Analysis of Physico-Chemical Properties and Heavy Metal Status of Mining Effluent of Chanderiya Region

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Abstract
One of the biggest issues plaguing the environment now is heavy metal contamination. Even though heavy metals are found in nature, their concentrations are increased to levels that are dangerous to plants and animals due to human activities such as mining, smelting, and the use of metal products in fertilizers, pesticides, and other industrial processes. The objective of this research is to examine the heavy metal content, thermal conductivity, electrical conductivity, turbidity, color, total dissolved solids, biological oxygen demand, chemical oxygen demand, and pH in mining effluent from the Chanderiya area in the district of Chittorgarh, Rajasthan, India. The effluent was found to have a light yellow to brownish tint, according to the results. Slightly acidic and murky, the sewage had an off-putting aroma. Effluent heavy metal concentrations were as follows: Zn>Mn>Fe>Pb>Cr. With the advent of low-cost, environmentally friendly, and futuristic techniques like bioremediation, there is great potential to use mining wastewater for drinking, household, and irrigational uses, as this research highlights the need of treating industrial effluent before discharging it into the environment.

Key words- Effluent, Mining, Physico-chemical, Heavy metals, Environment friendly, Bioremediation

Introduction

The three elements that comprise the environment are soil, water and air. The general state of the environment has a direct impact on the quality of life on earth. Heavy metal containing trash was produced in large quantities as a result of anthropogenic activity, industrialization and intensive farming methods.

The health of plants, animals and people is negatively impacted by an excess of heavy metals, which is also a primary cause of pollution in the environment. Exploration for minerals is a long- standing economic activity that occurs in the majority of nation's worldwide (Banunle *et al*., 2018).

Mining industries of any country plays a significant role in its development. Any region's entire growth and development depend heavily on mining operation (Bahiru, 2020). Additionally, it negatively affects the environment by causing contamination of the air, water and land among other things. It removes vegetation and alters the topography of the land, leading to severe erosion (Nigam *et al*., 2015). Heavy metals are the principle pollutants found in the industrial effluents from the mining industry. Metals may bioaccumulate in flora and fauna as a result of ongoing effluent discharge and the ensuing rise in environmental concentration of heavy metals (Sorsa *et al*., 2015).

Heavy metals are not biodegradable in natural world. They build up in the body's major organs, causing a variety of illness symptoms (Sorsa *et al*., 2015). Life on earth depends on water, which is crucial element of the ecosystem. Water is necessary component of crops and serves as a raw material for photosynthesis. Nigam *et al*. (2015) state that water quality is determined by its physical, chemical, and biological characteristics. Acid mine drainage, heavy metal pollution and leaching, chemical processing of pollutants, erosion, and sedimentation are the four main ways in which mining impacts water quality. (Nigam *et al*., 2015).

It is well recognized that industrial effluent containing heavy metals pose a serious risks to human, plant and animal and natural water quality (Mustapha and Halimoon, 2015). Numerous health problems, including as cancer, stunted development, damage to the liver and kidneys, birth abnormalities, and skin lesions, have been associated to metal pollution, particularly with

Pb, Zn, Mn, and Cr. The individuals who live close to mining sites are impacted by all of the issues listed above (Audu *et al*., 2020). The current study aims to evaluate the physicochemical characteristics and quantities of heavy metals in mining effluent, to determine the level of pollution and its effects on the environment's safety, an assessment of the buildup of heavy metal (Sorsa *et al*., 2015).Heavy metal biosorption from industrial wastewater has been the subject of many proposed and implemented clean-up systems.

Nonetheless, the majority of these approaches are both costly and harmful to the environment. Evaporation, chemical precipitation, electrochemical treatment, and reverse osmosis are some of the more traditional ways for heavy metal removal from polluted wastewater. There were technical and economic limitations to all of these physical and chemical approaches, such as their high operating costs and the large amounts of sludge and chemicals they released into the environment. That is why it is crucial to find alternatives that are both cost-effective and gentler on the environment, such as biological treatments. This study is helpful to develop the affordable eco-friendly technique for the treatment of effluent before discharge into the environment.The study was important since a lot of farmers used this waste water as irrigation water (Bahiru, 2019).

