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Treatment of wastewater using woven and non woven coir geotextiles

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A B S T R A C T

Onsite wastewater disposal is the common method adopted for discharging the effluents from all the residential buildings and in most small-scale commercial operations. Installation of conventional treatment systems is often not preferred in these places due to the very low quantity of wastewater generated and higher installation and operational cost of these plants. To bring back the health of the soil as well as to ensure the prevention of further deterioration of our fresh water sources, cost-effective waste load reduction method are necessary. This paper focuses on the construction of experimental setup and treatment of wastewater using sand,woven and non woven coir geotextiles.The results showed that 94.47% BOD and 96.34% COD were removed after the treatment with woven coir geotextiles.

Keywords: Coir geotextiles,Wastewater,Treatment.

1. Introduction

Design and implementation of efficient wastewater treatment methods to meet the regional demands of pollution control have always been a major challenge facing the technologists. Several attempts in the past to limit uncontrolled discharges of polluted water have led to the development of wastewater-treatment solutions using innovative process concepts. Inspite of wide countries is still to follow the conventional practices, without paying attention to better techniques and solutions. Among these, the most common method usually adopted by most of the residential or small-scale commercial units in India is either to discharge the wastewater onsite or drain it into any public wastewater carriage systems[1]. It is also obvious that the setting up of conventional treatment systems for the above-mentioned situations may not be feasible due to the high cost of equipment and inadequate space for installation of these units. Also, setting up of a new, centralized wastewater treatment facility together with the laying of fresh sewer lines in emerging urban locations in India is certainly a cumbersome exercise. Under such circumstances, search for solutions that accommodate factors like cost-effectiveness in operation and low space requirement demands a more pragmatic approach in the planning and design of sewage treatment systems. Hence, the best possible solution for such scenarios would be to install compact units capable of reducing the waste load entering the sewers. This would finally result in the design of more efficient and smaller treatment plants capable of achieving better level of purity at low operational cost and environmental damage[1].

Biological filtration is a waste treatment process where organic pollutants present in any fluid stream could be brought in contact with the microorganisms attached to the surface of the filter media. These microorganisms utilize the absorbed organic molecules for their growth and thus initiate the process of biodegradation. This process could be either aerobic or anaerobic depending on the type of operational environment maintained in the treatment unit. Due to the higher specific surface area, fibrous materials are often considered a better choice for increased microbial support and treatment efficiency. In addition, high removal rates in BOD_3 (biological oxygen demand) levels and nutrients have also been observed in fibre-based reactors. Also, various studies have established the utility of polymer fibre geotextiles to support planning and design of sewage treatment systems. Hence, the best possible solution for such scenarios would be to install compact units capable of reducing the waste load entering the sewers. This would finally result in the design of more efficient and smaller treatment plants capable of achieving better level of purity at low operational cost and environmental damage. Also, various studies have established the utility of polymer fibre geotextiles to support biofilm development and also augment the biodegradation rate. Besides higher biodegradation rate, the ability of the treatment unit to withstand sudden shock is also a vital requirement for any wastewater treatment operations. Organic-rich soils like peat and compost, when used as biofilters for onsite disposal have exhibited better ability to take shocks like sudden increase in the organic loads during their routine treatment cycles. The main objectives are to construct a setup for the treatment of wastewater using coir geotextiles and to test the influent and effluent parameters before and after the treatment and check whether suitable for reuse applications[1].

2. Materials and Methods

- **Coir geotextiles**

Coir is a hard and tough organic fibre extracted from the husk of coconut. It is rich in cellulose and lignin, besides having high specific area and wetting ability factors which are essential for bacterial adhesion in fixed film processes[1].Geotextiles are planar sheets which may be woven, non-woven or knitted which are relatively thick. They are capable of transmitting fluids across or in-plane or both but can retain suspended

particles. Woven geotextiles are manufactured by interlacing fibres usually at right angles. While the non-woven type by mechanical, heat or chemical bonding of directional or randomly oriented fibres. The different types of coir geotextiles and their physical properties are given in the Table 1.

Table 1: *Physical properties of coir geotextiles* [2]

Designation	Mass per unit area (g/sq m)	Thickness (mm)	Aperture size (mm)
H2M1	758.18	6.42	9X12
H2M2	864.8	6.79	8X17
H2M4	1286.56	8.39	10X2
H2M5	727.14	7.03	8X10
H2M6	401.44	6.46	25X25

Based on the properties listed in the Table 1,H2M2 designated coir geotextile is used in the experimental setup. It is thoroughly washed with water to remove dust and other impurities.

- **Fecal coliforms**

A fecal coliform is a facultatively anaerobic ,rod shaped, gram negative, non- sporulating bacterium. Coliform bacteria generally originate in the intestines of warm blooded animals. Fecal coliforms are capable of growth in the presence of bile salts or similar surface agents,are oxidase negative, and produce acid and gas from lactose within 48 hours at 44±0.5ºC.

