Treatment of Domestic Wastewater Using Geotextile as a Filter Media

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Abstract: *The objective of this study was to investigate the filtration performance of non-woven geotextile. The laboratory portion of the study included column test with alternating layers of filter media consisting of sand, gravel and granular activated carbon. Non-woven geotextile was layered within the filter media. The maximum removal efficiency in terms of COD and TDS was found to be 96.87% and 95.17% in column layered with sand, GAC (500GSM) and geotextile respectively were geotextile was placed at the upper, middle and bottom layer. The porosity of the geotextile material played an important role in filtration process, as the pore size decreased the filtration efficiency increased.*

Keywords – wastewater, coagulation-flocculation, geotextile

Introduction

Wastewater emerges from both modern and local exercises and their Treatment, Management and Reuse are one of the key issues of the day that requests high specialized ability, vitality and framework to accomplish a superior treatment objective. Mechanically disposed of water is particular to the way of industry and henceforth sort of treatment embraced may be extraordinary yet household wastewater or sewerage is predictable in nature. Legitimate determination of geotextile channels assumes an essential part in accomplishing better filtration execution. Generally, a non-woven sort geotextile is favored in filtration application (Kutay et al. 2005). A geotextile is a manufactured fabric made of various polymer mixes. The geotextile has a permeable or a penetrable character and equipped for holding SS when wastewater is gone through it. Potential contaminants in residential wastewater incorporate illness bringing on microbes, irresistible infections, family chemicals and abundance supplements, for example, smelling salts, alongside the more customary suspended solids and biochemical oxygen request. Geotextile materials, when chosen fittingly, take into consideration the substitution of customary granular channel and waste layers, giving a huge natural and financial advantage. For fouling control in layer filtration, determination of reasonable coagulation conditions (e.g., coagulant sort, dosage and food water pH) is vital. The utilization of in-line coagulation would: (i be able to) diminish layer fouling which is a noteworthy cost worry in cutting edge wastewater treatment utilizing layers, (ii) all the while expel supplements to meet strict water quality limits for certain reuse purposes (e.g., eutrophication control of getting water body), and (iii) diminish the impression of the treatment plant contrasted with utilizing traditional flocculation sedimentation forms.

Material and methodology

A laboratory column setup was assembled to test the efficiency of geotextile in filtrating domestic wastewater. The wastewater was filtered using four (150GSM, 200GSM, 300GSM and 500GSM) non-woven geotextile along with Sand, granular activated carbon (GAC) and gravel in four different filter bed arrangement. The details of the materials used are discussed below

Fabrication of column

The column was fabricated using plexi glass with an internal diameter of 7cm and 49cm length. The column was provided with 3 outlet ports made out of brass in order to collect the effluent sample. 3mm perforated support was provided at 2cm, 16cm and 37cm respectively in order to achieve constant flow of wastewater. Fig 3.1 shows the fabrication details of the column setup.

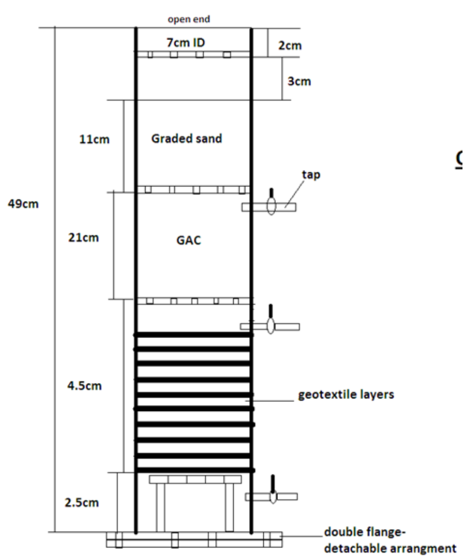


Fig 1.1: Schematic representation of column setup

Collection of Domestic Wastewater

The domestic wastewater used in this study was collected from Sri Jayachamarajendra College of engineering (SJCE) campus. The type of sampling adopted was grab sampling. Samples were stored in refrigerator. Raw influent i.e. wastewater which has passed only through the screens was collected and analyzed in the laboratory.

Geotextiles

Four non-woven geotextiles (150GSM, 200GSM, 300GSM and 500GSM) of varying properties were used in the study. Different combinations of these geotextiles were employed in the filtration analysis to evaluate the efficiency of geotextile filters.

