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Water Quality Assessment of Mine Tailings in a Baryte Mine

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ABSTRACT

Mining is the backbone of the development of our country. Mining is the process of extracting minerals economically and safely. By extracting the minerals, the environment is disturbed. One of the environmental effects is water pollution. For mining activity water is necessary for different purposes like drilling, stowing, and mineral processing. Most of the water is used for mineral processing. The water which was used for mineral processing and other purposes was polluted with contamination. The contaminated water causes many diseases to the people. In this paper, collected baryte tail water from the Varalakshmi baryte mine and a collected water sample are evaluated in the laboratory. By evaluating the sample in the laboratory analyzed and identified the various physicochemical parameters and water quality index. The water quality index of baryte tailwater is 55.493 &57.759 was found from the laboratory results, based upon these results the quality of Baryte tailwater is poor. Based on the results proper treatment is given to the tailwater for using different purposes.

KEYWORDS: *Baryte tail water, physicochemical parameters, water quality index.*

I. INTRODUCTION

In India, there are 3100 mines, out of these 550 are fuel mines,560 mines are metal mines and 1970 are non-metal mines. Baryte is a non-metal mineral. The total reserves of barite mines in India are 70,146,559 tonnes. In Andhra Pradesh, nearly recoverable reserves are 67,053,540 tonnes (95.5%), so they can say that Andhra Pradesh is the major source of the baryte. In Andhra Pradesh, the barytes are present in Ananth Puram, Kadapa, Krishna, Kurnool, Nellore, and Prakasam districts. In Ananth Puram 31140 tonnes, In Kadapa 17,038,751 tonnes, In Krishna 3,500 tonnes, In Kurnool 38,395 tonnes, Nellore 3,18,678 tonnes, In Prakasham 48,520 tonnes are available. From this, we can say that Kadap is the first place in the baryte resources in Andhra Pradesh. Rajasthan is the second state for the production of barytes, It consists of 2,357,732 tonnes (3.36%), followed by Bihar contains 15,160 tonnes (0.02%), Himachal Pradesh 12,296 tonnes(0.17%), Karnataka 9,105 tonnes(0.01%), Madhya Pradesh 1,93,328 tonnes(0.27%),Tamilnadu 1,17, 184 tonnes(0.16%), Maharashtra 165, 215 tonnes(0.09%), West Bengal 303, 000 tonnes(0.43%) and Uttar Pradesh 20,000, tonnes(0.02%). Baryte is used in the chemical industry for the preparation of barium products like barium sulfate, Oxides, nitrate, chlorides, carbonate, hydroxide, and peroxide. it is used as a filler in paints, oil, photographic paper, and rubber. It acts as a lubricant and it is used for the manufacturing of x-ray tubes, glass industries, and ceramics.

The hardness of Baryte is very low (2.5 to 3.5mohr's scale) so it is very easy for breaking. Baryte is a sedimentary rock and it occurs as layers. Most of the baryte mines in India are operated by a shaft sinking. Initially is broken by the blasting operation then, the blasted material is transported to the surface. After reaching the blasted material to the surface they

undergo primary washing. Next, they undergo the screening process, in the screening process, the materials are separated by their sizes. After that fine particles again undergo a washing operation, Then this washed water is transported to the tail pond. Therefore Tail ponds consist of harmful Materials, which can affect the environment. Water pollution not only occurred with the baryte mine but also with the other different mines.

Table.1 Physical Property of Barite

Chemical Classification	Sulfate
Color	Colourless, white, light blue, light yellow, light red, light green
Luster	Vitreous to pearly
Diaphaneity	Transparent to translucent
Cleavage	Very good, basal, prismatic
Mohs Hardness	2.5 to 3.5
Specific Gravity	4.5
Diagnostic Properties	High specific gravity, three cleavage directions at right angles
Chemical Composition	Barium sulfate, $BaSO_4$
Crystal System	Orthorhombic
Uses	Drilling mud; high-density filler for paper, rubber, plastics
streak	White

Even tailings which are come from the mineral processing plants affect the surface and groundwater bodies. For controlling water pollution, we have to know about the causes and effects of water pollution. It is also necessary to study the impacts of pollution on water quality. We should know how the water quality is Affected by all these factors and how it will affect life and operations. For that different essential physicochemical parameters are to be determined.

II. METHODOLOGY

The overall methodology of this paper is presented in Figure 1

STUDYING DIFFERENT LITERATURE REVIEWS ON WATER CONTAMINATION

MINE SITE VISITING

WATER SAMPLES COLLECT FROM THE MINE AREA

LABORATORY ANALYSIS FOR THE DETERMINATION OF PH, TDS, HARDNESS, BOD, IRON, SULPHATE, FLUORIDE, TURBIDITY, EC, CHLORIDE, NITRATE

CALCULATION OF WATER QUALITY INDEX BY USING WEIGHTED ARITHMETIC WQI METHOD.