Bacterial pure cultures for fecal coliforms, streptococcus and staphylococcus were prepared in the laboratory and later transferred to the geotextile mat in equal quantities (20 g) to ensure uniformity in performance across all the reactor units[1]. This was necessary as the wastewater streams did not contain any microorganisms to initiate the process of biodegradation.

- **Sand**

Standard sand which conforms to IS 650:1982 which (100 percent) pass through 2mm IS sieve and shall be (100 percent) retained on 90-micron IS sieve with the following particle size distribution having uniformity coefficient of one is used for media in sand filter.It is thoroughly washed with deionized water to remove the dust, clay and attached organic impurities[2].

Construction of treatment setup

Three Glass apparatus of 8cmx10cmx50cm dimensions filled with sand, woven and non woven coir geotextiles. Synthetic wastewater was prepared using urea and starch . The treatment set up is shown in Figure1 below.

Figure 1:*Treatment setup*

The prepared synthetic wastewater is passed through the three glass apparatus filled with sand, woven and non woven coir geotextiles. The influent characteristics of synthetic wastewater is shown in Table 2.

Table 2: *Influent characteristics*

PARAMETER	UNIT	VALUE
pH	-	6.82
TDS	ppm	541
Conductivity	µs	6992
BOD	mg/l	1700
COD	mg/l	5200

3. Results and Discussion

The effluent characteristics like pH, TDS, BOD and COD were tested on 1st , 3rd,5th &7th day respectively. The BOD and COD values are shown in Table 3 and Table 4 respectively.

Table 3: *BOD values of the effluent after treatment*

Materials	1st day	3rd day	5th day	7th day
Sand	1025	790	236	95
Woven coir geotextile	655	480	294	94
Non woven coir geotextile	845	615	313	98

BOD is defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions at standard time and temperature.BOD test is the most important test to determine the polluting strength of wastewater. BOD for synthetic water is 1700mg/l. After treating with sand, woven coir geotextile and non woven coir geotextile the values of BOD after 7th day decreased to 95, 94and 98 respectively. The standard value of BOD for irrigation water is100 mg/l. This indicates that the water can be reused for irrigation purposes. The variation of BOD with days is shown in the below Figure 2.

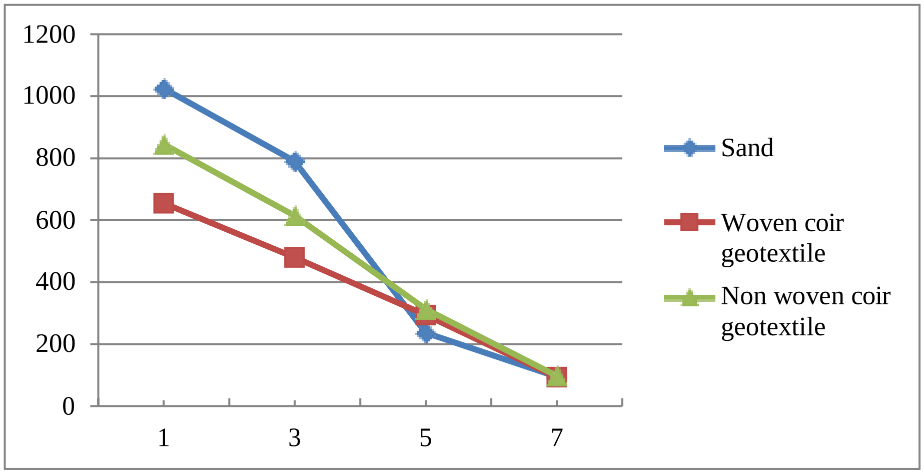

Figure2: *Variations of BOD with days*

In COD, the sample is refluxed in strong acid solution with known excess potassium dichromate organic matter. COD for synthetic water is 5200mg/l. After treating with sand, woven coir geotextile and non woven coir geotextile the value of COD decreases to 197,190 and 202 respectively. The COD of effluent should be less than 250 mg/l as per irrigation standards The value obtained were within the limits. The variation is shown in Figure 3.

Table 4: *COD values of the effluent after treatment*

Materials	1st day	3rd day	5th day	7th day
Sand	824	668	476	197
Woven coir geotextile	1152	996	611	190
Non woven coir geotextile	1176	1064	924	202