Materials and Methods

Study area

The present study area of mining industry lies in Chanderiya region of Chittorgarh district of Rajasthan, India. At the moment, the Chanderiya area is famous for its mining industry. In the southeastern region of Rajasthan state, you may find it between the longitudes of 74° 12′ and 75° 49′ and the latitudes of 23° 32′ and 25° 13′ north. The total land area of the district is 350.8 square kilometers, which is 3.17 % of the Rajasthan State. In the north, you'll find Bhilwara and Bundi; in the west, Udaipur; in the south-east, Pratapgarh district; and in the east, Kota. Near the Gambhiri River, it sits on a hilltop.

Chittorgarh has a very dry and arid environment. The sweltering summer months of April through June are here. Summertime highs typically range from 43.80 to 23.80^{0}C.

From October through February, we experience the winter season. The winters are mild. During winter, the temperature typically ranges from 28.37^{0}C to 11.6^{0}C. June to August is when the monsoon season begins. Rainfall ranges from 60 to 80 centimeters on average.

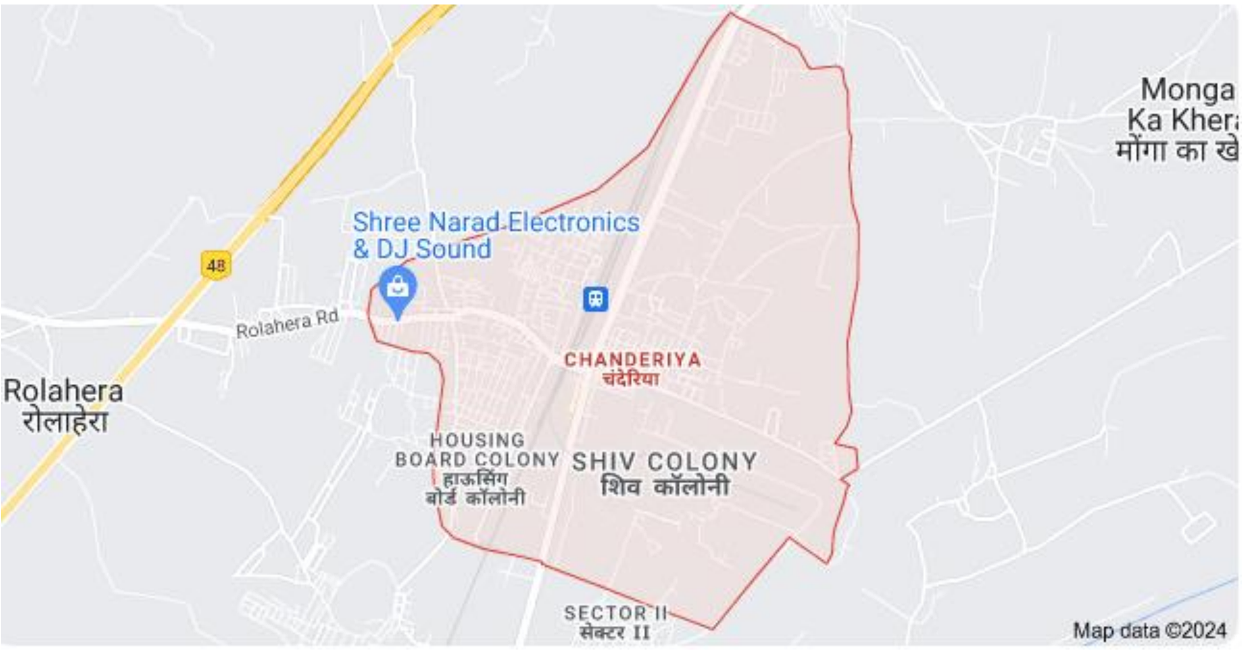

Figure 1: Map showing the sampling site Chanderiya region, Chittorgarh, Rajasthan, India.

Source: www.Google maps.com

Effluent sample collection

Plastic bottles were used to collect the wastewater sample from the effluent treatment plant's intake. Before being rinsed and disinfected with distilled water, the sample vial was incubated with 10% nitric acid in a hot water bath for 24 hours to clean it. The bottles were washed extensively with the wastewater at the locations prior to sampling. (Sorsa *et al*., 2015)

