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Pharmaceutical Wastewater Treatability Studies by SAT with Conjunction with Natural Adsorbents

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Abstract - *Water serves as an indispensable element for the preservation of life. However, mismanaging wastewater can pose substantial health hazards as it has the potential to transport and propagate a multitude of diseases. To tackle this challenge, techniques like Soil Aquifer Treatment (SAT) are employed to recharge groundwater with contaminated water. In this process, the unsaturated zone and aquifer act as natural filters, employing physical, chemical, and microbiological processes to alleviate the concentration of pollutants. SAT has gained prominence due to its cost-effectiveness and sustainability. A recent research endeavor has shed light on the effectiveness of the SAT system in eliminating specific pollutants, including Chloride, Hexavalent Chromium, Copper, Nickel, and Zinc. This study focused on leveraging the adsorption capabilities of Banana Peel powder to enhance the removal process. Notably, the research underscored that Banana Peels exhibited a greater adsorption capacity for Zinc, thus highlighting their potential as a proficient adsorbent. Furthermore, the investigation unveiled disparities in the efficiency of removing various heavy metals, with Zinc displaying the highest rate of removal when compared to Copper, Nickel, and Hexavalent Chromium.*

Key Words: Soil Aquifer Treatment, Banana Peels, Soil, Adsorbent, Zinc.

1. INTRODUCTION

Water stands as a crucial liquid essential for humanity's survival. While domestic water holds impurities, industrial wastewater contains a combination of impurities and pollutants. These contaminants have the potential to trigger various illnesses and render water unsuitable for consumption. With the nation's progress, rapid industrialization amplifies water usage, resulting in an escalated demand. Unfortunately, industries frequently release untreated wastewater into natural water sources, groundwater reservoirs, and freshwater basins, leading to widespread pollution.

To address this concern, Soil Aquifer Treatment (SAT) has emerged as a viable strategy, showcasing its effectiveness in eliminating heavy metals from wastewater. This method involves replenishing groundwater with contaminated water. Throughout this process, the unsaturated zone and aquifer serve as natural filters, employing physical, chemical, and microbial mechanisms to decrease the concentration of pollutants. SAT's attractiveness lies in its cost-efficiency and sustainability.

However, it's important to recognize limitations, such as the potential for clogging to occur following wastewater treatment. This project revolves around the study of soil columns, soil attributes, and adsorbents. The emphasis is placed on secondary effluent, with the goal of elucidating soil behavior and achieving optimal removal efficiency. The role of soil texture is pivotal, as distinct textures exhibit varying removal capacities. Adsorbents play a role in enhancing removal efficiency.

2. MATERIALS AND METHODOLOGY

2.1 Collection of Soil Samples

Soil samples were collected from the two different location that is in and around Bangalore. Silt Soil were collected from an open ground in Yelhanka and the Clayey Soil was collected from the lake in Hebbal. These two Soil samples were tested and then introduced in the columns.

2.2 Preparation of Adsorbent

Banana peels were the adsorbent that is collected from the hotels, local market, tea shops, fruit shops. These banana peels were washed with distilled water and then sun dried. After complete drying of the peels, it was grinded and powdered and then sieved. These sieved powders were used in the experimentation.

2.3 Experimental Setup

The experimental setup involves a PVC column with dimensions of 1.5 meters in length and a diameter of 6 inches. At the base of the column, a fine mesh with a pore size of 60µm is positioned. The bottom of the column is designed in

a funnel shape to facilitate the collection of treated water. The flow of wastewater into the column is regulated using a flow regulator. To maintain consistency, a ponding depth of 35 cm is maintained, and any excess water is guided out of the column through an overflow system. The column, including the mesh, is thoroughly cleaned after each trial.

2.4 Collection of Wastewater

The primary goal of this study is to assess the efficiency of the (SAT) system in treating wastewater from the Pharmaceutical Industry. The source of this wastewater is the Industrial Area located in Peenya, Bangalore.

3 RESULTS AND DISCUSSIONS

The experiments were conducted with the aim of evaluating the efficiency of Soil Aquifer Treatment (SAT) in the treatment of industrial wastewater. The investigation encompassed both scenarios: with and without the incorporation of an adsorbent.

The industrial wastewater used in the study was obtained from a specific industrial source. Two distinct soil types, namely clayey soil and silty soil, were utilized in the experiments. Additionally, an adsorbent, represented by banana peel powder, was introduced into the experimental setup.

The results obtained from the experimentation and the deductions derived from these outcomes will be thoroughly discussed here.

Table 1 : Characteristics of Wastewater

Parameters	Wastewater characteristics
pH	6.90
Conductivity, (µs/sec)	2200
T.D.S, mg/L	1030
Chloride, mg/L	299.9
Hexavalent Chromium(Cr^{+6}), mg/L	0.8
Copper, mg/L	0.579
Nickel, mg/L	0.0124
Zinc, mg/L	0.9354
Iron, mg/L	2.1005

Table -2: Performance with Only Sandy Clay Loam Soil

Parameter	Influent	Filtrate	RE %
pH	6.90	7.65	
Conductivity, (µs/sec)	2200	1385	
T.D.S, mg/L	1030	693	
Chloride, mg/L	299.9	214.4	28.50
Hexavalent Chromium(Cr^{+6}), mg/L	0.8	0.310	61.25
Copper, mg/L	0.579	0.2500	56.82
Nickel, mg/L	0.0124	-	100
Zinc, mg/L	0.9354	0.45	51.89
Iron, mg/L	2.1005	0.95	54.77

As per experimentation conducted, the soil texture found out to be sandy clay loam soil. It has some good absorption of metals and small amount of removal efficiency. In this soil maximum absorption of heavy metal is Hexavalent chromium of about 61%. Least absorbed is Zinc and Chloride of about 51% and 28% respectively and tabulated in Table.2.

