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# Enhancement of Filtration Process for the Treatment of Wastewater using Geotextile Material

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## ABSTRACT

Sewage disposal is a major problem in developing countries as many people in these areas don't have access to sanitary conditions and clean water. Untreated sewage water in such areas can contaminate the environment and cause diseases such as diarrhea. Filtration method using sand and gravel has been tried here for the removal of impurities in waste water and getting good removal of pollution parameters like chlorides, hardness, BOD and COD. Geotextile material are permeable materials which is widely used in all areas of civil, geotechnical, coastal, environmental and hydraulic engineering. In this study geotextile material is incorporated into filtration columns to study the enhancement of filtration. The removal percentage of pollution parameters were increased indicating the role of geotextile material in the filtration process

**Keywords :** BOD, COD, Disposal, Filtration, Geotextile.

## I. INTRODUCTION

Recent urban and rural expansion tremendously increased the water consumption which resulted in many fold increases in wastewater production throughout the world. The wastewater is a mixture of sewage water, agricultural drainage, industrial waste effluents and discharge from hospitals. More than 1.2 billion people lack access to clean drinking water. Since availability of fresh water is very important for human consumption and industrial and agricultural development; it becomes imperative to conserve and manage water resources. The controlled disposal of sewage and rainwater is very essential to improve the quality of life. It is necessary to seek a cost-effective and innovative solution to the problem caused by sewage disposal. Central Pollution Control. Board (CPCB) is monitoring the water quality of aquatic resources across the country.

Filtration method using different filter media for filtration have been tested by different researchers [1 ,2, 3]. Filtration technology is a low-cost treatment technology based on physical process to treat wastewater contaminants like colour, odour, hardness, BOD, COD, suspended solid etc. for a wide range of application in domestic as well as industrial application. Research on alternate filtration media has expanded the options available for improving

excellent quality. Filtration process is very cheap and different packing media are used in filters to remove the impurities. A laboratory scale multimedia filter model consisting of three reactors packed with different combinations of packing media such as plastic scrubbers, brick bats and aerocon stones of varying sizes was operated for varying detention time [4]. The results obtained from this experimental study showed removal efficiency for BOD as 70%, COD as 62% and TSS as 87% for 24 hours of detention time.

In a study conducted by [5], different granular media were used, consisting of sand and adsorbent carbon with different particle sizes, in the ascending and descending filtration mode. The results showed that it is possible to remove about 85 to 90% of the colour and turbidity using adsorbent carbon in the ascending filtration mode. The results have shown significant improvements in effluent quality parameters (colour, turbidity and COD) due to sand or adsorbent carbon filtration of secondary-treated effluent. Filtration columns equipped with superficial fine sand layer and two set of nonwoven geotextile has successfully removed 70–93 % concentration of wastewater [6].

In a study using geotextile filters as biofilm attachment media in wastewater treatment, removal of total suspended solids and BOD5 was 90 % [7]. In another study by Mulligan, using non woven geotextiles for the treatment of surface water, turbidity removal of 93-98%, suspended solids removal of 98.9%, COD removal of 65-71% and heavy metal removal of 98.9 % was obtained.[8].

In this study, a filtration column with sand and gravel of different sizes has been tested to remove chlorides, hardness, COD and BOD from waste water. A geotextile layer was added to each layer of sand to find out the enhancement of removal of the selected parameters.

## II. METHODS AND MATERIAL

A. Waste water

Synthetic waste water having known values of electrical conductivity, pH, chlorides, hardness, BOD and COD was prepared for all the studies. Municipal waste water used for the experiments was collected from sewage treatment plant.

B. Geotextile

Geo-textile are permeable fabric which when used in association with soil have the ability to separate filter, reinforce protect or drain. Geo-textile material is used which is purchased from the market.

C. Filtration set up 1 (column 1)

A laboratory scale filtration column was set up for experimental studies. A transparent cylindrical column of height 60.8cm and diameter 10cm was used. The cylindrical column is filled with gravel and sand in layers each of 10cm height. The upper end of the column was open. A geo grid layer was fixed to hold the aggregates at the bottom of the column. The 6mm gravel is placed at the bottom most layer and 4.75mm gravel above it. Sand is placed above gravel layer having sizes 1.75mm, 0.8mm and 0.6mm. Each layer of gravel, sand and gravel-sand is separated by placing a mesh. Another mesh is placed at the top most layer above the 0.6mm sand as well.

