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Removal of Sulphate Ions by Soil Filter System

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Abstract - *Successful agriculture depends on purity of soil and water. In most of the industries essential element is the effluent storage tanks. These tanks and pipelines are subjected to corrosion and structural failures with subsequent leaks that introduce a variety of contaminants into soil. It reaches the ground water causing the contamination of both soil and water. Charcoal is a residue consisting mainly of carbon the presence of charcoal below the foundation of effluent storage tank may reduce the contamination. The charcoal is having very good adsorption capacity and cheap also. The study aims to establish a relation between height of soil column and the percentage of removal of ion hence to determine the depth for hundred percentage of removal of ion.*

***Key Words*:** Laterite soil, Charcoal, Sulphate solution, Column test, Removal efficiency

1. INTRODUCTION

Successful agriculture depends on purity of soil and water. But presently the groundwater is getting polluted due to industrialization. In most of the industries including fertilizers manufacturing industries, paint industries etc. the essential element in the manufacturing unit is the effluent storage tanks. These underground or above ground storage tanks and transmission pipelines are the major cause of groundwater pollution. If these tanks are defective, they could leak their contents into the ground, creating contamination that may damage the environment and cause a hazard to human health. These liquid wastes affect the physical and chemical properties of the soil and changes its geotechnical properties. The contact of liquid waste and soil may affect the strength of soil below and around the storage tank. A minimum depth of soil bed should be provided below the storage tank to eliminate the contamination of ground water. But soil as a single filter media may not be much effective so that it is mixed with Charcoal, a residue consisting mainly of carbon. Since charcoal is a very good adsorbent, the presence of charcoal below the foundation of the storage tank may reduce the contamination.

2. EXPERIMENTAL STUDY

2.1 Removal of sulphate by single media filter

The removal of sulphate ions by soil was studied using soil column tests. The high concentration of sulphate ions in the effluent leads to the contamination of Periyar River. The drinking water standards for sulphate between 250 to 500 mg/L. The maximum concentration of sulphate ion to be discharged into surface water bodies or sea water should not be greater than 1000 mg/L. On the basis of this study the concentration of sulphate was fixed as 1000 mg/L.

The soil was filled in the three PVC pipes of constant diameter (11cm) and varying heights (40cm, 80cm and 120cm) in three layers .Each layer was tamped twenty five times as per Preparing sulphate solution containing 1000 mg/L of sulphate was allowed to pass through three soil columns. Collect the sample solution from the bowl placed below the column. The percentage removal of sulphate ions was determined by using spectrophotometer. The photograph of the experimental setup is to determine the removal of Sulphate ions as shown in Fig.1

Fig -1. Experimental set up for column test

2. 2 Removal of sulphate by mixed media filter

The removal of sulphate by mixed media was determined by the same procedure as that of single media. 1%, 3% and 5% of charcoal are mixed with soil and to determine removal efficiency. The three set of soil columns follows a linear geometry

Table -1: Percentage of removals of ions by soil with varying percentage of charcoal

Height of soil column (cm)	Percentage of removal of ions (%)			
	0% charcoal	1% charcoal	3% charcoal	5% charcoal

40	64.51	69.81	76.32	83.44
80	73.21	77.42	84.78	90.68
120	78.17	88.24	88.24	95.36

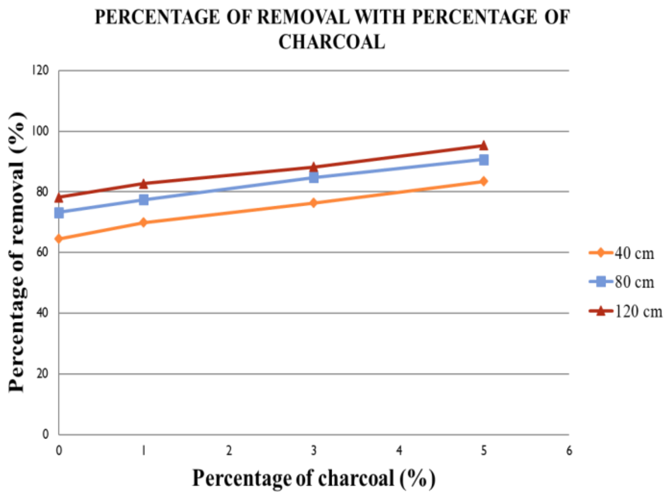

Chart -1: Percentage of removal with percentage of charcoal

The obtained mathematical expressions are:
For 40cm soil column, **R =3.161 X + 64.05**
For 80cm soil column, **R =3.488 X + 73.67**
For 120cm soil column, **R =3.334 X + 78.60**

