STUDY OF BAMBOO CHARCOAL POLYESTER NONWOVEN FABRIC FOR EFFLUENT WATER FILTRATION

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Abstract: *Pollution is direct or indirect change of any component of the biosphere that is harmful to the living components and in particular undesirable for man. It adversely affects the industrial progress, cultural and natural environment. Water pollution refers to the contamination of water bodies such as rivers, oceans, lakes, and groundwater caused by human activities. This can be harmful to plants and organisms which live in these water bodies. Different type of needle punched nonwovens of 100% bamboo charcoal polyester fibre (BCP), 100% polyester fiber and BCP: Cotton blends with different GSM were selected. Domestic untreated sewage water, treated sewage water and tap water were filtered using the developed nonwovens at standard speed and time. The DO, BOD, COD, and TDS were evaluated using standard procedure. The experimental results reported that the BCP nonwovens showed greater reduction of COD, BOD and TDS when the thickness was higher. The dissolved oxygen level has increased after filtration indicating that filtered water provides suitable survival condition to the aquatic life. On the other hand BCP: Cotton blend and polyester fibre showed less reduction than 100 % BCP fabric. The presence of the bamboo charcoal nanoparticles in nonwovens influenced the waste water filtration. This may reduce the chemical usage of the effluent treatment.*

Keyword: *Nonwoven, filtration, Bamboo charcoal, Total Dissolved solids, Effluent*

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1. INTRODUCTION

Water filtration is the process of removing undesirable chemicals biological contaminants suspended solids and gases from contaminated water [5]. Many chemicals are discharged into water bodies and reach the surface and ground water systems through use in home and agricultural fields or from any textile process effluent. Soon after entering the soil, water or atmosphere chemicals change their compositions and these set off a chain of actions with organism in the environment stream can assimilate certain quantity of contaminants before reaching a polluted state [1]. Different types of textile fibres are used for filtration purpose. Synthetic fibres give better performance than natural fibres. Nonwovens have distinct advantage over woven for filtration applications due to unique characteristics like random orientation and three dimensional arrangement of fibres, bulkiness of the fabric, higher fluid flow rate etc besides they being cheaper [3]. Among many materials used, bamboo charcoal has many applications in both conventional and hi-tech industries. It can be used in medicines, cosmetics, food processing, health related products, deodorants and composites. Bamboo charcoal fiber has innumerable pores in its structure making it an excellent medium for adsorbing volatile chemicals (odours) controlling temperature, voiding moisture, inhibiting the growth of bacteria and fungi and preventing static electricity build up [4,6].

2. METHODOLOGY

Bamboo charcoal nanoparticles melt spun in polyester was made into fiber. This fiber will be referring as BCP and nonwoven was made from the fiber. Three different fibres 100% Bamboo charcoal polyester (BCP), 100% polyester and blends of BCP: Cotton (60:40) were selected to make needle punched nonwoven fabrics. The nonwoven fabrics were made in two different GSM of 150 and 200. The samples were labelled as under

S1- 100 % BCP (200 GSM)

S2 – 100% BCP (150 GSM)

S3- 60% BCP: 40 % cotton (200 GSM)

S4 – 60% BCP: 40 % cotton (150 GSM)

S5 – 100% polyester (200 GSM)

S6 – 100% polyester (150 GSM)

Treated and untreated sewage water effluent was collected from Sewage Plant, Andhra Pradesh Pollution Board, Shamshabad. The collected effluent was filtered using BCP nonwoven fabric at standard speed and time. The filtered water and unfiltered sewage effluent water was used to analyse the DO (Dissolved Oxygen), BOD (Biological oxygen Demand), COD (Chemical Oxygen Demand), TDS (Total Dissolved Solids). The analysis was carried out in Department of Environment Science and Technology, College of Agriculture, ANGRAU, Hyderabad. The basic parameter of effluent is given table no.1.

Table.1. Basic parameters of effluent sample

Parameters	Sample Types		
	Tap water	Treated sewage	Untreated sewage
pH	6.9	7.6	6.7
DO (mg/lit)	3.78	3.72	2.43
COD (mg/lit)	41.15	242.0	480.0
BOD (mg/lit)	20.0	22.0	120.0
TDS (ppm)	953	914	1030

2.1Dissolved Oxygen

Dissolved Oxygen is the most important indicator of the health of a water body and its capacity to support a balanced aquatic ecosystem of plants and animals [7].

