EXPERIMENTAL INVESTIGATION ON REMOVAL OF SULPHATE ION CONCENTRATION ADOPTING SOIL FILTER SYSTEM

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Abstract -*Groundwater is one of the purest forms of drinking water available on earth. Presently ground water is getting polluted day by day due to the discharging of industrial effluent into the ground. Industrial effluent contains large amount of sulphate concentration. Sulphate from the pollution sources which contribute to disintegration of quality of ground water. As per IS10500:1991 the desirable limit of sulphate in drinking water is 250mg/l and limits between the ranges from 250-2000 mg/l. Sulphate has considerable concern because it is indirectly responsible for serious problems often associated with the handling and treatment of wastewater. Unpleasant odor and sewer corrosion are the problems resulting from the reduction of sulphate to hydrogen sulphide under anaerobic conditions. High concentration of sulphate in industrial effluent has an impact in surface water as that of ground water. In order to avoid the contamination of ground water, considerable amount of charcoal is mix with soil up to a effective depth. Activated charcoal is a form of carbon and it is a good absorbent. Charcoal - soil mix which helps to reduce the contamination of ground water up to a large extent.*

Key Words- *Activated charcoal, effluent, Sulphate, Groundwater, Unconfined compressive strength.*

1. INTRODUCTION

The policies based on infrastructure requirements have demanded certain characteristics of soil with poor geotechnical and sustainable properties. The groundwater being the major source of drinking water, it is our duty and responsibility to prevent it from getting polluted. One of the major pollutants that contaminate ground water is the sulphate. Sulphate often causes corrosion and disintegration leading to contamination of ground water. This study focuses on how to reduce or eliminate the sulphate ion concentration in water that has been discharged from industries and other commercial activities. Several techniques like ion-exchange, nanofiltration, reverse osmosis, electro dialysis, bentonite / kaolinite treatment are used now a days. Even though ion exchange and nanofiltration are effective methods, in ion exchange method, high pressure should be maintained and nanofilteration is less effective for monovalent ions. Reverse osmosis remove only monovalent ions. Bentonite is having less removal efficiency in high sulfate water. Also, these methods are expensive and need complicated instrumental setup. Hence, here we deal with the removal of sulphate ion by using charcoal with the aid of its good adsorption behavior.

2. OBJECTIVES

- To prevent the groundwater pollution by completely eliminating the chance of mixing high sulphate containing industrial effluent with ground water.
- To determine the depth of soil-charcoal mix for 100% removal of sulphate.
- To found the characteristics compressive strength of soil with different % of charcoal using UCC.
- To determine the optimum % of charcoal in soil charcoal mix for column test.

3. EXPERIMENTAL INVESTIGATION

3.1 TESTS ON SOIL

Various laboratory tests were conducted to determine the basic physical properties of laterite soil. The results obtained are:

Table -1: Properties of laterite soil

PROPERTIES		VALUES
Water Content		13.69%
Optimum Moisture Content		27.1%
Specific Gravity		2.98
Maximum Dry Density		1.447 g/cc
Coefficient of Uniformity		10
Coefficient of Curvature		1.55
Unconfined Compressive Strength		225.691kN/m^2
Permeability	Constant head	18.1*10^{-3} cm/s
	Falling head	1.905*10^{-3} cm/s

The sample is tested to obtain maximum compressive strength using UCC test, with the aid of stress-strain variation of the sample. Soil- charcoal mixes were prepared at various proportions to compare the variation in strength of normal soil and soil- charcoal mixes. Four different mixes were prepared as 1%, 2%, 3%, & 4% of charcoal by weight of soil.

An UCC test specimen of size 37mm diameter & 76 mm height were prepared using these samples and is placed under the test apparatus. Maximum compressive strength of each specimen is then found out by plotting stress-strain curve. The strength of the soil is found to be varying with different proportions of soil-charcoal mix. The graph showing increment in % of charcoal in X- axis & compressive strength in kN/m^2 in Y- axis is plotted.The strength was found to have a maximum value of 277.206 kN/m^2 for 3% charcoal.

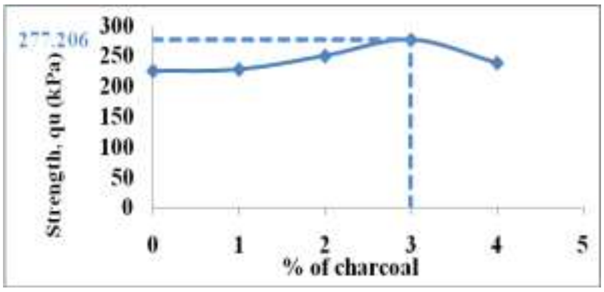

Chart -1:Strength vs. % charcoal graph

3.2 COLUMN TEST

Objectives:

- To observe the variation in sulphate concentration with depth
- To determine the depth of soil column required for 100% removal of sulphate.

Procedure:

Columns of different heights were fabricated to hold the soil. Then, sulphate sample of 3000mg/l concentration is prepared, representing industrial effluent. Normal laterite soil as well as soil with 3% charcoal by weigtht was filled in these columns successively. Prepared sulphate sample is then poured into the soil column. Turbidity of the collected sample is measured using turbidimeter. Through this, the adsorption of sulphate is observed in normal laterite soil and in soil with optimum % of charcoal. The sulphate adsorption is noted at 3 different heights of 40cm, 80cm&120cm.