From the above expressions, the percentages of charcoal required for hundred percentage removal of ions were obtained. The percentage of charcoal required for hundred percentage removals of ions for 40cm, 80cm and 120cm soil columns were obtained as 9.95%, 7.54% and 6.42% respectively, that is shown in table

Table -2: Percentage of removals of ions by soil with varying percentage of charcoal

Percentage of charcoal for 100% removal of sulphate(%)	Depth of soil column(cm)
9.95	40
7.54	80
6.418	120

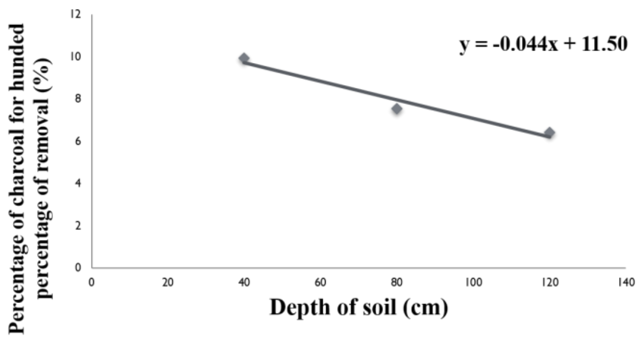

Chart -2: Variation of percentage of charcoal for hundred percentage removal with depth of soil

The expression for the line is obtained as:

R = - 0.044 D + 11.50

Where R is the percentage of charcoal required for hundred percentage removal of ions and D is the depth of soil in centimeters. The above graph can be used to determine the percentage of charcoal required to remove hundred percentage of sulphate ions at any depth of soil.

2. 3 Variation of plasticity index of soil

The addition of sulphate affects the geotechnical properties of the laterite soil. The effect of sulphate on Liquid limit ,Plastic limit and Plasticity index were studied and are given below. Liquid limit is the minimum water content at which soil changes from liquid to plastic limit. Plastic limit is the minimum water content at which soil changes from plastic to semisolid and Plasticity index is the difference between liquid limit and plastic limit.

Table -3: Plasticity index variation

Conditions	Liquid limit	Plastic limit	Plasticity index
Laterite soil	46	33.33	12.7
Laterite soil mixed with sulphate	50.21	22.52	27.73
Mixture of laterite soil and charcoal with sulphate	33.43	16.22	17.21

When soil mixed with sulphate plasticity index increases from12.7 % to 27.73%. It indicate that low bearing capacity.

High plasticity index of soil if present in the foundation of storage tank may causes sliding of the structure. When soil charcoal mixture mixed with sulphate, the observation sheet is shown in table 4.8. Plasticity index of the soil mixed with sulphate ions is 27.73 %. When soil charcoal mixed with sulphate Plasticity index decreases from 27.73% to 17.21%. It indicate that the bearing capacity of the filter media increased. Low plasticity index of soil indicates that it is safe from sliding failure. The structure constructed on such soil is safe from all failures like sinking, sliding etc.

3. CONCLUSIONS

The relationship between depth of soil and percentage of charcoal required for hundred percentage removal of sulphate ion is obtained as:

$$R = -0.044D + 11.5$$

Where R is the percentage of charcoal required for hundred percentage removal of ions and D is the depth of soil in centimetres. The above expression can be used to determine the percentage of charcoal required to remove hundred percentages of ions at any depth of soil. The increase in concentration of sulphate ions increases the liquid limit but the presence of charcoal reduces the liquid limit. As the increasing percentage of charcoal added into the soil the liquid limit get decreases. The addition of charcoal into the soil improves the removal capacity of soil. High plasticity index of soil if present in the foundation of effluent storage tank may causes sliding of the structure. Sulphate ions in the soil causes increasing plasticity index of the soil. Charcoal which decreases plasticity index of the soil, which is safe from sliding failures

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