Removal of Heavy Metals from Textile Mill Wastewater by Soil Aquifer Treatment System in Conjunction with Adsorbent

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Abstract - *Soil Aquifer Treatment (SAT) is a developing natural treatment technology, in combination with other treatment technologies, can produce effluent of satisfactory quality for indirect potable reuse. In the present study Soil Aquifer Treatment System is adopted for wastewater reclamation for potable and non-potable uses. Textile Mill wastewater was used for experimentation to assess the treatment efficiency of SAT system in treating these wastewaters under varied experimental conditions. Clayey sand and silty sand are the two soils used for experimentation along with the Peepal has the adsorbent. Zinc and Chromium removal efficiency in clayey sand 84% and 80%, silty sand 82% and 77%, clayey sand with peepal leaf adsorbent 98% and 97%, silty sand with peepal leaf adsorbent 96% and 95% were obtained.*

***Key Words*:** Soil Aquifer Treatment, Textile mill Wastewater, Soils, Adsorbent, Zinc and Chromium.

1. INTRODUCTION

Water plays a vital role to all form of life existing on earth. Water of standard quality is necessary for all these activities domestic, agriculture, commercial and industrial uses. The waste generated from these activities is responsible for polluting the water. The constant blending of heavy metals from industrial effluents by activities like textile dying, mining, metal processing, electro plating, etc., to water stream induces various adverse effects on human health and the environment. Toxic metals have a tendency to bio accumulate by entering into the food chain. Numerous conventional methods like electro precipitation, membrane separation, evaporation, ion exchange, etc. is adopted for the elimination of heavy metals, all those methods are expensive and insufficient for low concentration of heavy metals. Soil Aquifer Treatment is inexpensive technique, which treats the wastewater during the infiltration process. Ion exchange, bio adsorption and physic-chemical reactions occur during infiltration process.

Zinc and chromium is the toxic heavy metal discharged into the environment by the industrial activities. Heavy metals are non-biodegradable unlike other organic pollutants. Zinc are widely used in metal industries like mining, metal cleaning, plating baths, pulp and paper mills, fertilizers, refineries, textile industry etc., which produce high levels of zinc in effluents. Zinc is a vital element essential for human health like to prevent premature skin aging and muscles. But too much of Zinc ingestion about 225 mg can cause prominent health issues like stomach cramps, vomiting, nausea, skin irritations, etc.

Chromium exists in environment both in form of trivalent and hexavalent. It is identified that Cr (VI) is 500 times more toxic than the Cr (III) form. Industries like chrome-plating, automobiles, steel and alloys, textile industry, paints, leather tanning and ammunition factories make use of Hexavalent chromium has it have unique properties of corrosion resistance, hardness and colour. Excess of chromium causes damage to liver, kidneys and nerves system.

2. MATERIALS AND METHODS

2.1 Collection of Soil

Soil sample were collected from the depth ranging from 10 to 50cm. The selection of this depth was based on the fact that most of the purification takes place at the uppermost layer of the soil and also most fecal bacteria perishes off at the top layer of the soil.

2.2 Adsorbents Preparation

Peepal leaf (Ficusreligiosa) leaves were collected from trees abundantly available at the Rail Nagar, Hubli, India The collected leaves were washed with water several times till no dirt particles contained in wash water followed by drying in sunlight for 3 to 4 days until its fully dried. The dried leaves were crushed in gunny bag initially and powered using domestic mixer grinder and different size fractions were collected. The dried leaf powder (without any pre-treatment) of size 300μ and 75μ was used.

2.3 Collection of Textile Mill Wastewater

The textile mill wastewater was collected from Gadag Co-operative Textile Mill Ltd., Hulkoti. Grab sampling was used to collect the samples from the textile mill. Samples were collected in large plastic cans and preserved in the refrigerator so that the characteristic of the textile mill wastewater doesn't changes its characteristics thought out the experimental work.

2.4 Experimental Setup

Four columns made up of PVC pipe were constructed for the experimentation. Each column of 115cm length and 16cm inner diameter with the outlet at the bottom and overflow pipe at the side of top. In order to prevent the escape of soil the bottom of each column was plugged with 60 micron mesh inside. The columns are filled by maintaining the field density of the soil. Feeding tank, containing wastewater sample is placed at the top, wastewater fed from the top and after getting treated renovated water is collected from the outlet provided at the bottom of columns. Column 1 (C1) is filled with clayey gravel soil at a depth of 85cm, column 2 (C2) is filled with silty sand soil at a depth of 85cm, column 3 (C3) is filled with two layer of peepal leaf adsorbents placed in between three alternate layer of clayey sand soil of soil layer depth 25cm and adsorbent depth 5cm, column 4 (C4) is filled with two layer of peepal leaf adsorbents placed in between three alternate layer of silty sand soil of soil layer depth 25cm and adsorbent depth 5cm.