COMPARISON OF RESULT VALUES WITH STANDARD VALUES.

TREATMENTS FOR IMPROVING WATER QUALITY

CONCLUSION

Figure 1. Flowchart of the methodology

The samples were collected from the Varalakshmi baryte mine which is located at the Velpula (village), Pulivendula (Mandal), in the state of Andhra Pradesh. In this paper, two samples are collected in the baryte tailwater. One is on the mouth of the shaft where primary washing is carried out as shown in figure 1and another one is on the tail pond as shown in figure 2. The sample is collected in a one-liter transparent bottle and sent to the laboratory for analysis of the parameters. Water samples were analyzed for 11 physicochemical parameters like PH, Electrical conductivity, TDS, hardness, iron, turbidity, fluorides, sulfate, nitrates, and chlorides. The water quality index was also analyzed for the baryte tailwater.

Figure 2. Collecting samples near the mouth of the shaft

Figure 3. Collecting samples from the tailing pond

The physicochemical parameters are pH, Electrical conductivity, TDS, hardness, iron, turbidity, fluorides, sulfates nitrates, and chlorides. The BIS standard value of physicochemical parameters is shown in Table 2.

Table 2: Standard values of physicochemical parameters

Parameters	BIS Standards S_n
pH	6.5-8.5
Electrical conductivity	400
TDS	500
Hardness	300
Iron	0.3
Turbidity	5
Fluoride	1.0
Nitrate	45
Sulfates	150
Chloride	250

Water samples are Analysed for different parameters. The weighted athematic water quality index is used for determining the level of purity of water. 11 physicochemical Parameters likes, pH, turbidity, total hardness, chloride, nitrate, sulfate total dissolved solids, Electrical conductivity,

and iron was selected for determining the water quality index value.

The WA-WQI (Brown, 1972) can be calculated by using the following Expression:

$$WQI = \Sigma QnWn / \Sigma W$$

Qnquality rating scale can be calculated for each parameter by using the following Expression

$$Qn = 100 \times [(Vn - Vo)/ (So - Vo)]$$

1) Where,

V_n is the concentration of the nth parameter from the analyzed water.

V_o is the ideal value of the nth parameter and Vo= (7 for PH,0 for all other parameters).

S_n is the standard permissible value of the nth parameter.

W_n is the weightage for the nth parameter and is calculated from the following expression.

$W_n = (K/S_n)$, Where K is the proportionality constant.

The standard value of the Water Quality Index is presented in Table 3

Table 3: Water Quality Index

S. No	Classification of Categories	WQI Values	Grades
1.	Excellent water	0 – 25	A
2.	Good water	26 – 50	B
3.	Poor Quality Water	51 – 75	C
4.	Very poor water	75 – 100	D
5.	Water unsuitable for drinking	>100	E

III. RESULT AND DISCUSSION

Sample 1 is collected at the mouth of the shaft and sample 2 is collected from the tailing pond. The physicochemical properties of samples are analyzed in the laboratory. The physicochemical properties of sample 1is presented in Table 4 and the Physicochemical properties of sample 2 are presented in Table 5.

Table 4: Physicochemical properties of sample 1

Parameters	$1/S_n$	$\Sigma(1/S_n)$	□= $(1/\Sigma(1/S_n)$	$W_n = (K/S_n)$	Ideal value	Mean C_o value V_n	V_n / S_n	V_n/S_n *100= Q_n	Q_nW_n

					V_O				
pH	0.117642	4.692577	0.213102523	0.025070885	7	6.38	0.9815	98.153	2.46
Electrical conductivity	0.0004	4.692577	0.213102523	0.0005327	0	1.516	0.00379	0.379	0.00020189 33
TDS	0.0002	4.692577	0.213102523	0.000426205	0	637	1.274	127.4	0.054 29851 7
Hardness	0.00033	4.692577	0.213102523	0.000710341	0	507	1.69	169	0.120 04762 9
Iron	3.33	4.692577	0.213102523	0.710341 7	0	0.17	0.5666	56.666	40.25 26963 3
Turbidity	0.2	4.692577	0.213102523	0.042620504	0	2.6	0.52	52	2.216 26620 8
Fluoride	1.0	4.692577	0.213102523	0.213102523	0	0.45	0.45	45	9.589 613 535
Nitrate	0.022	4.692577	0.213102523	0.004735611	0	11	0.2444	24.444	0.115 744
Sulphate	0.066	4.692577	0.213102523	0.001420683	0	110	0.733	73.333	0.104 18342
Chloride	0.004	4.692577	0.213102523	0.000852 41	0	270	1.08	108	0.092 06038
			ΣW_n = 0.999813562					$\Sigma Q_n W_n$ = 55.4937985 7	

WQI of water is calculated by using equation (1),the Water Quality Index sample-1 is 55.49379857.