Methodology

The domestic wastewater was initially treated with chemical coagulants such as Alum and ferric chloride (Fecl3). The best coagulant (Fecl3) among the two and the optimum dosage required for the treatment purpose was determined (1 mg/l for 1000ml) by conducting various trial and errors. This initially treated wastewater was allowed to settle for 24hours so that the sludge gets settled at the bottom and then the supernatant was passed through the filter bed. Four different arrangement of filter bed was setup for the analysis. The four different types of geotextiles were initially checked for the better filtration efficiency by passing the raw wastewater through it and the one with greater removal efficiency (500GSM) was selected to place in the filter bed. The treated effluent was checked for various parameters such as pH, COD, BOD and TDS. And by comparing the removal efficiency of these parameters the best filter bed arrangement was selected.

Experimental Setup of Filter Bed

The study was carried out in a column of 49cm length and an internal diameter of 7cm. 3mm perforated support was provided at 2cm, 16cm and 37cm respectively, so that the water trickles down with uniform distribution. The column is provided with three taps to collect the treated effluent from each filter bed layer. In this column layer of sand, granular activated carbon and geotextile (500GSM, 16nos) were placed. The top layer was filled with sand (11cm) followed by GAC (21cm) in the middle and geotextile (5cm) at the bottom. The wastewater was initially treated with ferric chloride (Fecl3), and allowed to settle for 24hours then the supernatant was taken and passed through the filter bed. The wastewater flowed through the column by gravity with uniform distribution over the filter bed layers. The treated effluent was collected from the tap provided at each layer at an interval of two days for about two weeks and was analyzed for various parameters. Similarly the column was filled with four different arrangements of filter bed and the results were analyzed. Fig 3.1 (a), (b), (c), (d) shows the various filter bed arrangements.

Fig 4.2: (a) Arrangement 1 sand, granular activated carbon and geotextile placed as filter bed layers. (b) Arrangement 2 sand, granular activated carbon and geotextile placed alternatively as filter bed layers. (c) Arrangement 3 gravel <10mm and geotextile placed alternatively as filter bed layers. (d) Arrangement 4Geotextile of 500GSM and 300GSM placed alternatively as filter bed layers.

Results and discussions

The performance of the column with various filter bed materials for the treatment of domestic wastewater was studied and reported. The results obtained are discussed below

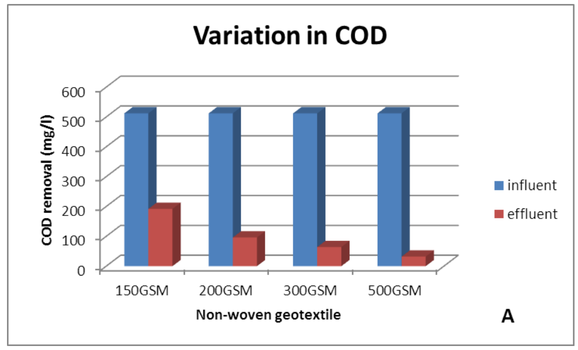
The domestic wastewater collected was characterized initially for various parameters.

Table 1: Initial characteristics of domestic wastewater

Parameters	Values
pH	7.08
COD	1408mg/l
BOD	176mg/l
Electrical conductivity	1629µΩ/cm
TDS	1000mg/l
Phosphate	12.478mg/l
Nitrate	11.42mg/l
Chloride	120.63mg/l
Alkalinity	660mg/l
Hardness	480mg/l
Turbidity	65NTU

Performance of four non-woven geotextile in filtering the raw wastewater

The four non-woven geotextile (150GSM, 200GSM, 300GSM, 500GSM) used in the study were examined to check the better removal efficiency in terms of COD and TDS. These non-woven geotextiles were arranged vertically (16 layers) and the raw domestic wastewater was passed through it. The filtered wastewater was then analyzed for parameters such as COD and TDS. The removal efficiency in terms of COD and TDS showed maximum removal for 500GSM non-woven geotextile. The average percentage removal in terms of COD and TDS for 500GSM material was found to be 93.7% and 88% respectively. Also it was noted that the performance of the material decreased with the increase in pore size. Out of the collected non-woven geotextile 500GSM had lowest pore size. The performance of each non-woven geotextile is shown in the fig4.3 (A) and (B).



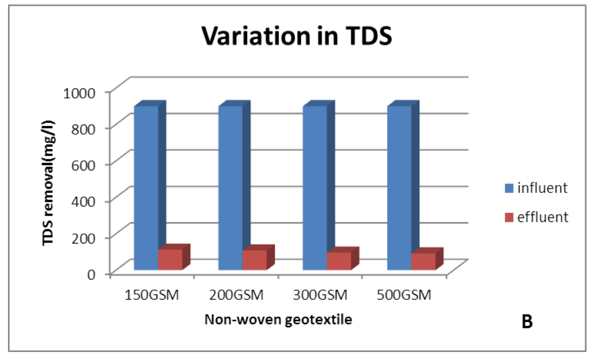


Fig 4.3(A) and (B): Graph showing the variation in COD and TDS after filtering through non-woven geotextile

Column studies were carried out in order to determine the better filter bed arrangement for pollutant attenuation. Each arrangement of filter bed was analyzed for a period of about two weeks at lab-scale. The wastewater was initially treated with ferric chloride (Fecl3), and allowed to settle for 24hours then the supernatant was taken and passed through the filter bed. The wastewater flowed through the column by gravity with uniform distribution over the filter bed layers. The treated effluent was collected from the tap provided at each layer at an interval of two days for about two weeks and was analyzed for various parameters. The results obtained from column 1 and 2 had higher removal efficiency in terms of COD and TDS compared to column 3 and 4.

