

# Treatment of Wastewater by Soil Aquifer Treatment (SAT) in Conjunction with Natural Adsorbent

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**ABSTRACT:** Water is one of those most essential things that we use daily be it for drinking, bathing, cooking, industrial purpose, household activities etc. and due to all these activities we tend to generate wastewater of large quantity. Hence it is very important to treat and reuse this water because of water shortage. Hence we have decided to use the soil aquifer treatment system after studying different research works conducted by N. Othman, Rekha K. H etc. the column study is adopted where the soil density etc. is maintained same as that in the site from where the soil sample was collected. Then the wastewater is allowed to pass in the columns containing clayey sand, silty sand, clayey sand with adsorbent and silty sand with adsorbent. The influent wastewater characteristics and effluent wastewater characteristics are compared for removal efficiency and treatability aspects of wastewater are determined. Experiments when conducted showed that the maximum removal efficiency of zinc in clayey sand with adsorbent was 97.62% and minimum removal efficiency was observed in silty sand without adsorbent i.e. 82.14%. Therefore SAT system is an efficient method that can be used for wastewater treatment by land usage. This method is cost effective, easy and less supervision required.

**KEYWORDS:** Soil aquifer treatment (SAT), Zn, Natural Adsorbent.

## I. INTRODUCTION

We need water for multiple purposes, be it for irrigation, industrial purpose, manufacturing goods, household activities, water sports, for animal husbandry etc. Due to all these activities a large quantity of wastewater is generated. Since the availability of fresh water is very less and people are facing water shortage, hence it is very important to reclaim the wastewater or pre-treated water by using land for treatment. This land treatment was popular even back in 2600BC i.e. in Minoan civilization. This land treatment method is known as soil aquifer treatment. This method is proved to be very efficient, economical and also environment friendly. It is easy to operate, easy to maintain and aesthetic in nature. As we know the soil is a natural filter and this SAT system can eliminate suspended solids, biodegradable materials, bacteria, viruses and other microorganisms the quality of the water is improved when tested after this treatment. This method provides required or acceptable rate of treatment to the wastewater and helps in improving the water quality for the intended use. As previously reported by many there is a significant reduction of phosphorous, nitrogen and removal of heavy metals from wastewater was also possible by sorption and physio-chemical stabilization.

The industrial wastewater and pre-treated water contain certain amount of heavy metals in it and we know that heavy metals can also be found naturally in the earth's crust. Due to human activities the biochemical and geochemical balance of heavy metals change and tend to enter our drinking water supply system. When these heavy metals enter the human body through water or food can harm different organs, higher the exposure higher will be the risk faced. Zinc plays major role even on plants, soil, animals, aquatic life and humans. If zinc is found more than it is required either in water, food or any other sources can cause depression, lethargy, increased thirst, neurological signs etc. in humans. Heavy metal exert toxic effects on soil microorganism hence results in change of the diversity, population size and overall activity of the soil microbial community and influence the metabolism of soil microbes. In general, an increase of metal concentration affect soil microbial properties example respiration rate, enzyme activity, which appears to be very useful indicators of soil pollution. Heavy metals are also very essential for plant growth and metabolism of plants.