D. Filtration set up 2 (column 2)

The same set up 1 is done with geotextile layer covering the mesh between each layers of sand and gravel. Each layer of gravel, sand and gravel-sand is separated by placing a mesh which is covered with geo-textile material. Another mesh and a geo-textile material is placed at the top most layer above the 0.6mm sand as well.

E. Experimental analysis

The filtration columns were tested with synthetic waste water and municipal waste water. The characteristics of municipal waste water were initially tested before passing through the filtration column. The parameters tested were Electrical Conductivity, pH, Hardness, dissolved oxygen, BOD and COD. The set up is shown in Figure 1.

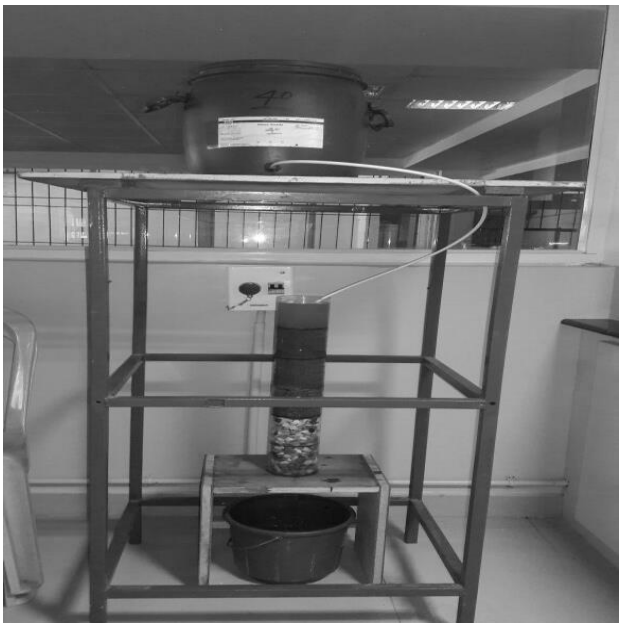

Figure. 1 Experimental set up of filtration column

## III. RESULTS AND DISCUSSION

Synthetic waste water 1 and 2 and municipal waste water was passed through the filtration set up 1 and 2 continuously and the values of the parameters are tested after certain time intervals. The following parameters were tested.

A. Electrical conductivity

Electrical conductivity is the measure of the material's ability to accommodate the transport of an electric charge. The sample of waste water was allowed to pass through the column set up 1 and 2 for 3 hours.

Table 1. Value of parameters tested after passing through filtration columns 1 and 2 for synthetic waste water 1

| Parameters | Passing through filtration | Time min | | | | |
|---|---|---|---|---|---|---|
| | | Initial | 30 | 60 | 120 | 180 |
| Electrical conductivity (mS) | Column 1 | 320 | 310 | 300 | 300 | 300 |
| | Column 2 | 320 | 290 | 270 | 250 | 230 |
| pH | Column 1 | 7 | 7 | 7 | 7 | 7 |
| | Column 2 | 7 | 7 | 7 | 7 | 7 |
| Chlorides (mg/l) | Column 1 | 410 | 400 | 392 | 385 | 380 |
| | Column 2 | 410 | 255 | 251 | 246.4 | 243.2 |
| Hardness (mg/l) | Column 1 | 320 | 310 | 298 | 290 | 282 |
| | Column 2 | 320 | 195.3 | 187.7 | 182.7 | 177.66 |
| COD (mg/l) | Column 1 | 22.4 | 19.2 | 15.68 | 10.8 | 8.7 |
| | Column 2 | 22.4 | 15.74 | 12.86 | 8.86 | 7.13 |
| BOD (mg/l) | Column 1 | 74 | 68 | 44 | 34 | 38 |
| | Column 2 | 74 | 54 | 44 | 33 | 20 |