Table 5: Physicochemical properties of sample 2

Parameters	$1/S_n$	$\Sigma(1/S_n)$	□= $(1/\Sigma(1/S_n))$	$W_n = (K/S_n)$	Ideal value V_O	Mean C_o value V_n	V_n/S_n	V_n/S_n *100= Q_n	Q_nW_n
pH	0.117642	4.692577	4.692577	0.025070885	7	6.39	0.983	98.307	2.464
Electrical conductivity	0.0004	4.692577	0.213102523	0.0005327	0	1.515	0.000 37 87	0.378 75	0.000 20176
TDS	0.0002	4.692577	0.213102523	0.000426205	0	635	1.27	127	0.054 12803 5
Hardness	0.00033	4.692577	0.213102523	0.000710341	0	505	1.6833	168.333	0.119 57406 88
Iron	3.33	4.692577	0.213102523	0.710341 7	0	0.18	0.6	60	42.62 0502
Turbidity	0.2	4.692577	0.213102523	0.042620504	0	2.4	0.48	48	2.045 784
Fluoride	1.0	4.692577	0.213102523	0.213102523	0	0.48	0.48	48	10.22 89211
Nitrate	0.02	4.692577	0.213102523	0.004735611	0	10.6	0.2355	23.555	0.033 4697

	2						5		
Sulphate	0.066	4.692577	0.213102523	0.001420683	0	108	0.72	72	0.10228917 6
Chloride	0.004	4.692577	0.213102523	0.000852 41	0	265	1.06	106	0.09003554 6
			ΣW_n = 0.999813562					$\Sigma Q_n W_n$ = 57.7592047	

WQI of water is calculated by using equation (1),the Water Quality Index sample-2 is 57.7592047.

The resultant values of samples 1 and 2 presented in Table 4 and Table 5 are compared with the standards presented in Table 3. On comparison, it is clear that the iron concentration in sample 1 and sample 2 is 0.17mg/l and 0.18mg/l respectively. Turbidity present in samples 1 and 2 is 2.6 and 2.4NTUs. The concentration of the fluoride in sample 1 and sample 2 is 0.45 mg/l and 0.48 mg/l. The concentration of nitrates in samples 1 and sample 2 is 11mg/l and 10.6mg/l respectively. The concentration of sulfate in samples 1 and sample 2 is 110 mg/l and 108 mg/l. The concentration of Electrical conductivity in samples 1 and sample 2 is 1.516 mg/l and 1.515 respectively. Iron, Turbidity, Nitrates, Fluorides, Sulphates, and Electrical conductivity are within the standard limits, indicating no impacts on humans.

However, the resultant pH value in sample-1 and sample-2 contain 6.38 and 6.39. The presence of the Total Dissolved Solids in sample 1 and sample 2 is 637 mg/l and 635 mg/l respectively. The hardness of sample 1 and sample 2 is 507 mg/l and 505 mg/l. The concentration of chlorides in samples 1 and sample 2 is 270 mg/l and 265 mg/l. The values of pH, TDS, Hardness, and Chlorides are higher than the standard limits, indicating that the water is not suitable for domestic and industrial purposes.

Proper treatment was carried out for the tailwater before using this water for domestic purposes. Following are some of the suggestions to improve the quality of water. The harness of the water is removed by the salt-based softener. This method work by exchanging ions in the calcium and magnesium in the water. The pH of the water is reduced by the neutralizing material. It should be noted that in the neutralizing process, there is a chance of increasing the hardness. Neutralizing filters are point-of-entry devices that raise water pH to neutral (to 7) which reduces the plumbing corrosion problem. If pH is greater than 7 then calcium carbonate is to keep mine tailing water neutral. If the pH value is less than 7 synthetic magnesium oxide is used to keep water neutral. The TDS and chlorides are reduced by reverse osmosis.

IV. CONCLUSION

On analysis of the samples collected, it is found that turbidity,Iron, Sulphates, Fluorides, Nitrates, and Electrical conductivity are within the standard limits, but the TDS, pH, Chlorides, and Hardness are higher than the standard limits. The resultant data show that the Water Quality Index of water samples is 55.493&57.759. According to the standard water quality index values the Barty tail water is poor. So that this water is not used for Domestic purposes without proper treatment.

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