## II. RELATED WORK

[1]. V.C. Renge et al., (2012) carried out study on removal of heavy metal from wastewater using low cost adsorbents. According to author, activated carbon has been frequently used as adsorbent for removal of heavy metal from wastewater but activated carbon remains an expensive material. Therefore the research is interested towards the production of low cost alternatives to commercially available activated carbon. According to his study less expensive adsorbent like various agricultural waste by-products such as seaweed, egg shell, saw dust; algae are effective in removal of heavy metal from waste stream to great extent.[2]. Renu et al., (2017) conducted experiment on removal of heavy metal from wastewater using various adsorbents. Heavy metals are discharged into water from various industries. They can be toxic. Thus the author carried out adsorption process for removal of heavy metals from wastewater. The different adsorbents are used for heavy metal removal such as chromium, calcium and copper and also provided information on commercially available and natural bio- adsorbents.[3]. Rekha K.H et al., (2018) carried out study on deportation of heavy metal from wastewater using SAT with adsorbent. In the examination, the heavy metals attributes like the quantitative, appropriation and specification in different profundities of soil of two years worked lab scale was analyzed. The clayey sand, inorganic silt with sand and silty sand are used for experiment. Eucalyptus leaves, sawdust and citrus limetta are used as adsorbent. The study shows that the SAT system with adsorbents is more viable in treating destructive wastewater.[4]. Ranjan et al., (2015) conducted experiment on removal of heavy metals from wastewater using low cost adsorbents. The conventional method of treatment of heavy metals includes chemical oxidation etc. are expensive. Hence agricultural wastes like rice husk, neem bark, black gram, waste tea, walnut shell are potent adsorbent for heavy metal removal. Beside those low cost industrial by-products like fly ash, blast furnace sludge, waste slurry and others have been explored for their technical feasibility to remove toxic heavy metals from contaminated water.[5]. N. Othman et al., (2016), carried out an experiment using waste fish scale as adsorbent in removing zinc and ferum ion in wastewater and it is economical. It is environmental friendly method for the removal of metals from synthetic and domestic wastewater. M. tilapia fish scale is a promising adsorbent in removing Zn and Fe ion from synthetic and domestic wastewater solution.

## III. METHODOLOGY

### 1. COLLECTION OF SOIL

Two soil samples were used in order to assess the suitability of soil in treating the wastewater. Soil samples belonging to different classes were used for the work. The soil samples were collected from a site near Royal Enfield Showroom, Hadadi Road, Davanagere and Magenahalli which is about 20km away from the Davanagere city. Based on the analysis of soil samples collected, soil samples were classified as Silty sand and clayey sand.

### 2. ADSORBENT PREPARATION

The banana peel was collected and washed several times in tap water and then with distilled water. The washed banana peel is sun dried for a week. Then crush it into small pieces and permitted 24 hours of drying in a hot air oven at 80°C. The peel will have lost the moisture content, and the color will shift from yellow to brownish black as observed. The dried material was finely ground and screened in 150-212µm cut size sieves.

### 3. EXPERIMENTAL SETUP

The experiments are carried out to do the SAT efficiency studies for the treatment of industrial wastewater with individual adsorbent. For this experiment, two soils are used, and the adsorbent used is the banana peel. For the experimentation four columns made of PVC pipe were built. Column has a length of 115 cm and an inner diameter of 16 cm, with outlet at the bottom and overflow pipe at the top side. It is considered that the soil is filled in the column by calculating the pipe volume with respect to the depth of soil to be filled. The bottom of each column was plugged with 60 micron mesh inside to prevent soil from escaping. The columns are filled by preserving soil density in the field. Feeding tank, containing wastewater sample placed at the top, wastewater is fed from the top and is collected from the outlet at the bottom of the columns after having been treated.

Column 1 (C1) is filled with clayey sand at a depth of 85 cm, column 2 (C2) is filled with silty sand at a depth of 85 cm, column 3 (C3) is filled with banana peel adsorbent placed between the layers of silty sand at a depth of 38 cm and 37 cm and an adsorbent depth of 10 cm, column 4 (C4) is filled with banana peel adsorbent placed between the layers of clayey sand. The removal efficiency of zinc is noted for with and without banana peels powder as individual adsorbent.

IV. EXPERIMENTAL RESULTS

The experiments were performed to determine the efficiency of Soil Aquifer Treatment with or without the adsorbent in treating the wastewater obtained from different industries. Two types of soils and an adsorbent was used, i.e. clayey sand, silty sand, and banana peel powder. The results obtained from the experiment and the interferences thus drawn will be discussed here.