Table 2. Value of parameters tested after passing through filtration columns 1 and 2 for synthetic waste water 2

| | Passing through filtration | Time min | | | | |
|---|---|---|---|---|---|---|
| | | Initial | 30 | 60 | 120 | 180 |
| Electrical conductivity | Column 1 | 330 | 320 | 310 | 300 | 300 |
| | Column 2 | 320 | 220 | 200 | 190 | 180 |
| pH | Column 1 | 7 | 7 | 7 | 7 | 7 |
| | Column 2 | 7 | 7 | 7 | 7 | 7 |
| Chlorides (mg/l) | Column 1 | 348 | 333 | 321 | 315 | 305 |
| | Column 2 | 348 | 213 | 201.6 | 205 | 195 |
| Hardness (mg/l) | Column 1 | 318 | 310 | 300 | 294 | 285 |
| | Column 2 | 318 | 195 | 189 | 185 | 178 |
| COD (mg/l) | Column 1 | 53.5 | 47.4 | 38.8 | 31.5 | 23.7 |
| | Column 2 | 53.5 | 38.9 | 31.8 | 25.8 | 19.4 |
| BOD (mg/l) | Column 1 | 80 | 76 | 70 | 64 | 58 |
| | Column 2 | 80 | 62 | 57 | 52 | 47 |

The effluent was collected and tested for electrical conductivity. It was continuously decreasing as shown in Table 1 to 3.

Table 3. Value of parameters tested after passing through filtration columns 1 and 2 for municipal waste water

| Parameters | Passing through filtration | Time min | | | | |
|---|---|---|---|---|---|---|
| | | Initial | 30 | 60 | 120 | 180 |
| Electrical conductivity (mS) | Column 1 | 230 | 220 | 210 | 200 | 200 |
| | Column 2 | 170 | 150 | 150 | 140 | 140 |
| pH | Column 1 | 7 | 7 | 7 | 7 | 7 |
| | Column 2 | 7 | 7 | 7 | 7 | 7 |
| Chlorides (mg/l) | Column 1 | 112 | 101 | 100 | 99 | 95 |
| | Column 2 | 112 | 64.4 | 64 | 63.4 | 61 |
| Hardness (mg/l) | Column 1 | 300 | 290 | 283 | 275 | 267 |
| | Column 2 | 300 | 182.7 | 178.3 | 173.3 | 168.4 |
| COD (mg/l) | Column 1 | 51.2 | 44.8 | 35.2 | 28.8 | 19.2 |
| | Column 2 | 51.2 | 42 | 36.74 | 23.62 | 15.74 |
| BOD (mg/l) | Column 1 | 68 | 45 | 35 | 33 | 32 |
| | Column 2 | 68 | 44 | 36 | 28 | 20 |

B. pH

pH is the negative logarithm of the hydrogen ion concentration present in water. It is an indicator of the acidity or the alkalinity of water. The pH of the

solution was more or less constant after passing through the filtration columns.

C. Chlorides

Chlorides are generally present in water in the form of sodium chloride (NaCl) and maybe due to leaching of marine sedimentary deposits, pollution from sea water, brine or industrial and domestic wastes, etc. Their concentration above 250mg/l produce a noticeable salty taste in drinking water and are thus objectionable. The amount of Chlorides decreased after passing through the filtration columns.

D. Total hardness

Total hardness is the hardness of the mineral content of water. It is due to carbonates and bicarbonates of calcium and magnesium. Total hardness decreased after passing through the filtration column.

E. Chemical Oxygen Demand (COD)

COD is the amount of oxygen consumed by the organic compounds and inorganic matter which were oxidized in water [9]. It is a measure of soluble and particulate organic matter in water. COD decreased with time after passing through both the filtration columns.

F. Biohemical Oxygen Demand (BOD)

BOD is the amount of dissolved oxygen needed by aerobic biological organism to break down organic material present in the given water sample at certain temperature over a specific time period. BOD also decreased after passing through both the filtration columns.

G. Dissolved oxygen

Dissolved oxygen is the amount of oxygen present in the water. It was almost constant after passing through the filtration columns.