3. RESULTS AND DISCUSSION

Table 3.1: Performance of SAT System with and without Adsorbent in Removal of Zinc and Chromium

Raw/ Treated Wastewater	Parameters		Removal Efficiency %	
	Zinc	Chromium	Zinc	Chromium
Influent	3.36	1.83	-	-
Clayey Sand	0.51	0.38	84	79
Silty Sand	0.60	0.43	82	77
Clayey Sand with Adsorbent	0.08	0.052	98	97
Silty Sand with Adsorbent	0.11	0.080	97	96

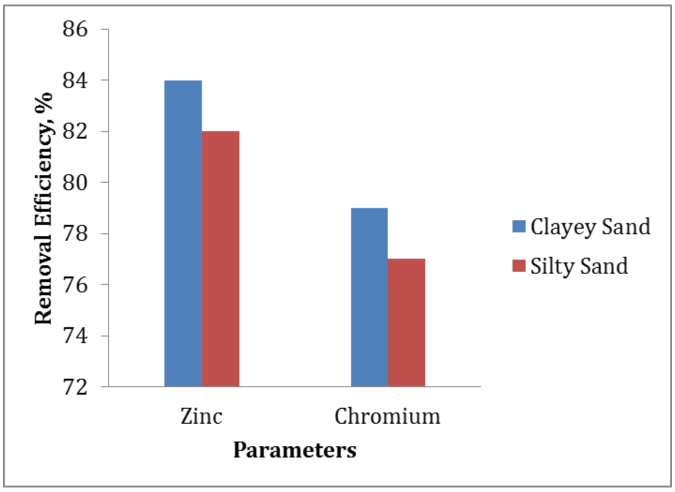

Fig 3.1 Removal Efficiency of Zinc and Chromium without Adsorbent, SAT System

From Table 3.1 and Fig 3.1 the removal efficiency of zinc 84% and chromium 79% in Clayey Sand of soil depth 85cm and removal efficiency of zinc 82% and chromium 77% in Silty Sand of soil depth 85cm. From this it is clear that removal efficiency of clayey sand soil is better when compared to silty sand soil.

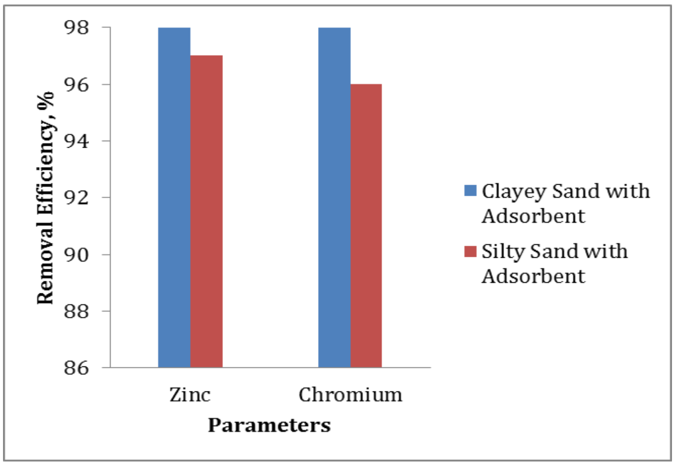

Fig 3.2 Removal Efficiency of Zinc and Chromium with Adsorbent, SAT System

From Table 3.1 and Fig 3.2 the removal efficiency of zinc 98% and chromium 97% in Clayey Sand with adsorbent (two layer of peepal leaf adsorbents placed in between three alternate layer of clayey sand soil of soil layer depth 25cm and adsorbent depth 5cm) and removal efficiency of zinc 97% and chromium 96% in Silty Sand with adsorbent (two layer of peepal leaf adsorbents placed in between three alternate layer of silty sand soil of soil layer depth 25cm and adsorbent depth 5cm). From this it is clear that removal efficiency of clayey sand soil with adsorbent is better when compared to silty sand soil with adsorbent.

4. CONCLUSIONS

Bench scale column studies were carried out to evaluate the potential of SAT system in treating textile mill wastewater under varied experimental condition viz. soil type, alternate soil layer in conjunction with adsorbent, initial concentration of pollutants. Based on the analysis of results the following conclusions have been drawn:

- In SAT system without adsorbent the removal efficiency of zinc and chromium was better in clayey sand soil when compared to silty sand soil.
- In SAT system with adsorbent the removal efficiency of zinc and chromium was better in clayey sand soil with peepal leaf as adsorbent when compared to silty sand soil with peepal leaf as adsorbent.
- SAT system can be utilized for treating textile mill wastewater and reclaimed water can be used for indirect uses.

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