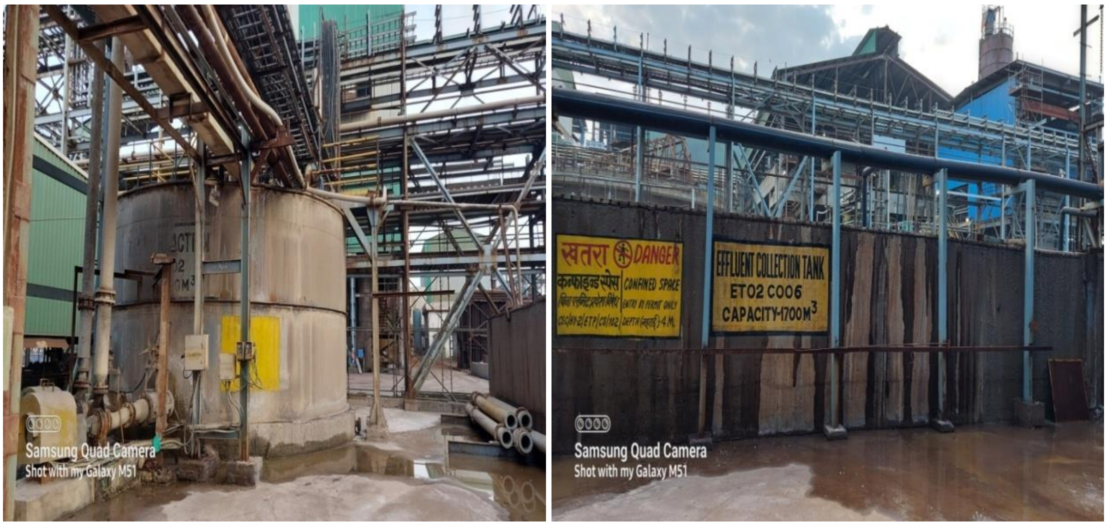

Figure 2: Effluent treatment plant

Physico-chemical analysis of effluent

Dissolved oxygen (DO), total dissolved solids (TDS), electrical conductivity (EC), pH, color, and chemical oxygen demand (BOD) were among the physico-chemical effluent parameters examined. A digital pH meter, specifically designed for use with BVM systems, was used to determine the wastewater's pH. To calibrate the pH electrode, three different buffers were used: 4.0, 7.0, and 10.0. After submerging the electrode in a sample of effluent water, readings were taken. (Kumar and Kumar, 2012). Turbidity was measured by digital turbidity meter (Model BVM specific) in Nephelometric unit (NTU) (Kumar and Kumar, 2012).

Electrical conductivity (EC) of the waste water was determined with digital conductivity meter (Model Chemiline technologies CL-220) (Parveen *et al.*, 2017). A total dissolved solid (TDS) was determined by gravimetric method after filtration (Nigam *et al.*, 2015). The Amount of dissolved oxygen in the samples was alsodetermined using the titrimetric Winkler’s Method (Banunle *et al.*, 2018). According to the Indian standard from 1989, all of these criteria were found in water and wastewater - Methods of sampling and test (physical and chemical).

Heavy metal estimation

The heavy metals that were analyzed in wastewater sample include Zn, Mn, Pb, Fe and Cr. An atomic absorption spectrophotometer was used to measure the content of heavy metals. (Perklin Elmer analyst 200) (Bahiru, 2019).

Result and Discussion

In table 1 you can see the physico-chemical properties of mining wastewater. The sample of mine effluent had an unpleasant odor and a light yellow tint, according to the results of the physico-chemical characteristics.

The corrosiveness of water is determined, in large part, by its pH, one of the most essential parameters in this context. The corrosiveness of water increases as its pH value decreases

(Nigam *et al*., 2015). Water can be impacted by even small pH variations, rendering it unsafe for drinking and other uses (Parveen *et al*., 2017). Total alkalinity and electrical conductivity showed a positive correlation with pH (Gupta, 2004). The pH value of mining waste water was observed is 7.4.The slightly alkaline character of the mine wastewater is shown by the higher pH value. Effluent contains weak basic salts, which cause it to be alkaline.

Turbidity - The turbidity is a measure of the total suspended solids (TSS) which is measured in Nephelometric unit (NTU). The material's concentration determines the water's transparency and light-scattering characteristics (Banunle *et al*., 2018). It matters because it influences both the choice and effectiveness of treatment methods as well as how consumers will perceive the water. Additionally, it promotes bacterial growth (Nigam *et al*., 2015). Natural water often has turbidities between 1 and 2000 NTU. Excessive turbidity levels are typically caused by the presence of inorganic compounds, plankton, fine clay and slit particles, organic compounds, and other microbes (Banunle *et al*., 2018; Asameah, 2012). Turbidity of mining waste water was 8.9 NTU.