H. Comparison Studies

The percentage removal of various parameters by using filtration column with and without geotextile is given in Figures 2 to 4.

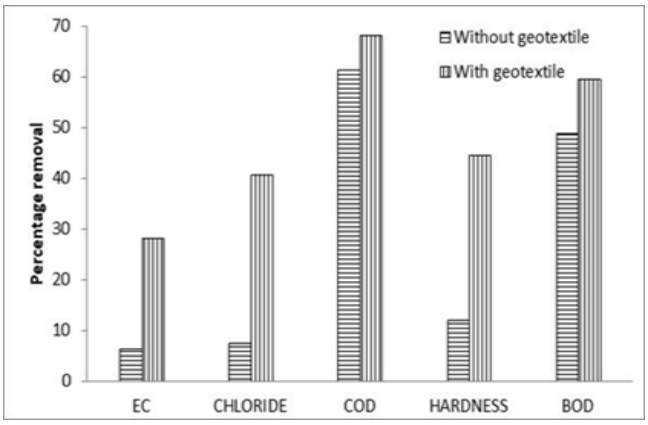


Figure 2. Comparison of percentage removal values of various parameters for synthetic waste water 1.

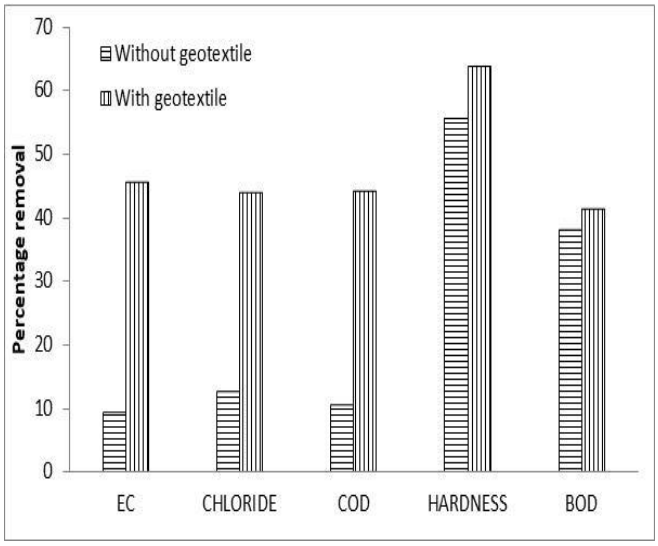


Figure 3. Comparison of percentage removal values of various parameters for synthetic waste water 2

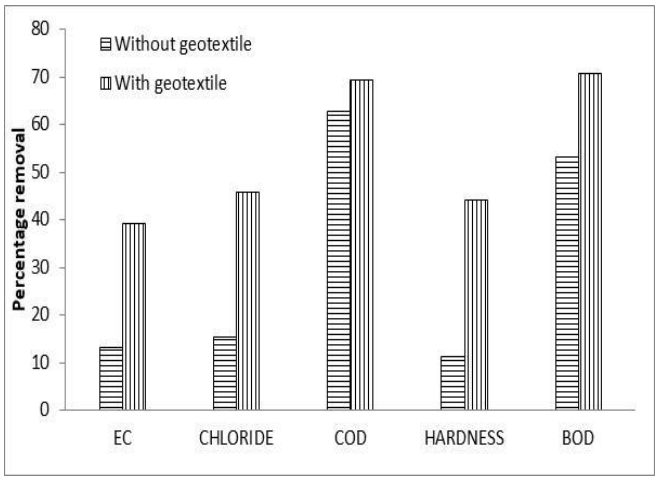


Figure 4. Comparison of percentage removal values of various parameters for municipal waste water

## IV. CONCLUSION

The following conclusions are drawn on the basis of the study of filtration tests conducted with and without the use of geotextile material.

- The filtration columns using sand and gravel was having fairly good removal of Chlorides, hardness, BOD and COD.
- With the incorporation of geotextile material in the filtration column, the removal of the selected parameters were found to be high indicating more efficient removal.
- As compared to other waste water treatment techniques, construction of a filtration column equipped with geotextile material is easy and economically feasible; further, it requires low maintenance and running cost.

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