Fig -1: Column test apparatus

3.3 TURBIDIMETER TEST

Calibration of turbidimeter was done using distilled water and 100 NTU standard solution.100ml of sulphate sample with 5ml conditioning reagent is mixed for finding turbidity. The concentration of sulphate in tested sample can be obtained from turbidimeter calibration chart. The calibration chart is prepared by finding turbidity of sample with concentration 0-40 mg/l with 5mg/l increment.

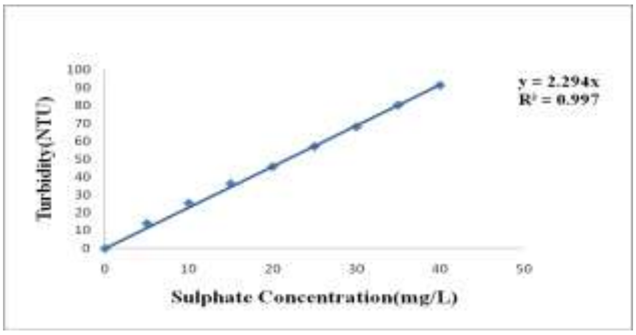

Chart -2: Turbidity Vs Sulphate concentration

4. RESULTS AND DISCUSSION

The depth required for 100% removal of sulphate can be analyzed from the percentage adsorption results obtained by conducting turbidmeter test. The depth at which, complete removal of sulphate can be analyzed by extrapolating the graph showing depth versus percentage sulphate removal. The following figures depict the depth for 100% removal of sulphate.

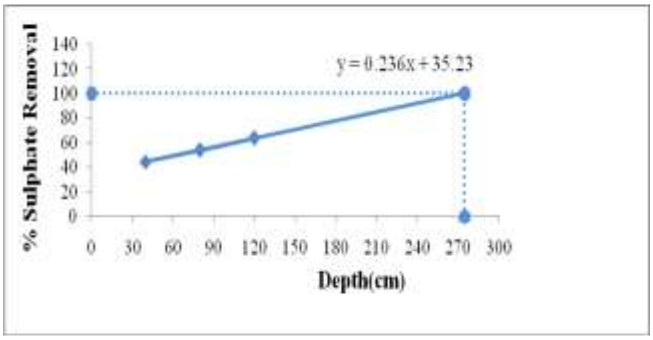

Chart -3: Depth vs. % sulphate removal-normal soil

From the graph, the relation between depth and % sulphate adsorbed is given by the equation:

$$y=0.236x+35.23$$

From calculation we get, depth for complete removal of sulphate from normal laterite soil as 274.45cm.

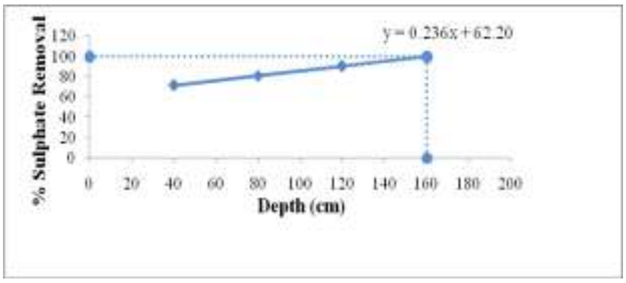

Chart -4: Depth vs % sulphate removal-soil-charcoal mix

For soil-charcoal mix, the plotted graph represents the equation as:

$$y=0.236x+62.20$$

The depth for complete removal of sulphate from soil-charcoal mix was found to be 160.17 cm. Hence the depth obtained shows that by the mixing of charcoal with soil, the depth required for complete removal of sulphate can be reduced by 41.6%. The existing methods such as ion exchange, reverse osmosis etc requires expensive equipments and they are installed as separate units only for the purpose of ion removal. Hence charcoal as a good adsorbent of ions can be used as an efficient substitute for the existing expensive methods.

5. CONCLUSION

The structures such as industrial waste water collecting tanks, underground pipes carrying high concentration sulphate etc, which are vulnerable to leakage, result in pollution of groundwater. By adopting soil-charcoal mix as a medium of filtration can prevent the pollution and sustainable construction can be ensured.

The results obtained from the project can be made into use for designing the depth of soil-charcoal mix required to be provided in the area where long time sulphate contact is involved .A column as in the experimental setup can be implemented in site with desired diameter and designed depth .The lateral movement of the waste water can be prevented by providing an impermeable sealing up to the designed depth.

The maximum efficiency in sulphate removal is obtained when soil is mixed with optimum (3%) charcoal. The strength of soil- charcoal mix at 3% was found to be 277.206 kN/ m^2, which indicates that the strength of normal laterite soil need not be compromised by the addition of charcoal. The results of turbidimeter test shows that normal soil requires a depth of 274.45 cm for 100% removal of sulphate while in the presence of 3% charcoal the required depth reduces to 160.17 cm .Hence by the addition of 3% of charcoal, the depth required for 100% removal of sulphate can be reduced by 41.6%.

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