Electrical conductivity (EC) - Being able to conduct electricity is one way to test electrical conductivity, which is also a way to indirectly measure the salt level in water. (Parveen *et al*., 2017). Siemens per meter (S/M) is the unit of measurement. Natural water has dissolved minerals in it, and the amount of dissolved minerals and the water's conductivity are correlated; in general, the higher the conductivity, the higher the concentration of dissolved minerals (Banunle *et al*., 2018). Wastewater was found to have an EC value of 32000 us/cm.

Total dissolved solids (TDS) - Total dissolved solids are the sum of all the inorganic salts and other substances that dissolve in water. Dissolved organic and inorganic contaminants cause a higher TDS value. (Parveen *et al*., 2017). The TDS of waste water was observed is 20800 mg/l.

Dissolved oxygen (DO) – Dissolved oxygen of wastewater sample measure the quantity of oxygen dissolved in the water. According to Banunle *et al*. (2018), there is numerous variables that affect it, including salinity, temperature, sunshine, air pressure, and water turbulence. The waste water's DO value was 3.1 mg/l.

Biological oxygen demand (BOD) - The biological oxygen demand (BOD) is the amount of oxygen that aerobic microbes in water need to break down organic substances. A high concentration of dissolved organic matter increased the BOD level and used a significant amount of oxygen. It is a widely used indicator of organic pollutants in water. According to Benit and Roslin (2015), it shows the amount of organic materials in water. Waste water was found to have a BOD value was 28 mg/l. (Parveen *et al*., 2017).

Chemical oxygen demand (COD) - Chemical oxygen demand (COD) is a measure of the oxygen concentration required to chemically oxidize organic and inorganic nutrients in water. The COD value of waste water observed was 110.31 mg/l.

Table 1: Mining waste water physicochemical properties.

S.No.	Parameter	Result
1.	pH	7.4
2.	Electrical conductivity (EC)	32000 us/cm.
3.	Total dissolved solids (TDS)	20800 mg/l.
4.	Turbidity	8.9 NTU
5.	Dissolved oxygen (DO)	3.1 mg/l.
6.	Biological oxygen demand (BOD)	28 mg/l.
7.	Chemical oxygen demand (COD)	110.31 mg/l.

Heavy metal estimation – The presence of heavy metal ions is supposedly the biggest issue with mining wastewater. The heavy elements that were tested in the sample were Zn, Mn, Pb, Fe, and Cr. The results showed that the heavy metal concentrations were Zn>Mn>Fe>Pb>Cr (Sorsa *et al*., 2015). Table 2 displays the concentrations of heavy metals in the wastewater sample. The waste water sample included the lowest concentration of Cr and the greatest concentration of Zn among the heavy metals.

Zinc is important for human health in many ways, including immune system function, brain activity, and fetal development and growth. It is also one of the least hazardous elements in the human diet. Zinc, however, is very hazardous at high amounts and may cause injury to humans (Helen and Othman, 2014; Bahiru, 2019). Soil acidification and phosphate depletion are consequences of wastewater with an excess of iron (Abagale *et al*., 2013; Bahiru, 2019). When it comes to metals, lead is among the worst for people's health.

According to Rehman *et al*. (2013) and Bahiru (2019), this non-essential element may lead to oxidative stress, anemia, colic headache, brain damage, and other health problems. The metabolism of glucose, fat, and cholesterol all rely on chromium. It is harmful and carcinogenic in high concentrations (Chishti *et al*., 2011).

Table 2: Heavy metal concentration in mining waste water.

S.No.	Heavy metal	Concentration (ppm)
1.	Zinc	14.10
2.	Manganese	3.25
3.	Lead	1.0
4.	Iron	1.12
5.	Chromium	0.25

Conclusion

The mining effluent was tested for a range of physico-chemical parameters, including color, turbidity, electrical conductivity, dissolved oxygen, heavy metal content, biological oxygen demand, chemical oxygen demand, and pH. The findings of the previous study show that most physico-chemical parameters are high, and the heavier metal content is found to be Zn > Mn > Fe > Pb > Cr. Bioremediation is a cost-effective and eco-conscious way to remediate these effluents. One dependable and inexpensive way to remediate wastewater is by biodegradation. After treatment, the wastewater has several potential new uses, including irrigation and human consumption. Additional research into the physicochemical characteristics of mining wastewater will aid in its treatment.

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