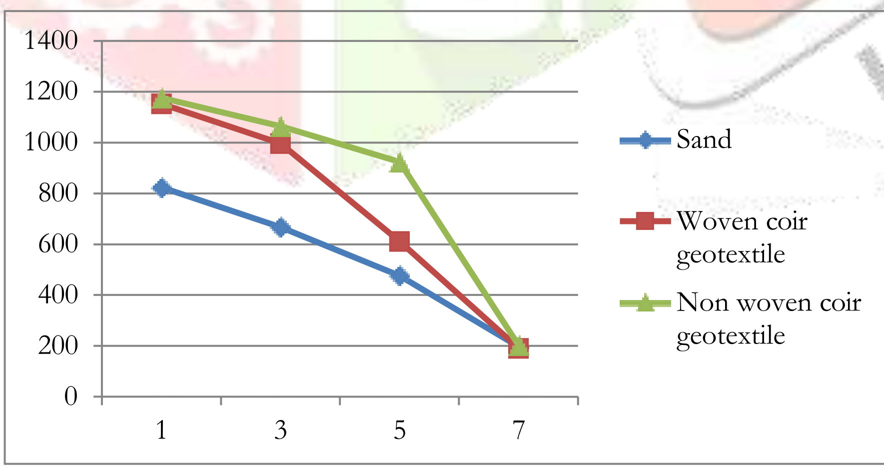

Figure 3: *Variations of COD with days*

The percentage removal efficiencies of wastewater characteristics are shown in Table 6.

Table 5: *Percentage removal efficiency of the wastewater characteristics after 7 days of treatment*

PARAMETER	PERCENTAGE REMOVAL EFFICIENCY(%)		
	Sand	Woven coir geotextile	Non woven coir geotextile
T D S	58.22	53.23	41.40
Conductivity	87.47	86.27	85.95
B O D	94.41	94.47	94.23
C O D	96.21	96.34	96.11

Removal efficiency shows the capacity of filter media for the treatment of wastewater. Removal efficiency 100% is almost ideal condition. The above graph shows the removal efficiencies of various characteristics of wastewater. For TDS, the highest removal efficiency is for sand (58.22%) and least removal efficiency is for non woven coir geotextile(41.40%). Here Woven coir geotextile shows comparatively good removal efficiency(53.23%). The conductivity test shows that the highest removal efficiency is for sand(87.47%) and the least removal efficiency for non woven coir geotextile(85.95%). From the test for BOD, the graph shows the highest removal efficiency is for woven coir geotextile(94.47%). The analysis of COD gives that ,the highest removal efficiency is for woven coir geotextile (96.34%). The variation is shown in Figure 4.

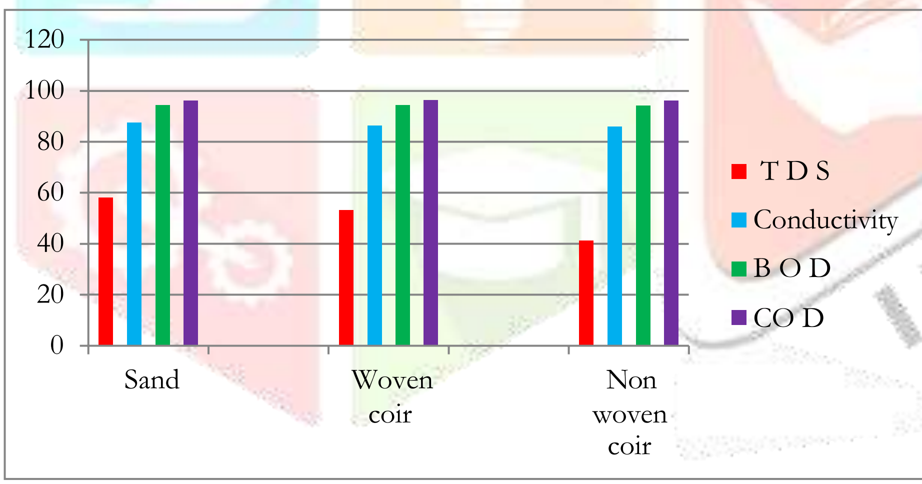

Figure 4. *Percentage removal efficiency of wastewater characteristics after 7 days*

4. Conclusions

Coir fibre is rich in cellulose and lignin, besides having high specific area and wetting ability factors which are essential for bacterial adhesion in fixed film processes. It can be used as effectively as commonly available synthetic bacterial support medium, for the removal of nutrients from wastewater. Coconut coir fiber filter beds can be used as an alternative option for any wastewater treatment instead of conventional beds. It is necessarily the cost effective technology of the wastewater treatment for better performance of the system.

For TDS, highest removal efficiency is for sand(58.22%) and least removal efficiency is for non woven coir geotextiles(41.40%). For Conductivity, highest removal efficiency is for sand(87.47%) and least removal efficiency is for non woven coir geotextiles(85.95%). From the test for BOD,the graph shows the highest removal efficiency is for woven coir geotextiles(94.47%). From the test for COD,the graph shows the highest removal efficiency is for woven coir geotextiles(96.34%).The treated wastewater can be used for irrigation purpose, since it satisfies the effluent standards for irrigation.Coir geotextile provides a better attachment media than sand for the growth of microorganisms. Compared to sand,filter clogging is minimum in coir geotextile filters.Coir geotextile directly attached along the sewer lines will make the wastewater treatment operations more energy-efficient.

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