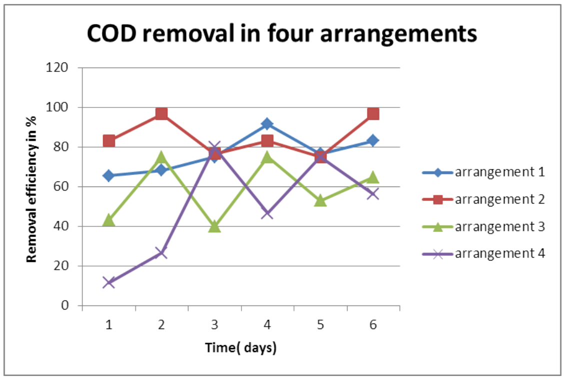


Fig 4.4: Graph showing the variation in COD four arrangements

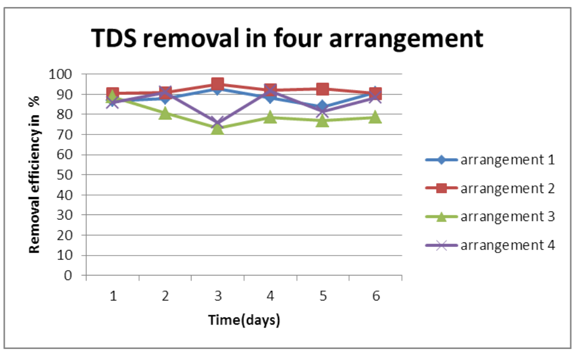


Fig 4.5: Graph showing the variation in TDS for four arrangements.

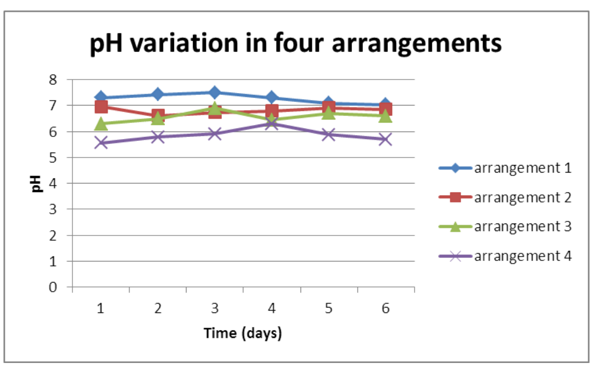


Fig 4.6: Graph depicting the variation in pH of filtered water in four arrangements

The results depicted that the removal efficiency of COD and TDS was maximum in column 2. The geotextile used in this column were placed on the upper, lower and middle surface of the column. The laboratory tests of this study do not address the potential for biological growth on the filter. While nonwoven polypropylene geotextiles are inert to biological degradation, biological growth can occur in and on the material, particularly when the geotextile is exposed to liquids with high organic content. Korkut et al. (2006) exposed nonwoven geotextile baffles to wastewater from a combined sewer system and demonstrated that geotextiles with attached biomass not only capture TSS, but also reduce the biochemical oxygen demand (BOD) and ammonia concentration of the influent. As specific weight of material increases system performance gets increased. This because of the reason that as pore size increases area exposed for filtration.

Conclusion

This project investigated the judicious use of nonwoven geotextiles as one or more layers placed in domestic wastewater treatment. Best system configuration would include both an upper and a lower geotextile membrane for optimal and higher efficiencies of treatment, while potential simultaneous reductions in volumes of granular material could also be achieved. Geotextiles showed capability to extend lifetime of intermittent sand filters by inhibiting the accumulation of material in the surface of it. Use of geotextiles has been found very effective solution in the treatment of wastewater. Geotextiles provide more strength, flexibility, durability and controlled degradation compared to sand filters. As geotextiles consist of synthetic fibers, bio degradation and subsequent short lifetime is not a problem. Geotextile filters improve the reliability and performance of traditional graded soil filters and are easier to construct. The low thickness of geotextile, as compared to their natural soil counterparts, is an advantage insofar as light weight on the subgrade, less airspace used. The ease of geotextiles installation is significant in comparison to thick soil layers (sands, gravels, or clays)

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