mg/l	0.030	0.03
Zn^{+2}	mg/l	0.26	0.24
Cr^{+3}	mg/l	0.01	0.02

Table 4: Characteristics of collected mine waters (summer season)(Jharia coalfield)

Parameters	**Unit**	**Phase I**	**Phase II**	**Phase III**
pH		7.75	7.63	7.71
EC	µS/cm	352	323	403
Turbidity	NTU	90	198	27
Total Dissolved Solids	mg/l	256	241	301
Total Alkalinity	mg/l as $CaCO_3$	134	111	145
Total Hardness	mg/l as $CaCO_3$	55	46	60
CO_3^{--}	mg/l	6	21	26
HCO_3^{-}	mg/l	136	225	254
Fe^{+3}	mg/l	0.52	0.47	0.39
Ca^{+2}	mg/l	35	29	38.5
Mg^{+2}	mg/l	20	17	21
Na^{+}	mg/l	4.10	3.50	5.50
K^{+}	mg/l	2.13	1.90	2.70
As^{---}	mg/l	0.01	0.01	0.01
SO_4^{--}	mg/l	1.40	1.50	1.31
PO_4^{---}	mg/l	1.50	1.40	1.54

SiO_2^{--}	mg/l	43	53	45
NO_3^-	mg/l	0.15	0.19	0.18
Cl^-	mg/l	5.04	5.68	5.54
NH_3	mg/l	0.13	0.18	0.14
DO	mg/l	5.30	4.80	5.10
BOD	mg/l	<3	<3	<3
COD	mg/l	10.80	11.30	8.60
Cd^{+2}	mg/l	0.024	0.035	0.032
Zn^{+2}	mg/l	0.27	0.28	0.23
Cr^{+3}	mg/l	0.017	0.016	0.014

Table 5: Characteristics of collected mine waters (non-coal mine, North-East)

Parameters	Unit	Post-monsoon	Winter	Summer
pH		3.8	4.1	4.6
EC	µS/cm	586	712	648
Turbidity	NTU	112	148	160
Total Dissolved Solids	mg/l	356	421	388
Total Acidity	mg/l as $CaCO_3$	48	62	56
Total Hardness	mg/l as $CaCO_3$	78	84	102
Ca^{+2}	mg/l	30.4	33.3	40.8
Mg^{+2}	mg/l	5.6	7.6	12.8
Na^+	mg/l	4.10	3.50	5.50
Fe^{+2}	mg/l	3.2	2.8	6.1
DO	mg/l	3.8	2.2	3.8
BOD	mg/l	-	-	-
COD	mg/l	30.8	48.2	56.7
Trace elements (Al, Cr, Zn, Pb, Cu, Cd, Ni, Co)	µg/l	Present in less quantity to non detectable levels		

Table 6: Characteristics of Acid Mine waters

	Unit	Category of the Acid Mine waters	
		B-1	B-2
Water Quality Parameters			
pH		5.0-7.0	2.0-4.5
Acidity	mg/l, as $CaCO_3$	25-150	100-250
Hardness	mg/l, as $CaCO_3$	200-500	500-3500
Total Dissolved Solids	mg/l	400-800	1000-4000
Demand Parameters			
DO	mg/l	5.5-8.5	3.8-7.5
BOD	mg/l	1-2	1-5

COD	mg/l	10-60	20-100
Metal concentration			
Calcium	mg/l	20-80	100-250
Magnesium	mg/l	10-70	50-100
Ferric Iron	mg/l	0-20	10-250
Ferrous Iron	mg/l	200-600 and above	100
Trace Elements Al, Cu, Zn, Mg, Ni, Pb, Cr, Sb, etc		Present in less quantities depending types of strata	

Fig. 1: Sampling location for mine water collection in coal field area

Fig. 2: Open Cast Mining (Coal)

Fig. 3: Mining activities in hilly area with storage of excavated materials

Fig. 4: Mining activities with storage of mine water in mine out pit with plantation around