The removal efficiency is being calculated by using the following formula:

$$\text{Removal efficiency in \%} = \left[ \frac{C_{inf} - C_{eff}}{C_{inf}} \right] * 100$$

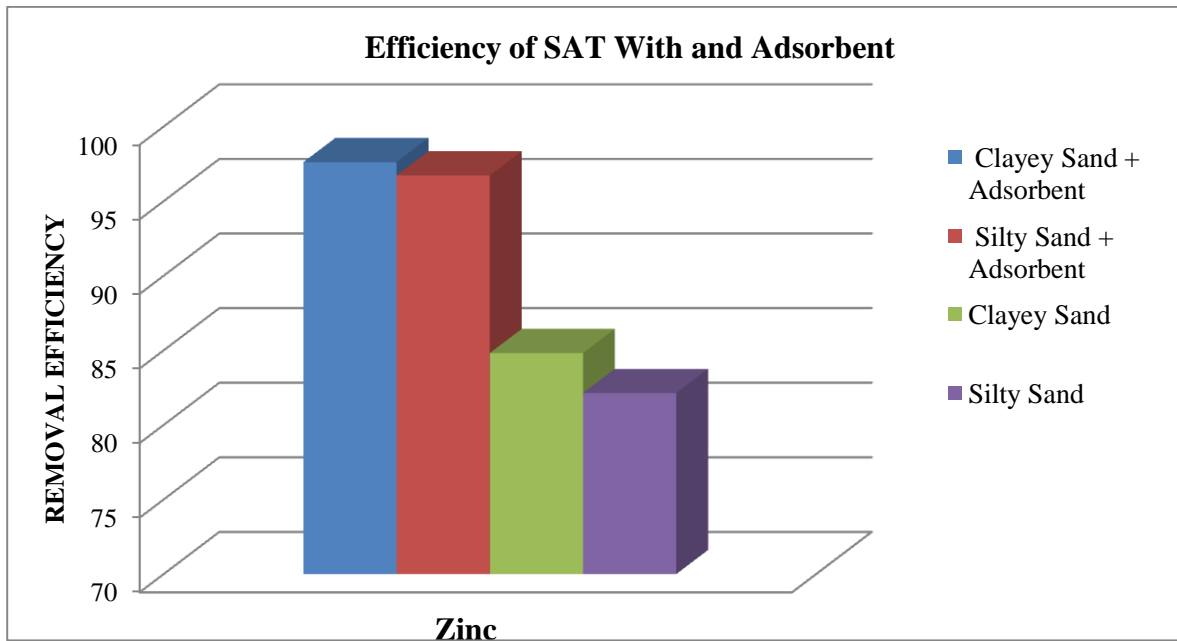


Chart 1: Removal Efficiency of SAT With And Without Adsorbent

From the above chart we can observe that

- The maximum removal efficiency of zinc in clayey sand with adsorbent is 97.62%.
- In case of clayey sand without adsorbent the efficiency of SAT is 84.82%.
- In silty sand with adsorbent the removal efficiency is 96.73%.
- Minimum removal efficiency is observed in silty sand without adsorbent is 82.14%.

V. CONCLUSION

Small scale column studies was conducted to assess the capacity of SAT system in the treatment of wastewater from various industries under different experimental conditions i.e. soil type, placing the adsorbent in between the soil layers, initial effluent concentration. Depending on the outcomes obtained conclusions can be drawn as follows:

- In SAT system the maximum removal efficiency of zinc is in clayey sand with adsorbent i.e. 97.62% and minimum removal efficiency was observed in silty sand without adsorbent i.e. 82.14%.
- By analysis of results, SAT system efficiency for treating wastewater is better in clayey sand with banana peel as adsorbent compared to clayey sand, silty sand and silty sand with adsorbent.
- The SAT system may be used to treat wastewater from different industries, and treated water may be used for secondary application.
- The adsorbents used are environmentally friendly, compostable and it is available locally and plays an effective role in the treating of water and wastewater.
- SAT system can be easily adopted for increasing groundwater recharge as well as for treating storm water, pre-treated water etc. depending on the soil type and hydrological conditions of the area or location.

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