GREAT STEP 2018

ENVIRO CASE STUDY

PROBLEM STATEMENT

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In Opencast chromite (Cr_2O_3) mines, mining is carried out at a depth below the groundwater table, resulting in seepage of groundwater into the mine pit. The surface runoff water (in the monsoon seasons) from the overburden dumps also add to the seepage water. Certain quantity of water is used for various mine processes including that of chrome ore beneficiation and these used water also add to the mine drainage water.

The mine drainage water from chromite mines contains trivalent (Cr3+) and hexavalent Cr(VI) chromium. While Cr3+ is an essential element for humans, Cr(VI) is highly toxic, mutagenic and carcinogenic. The combined concentration of hexavalent and trivalent chromium in the mine effluent is referred to as **total chromium concentration**. If Cr(VI) containing mine drainage water is released untreated, can severely contaminate the water bodies.

A chromite mine located in Odisha produces 10.0 lakh Metric Tonne of ore per annum and 45.0 lakh m^3 (6.5 lakh MT) of overburden. The average grade of the produced ore is 35 % chromite. The mine produces 2.5 Lakh MT mill tailings with average 10% Cr_2O_3. The mine produces drainage water of 230 m^3/day in the peak season and 100 m^3/day in the lean season. It also uses 20 m^3/day of water for various processes including chrome ore beneficiation, cooling, dust control, washing etc. Seventy five percent of process water is re-circulated and recycled. The mine effluent water (that includes mine drainage water + recycled process water) needs to be discharged on a nearby water stream after meeting the Industrial effluent standard (IS 2490). A water sample from the effluent of the mine was analyzed and the following water quality parameters (Table 1) were measured.

Table 1. Analysis of Mine Effluent from a Chromite Mine*

Sl N.	Parameters	Value	IS:2490
1	pH	6.0-6.6	5.5-9.0
2	Total Suspended Solids	79-88	100
3	Total Dissolved Solids	640-850	2100
4	Sulphates (as SO4 --)	36-56	1000
5	Fluorides as (F-)	-	0.6-1.2
6	Cadmium (as Cd)	<2.0	2.0
7	Selenium (as Se)	<0.05	0.001
8	Zinc (as Zn)	0.04-0.08	5.0
9	Lead (as Pb)	<0.01	0.01
10	Copper (as Cu)	0.01-0.02	3.0
11	Iron (as Fe)	0.31-0.42	-
12	Manganese (as Mn)	<0.1	-
13	Chromium (as Cr+6)	0.70	0.1
14	Total Chromium	5.0	2.0

*All units except pH in mg/L

It is proposed to establish an effluent treatment plant for the above mine effluent in order to reduce the chromium concentration to acceptable limits (as per IS 2490) before it is discharged in a nearby water stream.

a. Give the process of oxidation/reduction of Cr ions.
b. Suggest suitable physical/chemical/biological process for removal of Cr(VI) ions.
c. Design the treatment plant for the above mine. Discuss the different sequential process.
d. Discuss the economics of the water treatment process.