Table -3: Performance of Sandy Clay Loam Soil with Banana Adsorbent

Parameters	Influent	Filtrate	RE %
pH	6.90	7.15	
Conductivity, (µs/sec)	2200	1200	
T.D.S, mg/L	1030	625	
Chloride, mg/L	299.9	56.6	81.12
Hexavalent Chromium(Cr^{+6}), mg/L	0.8	0.11	84.37
Copper, mg/L	0.579	0.0788	81.01
Nickel, mg/L	0.0124	0.003	75.80
Zinc, mg/L	0.9354	0.1277	86.34
Iron, mg/L	2.1005	1.20	42.87

In the Table 3., we have seen for only soil used, but in this case, we have used banana peel powder as an adsorbent. pH can be observed neutral, conductivity and Total Dissolved Solids in the water is reduced as it a good sign. In here, maximum removal efficiency is observed to be Zinc with about 86% and minimum removal is seen to be Iron of 42%. Hence with Banana peels as an adsorbent, zinc removal was observed from waste water. Removal efficiency increase due to Banana Peels is observed.

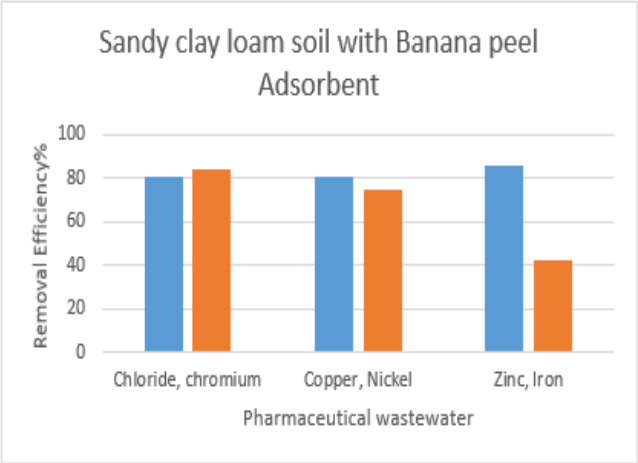

Fig 1: Graphical Representation for Efficiency of SAT

Table -4: Performance of Clayey Soil

Parameters	Influent	Filtrate	(RE%)
pH	6.90	7.55	
Conductivity, (µs/sec)	2200	1988	
T.D.S, mg/L	1030	992	
Chloride, mg/L	299.9	309.903	-3.33
Hexavalent Chromium (Cr^{+6}), mg/L	0.8	0.75	6.25
Copper, mg/L	0.579	0.39	32.64
Nickel, mg/L	0.0124	-	-
Zinc, mg/L	0.9354	0.452	51.67
Iron, mg/L	2.1005	9.25	-340.49

In Table 4, Clayey soil showed very least in removing heavy metals, as represent in the Table 4, a rise in Chloride. Highest removal is said to be Zinc of 51%. Reduced to a lesser extent are the other heavy metals.

Table -5: Performance of Clayey Soil with Banana Peel Adsorbent

Parameters	Influent	Filtrate	(RE%)
pH	6.90	8.21	
Conductivity, (µs/sec)	2200	4400	
T.D.S, mg/L	1030	1990	
Chloride, mg/L	299.9	325.5	-8.5362
Hexavalent Chromium (Cr^{+6}), mg/L	0.8	0.34	57.5
Copper, mg/L	0.579	0.412	28.8428
Nickel, mg/L	0.0124	0.044	-254.84
Zinc, mg/L	0.9354	0.199	78.06
Iron, mg/L	2.1005	26.6	-1166.4

As we discussed, clayey soil showed very less amount of removal efficiency but due to presence of Adsorbent Zinc was removed from the waste water about 78% as shown in Table 5.

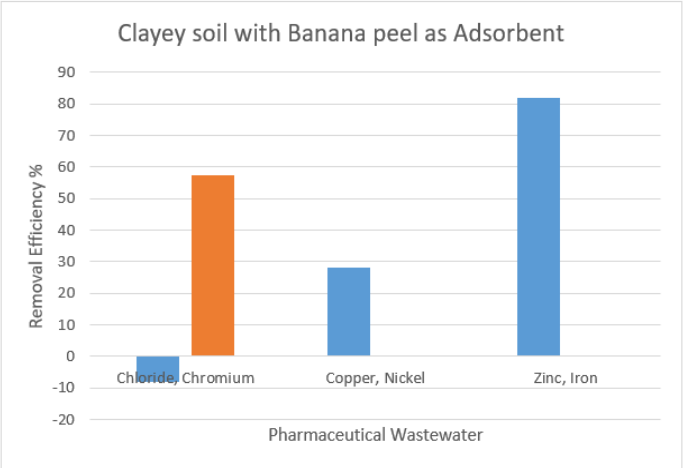

Fig 2: Graphical Representation for Efficiency of SAT

4. CONCLUSIONS

Experiments involving columns were undertaken to evaluate efficiency, particularly concentrating on the performance related to both soil and the adsorbent and conclude as follows

- The SAT system offers the possibility of treating wastewater from diverse industries and the treated water could be utilized for secondary purposes.
- The utilization of the adsorbent in combination with sandy clay loam soil demonstrates superior performance when compared to clayey soil.
- Using Sandy clay loam soil with Banana Peels as an adsorbent showed the maximum removal of Zinc about 86% and minimum removal of Nickel of about 75%.

- Using Clayey soil with Banana Peels as an adsorbent showed maximum removal of Zinc about 78%. Due to the presence of the Adsorbent.
- The utilization of clayey soil is associated with the observation of aquifer clogging.
- Presence of Adsorbent will increase the Efficiency of SAT.

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