Water sample was filtered using BCP nonwoven fabric. The filtered sample was used for analyzing the dissolved oxygen level in water. A 30 ml of filtered sample was taken and made up quantity of 300 ml by adding distilled water. The solution was transferred into BOD bottle. The bottle was shaken continuously to avoid air bubbles. Addition of 2 ml manganese sulphate was done to the bottle and shaken well. To the solution 2 ml of alkaline of potassium iodide was added which precipitates the solution. Adding 2 ml of conc. H_2SO_4 to the precipitate turns it to a clear liquid. A few drops of starch indicator was added before titration and titrated against sodium thiosulphate solution. When the blue colour solutions changed into colourless solution, the titre value was noted and Dissolved Oxygen level was calculated using the following formula.

$$DO = \frac{\text{Titrate value} - \text{Normality of } Na_2SO_4 \times 8 \times 1000}{\text{Volume of sampling bottle} - \text{Volume of } MnSO_4 \text{ and Potassium iodide}}$$

2.2. Chemical Oxygen Demand (COD)

Chemical Oxygen Demand is a test done to indirectly determine the amount of organic compounds present in a water sample. It is vital for the assessment of the quality of effluents and waste water [8].

To a 20 ml of filtered sample 10 ml of potassium dichromate was added. A pinch of silver sulphate and mercury sulphate was added into the solution. To the mix, 30 ml of Conc H_2SO_4 was added and kept in Fin Leibig condenser at 150ºC for 2 hrs. After cooling the condenser for 3 hrs, solution is transferred into 500 ml flask and made up to a volume of 500 ml by adding distilled water. To the solution 2-3 drops of ferroin indicator was added and shaken well. This solution was titrated against ferrous ammonium sulphate (FAS) until the blue green colour changed into reddish colour. The titre value was noted and COD was calculated using the following formula.

$$COD = \frac{(\text{Blank value} - \text{Titrate value}) \times N\ (0.25N) \times 1000 \times 8}{\text{Volume of sample (ml)}}$$

2.3. Biological Oxygen Demand (BOD)

BOD test procedure is based on the activities of bacteria and other aerobic microorganisms (microbes), which feed on organic matter in presence of oxygen. Higher the BOD, higher the amount of pollution in the test sample [7].

A 20 ml of filtered sample was taken and made up the volume of 1 litre by adding 980 ml of distilled water, transferred into a BOD bottle and kept it BOD cooling incubator for 5 days at 20ºC. After 5 days the solution was removed from the chamber. The BOD was measured by using the procedure indicated under DO.

BOD of the sample was calculated by using the formula.

$$BOD_5 = (DO - DO_5) - \text{Dilution factor}$$

DO - Dissolved oxygen DO_5 - Dissolved oxygen 5 day

2.4. Total Dissolved Solids (TDS)

The TDS meter (Himedia Ltd) was used to measure the TDS of the waste water. The meter was kept in the water and the readings were noted down directly.

3. RESULT AND DISCUSSION

3.1Dissolved Oxygen

The presence of oxygen in water is a positive sign, while the absence of oxygen is a signal of severe pollution.

Table.2 Dissolved oxygen level of the sample

S. No	Sample	Tap water (mg/lit)			Treated sewage (mg/lit)			Untreated Sewage (mg/lit)		
		UF	F	FE (%)	UF	F	FE (%)	UF	F	FE (%)
1	S1	3.78	4.66	18.8	3.72	4.93	24.5	2.43	6.45	62.3
2	S2	3.78	4.36	15.3	3.72	4.66	20.7	2.43	6.0	59.5
3	S3	3.78	4.10	7.8	3.72	4.62	19.4	2.43	5.54	56.1
4	S4	3.78	4.0	5.5	3.72	4.63	19.6	2.43	5.30	54.1
5	S5	3.78	3.8	0.5	3.72	3.80	2.1	2.43	2.50	2.80
6	S6	3.78	3.8	0.5	3.72	3.80	2.1	2.43	2.50	2.80

UF – Unfiltered F-Filtered FE-Filtration Efficiency

The above table indicated that the dissolved oxygen percentage increased in all three water samples after filtration. Highest DO percentage was found in untreated sewage after it was filtered with S1 while filtrate of S5 and S6 samples showed less increment in DO levels which might be because the nonwoven samples were purely polyester and do not contain any bamboo nanoparticles. It was also evident that DO levels of all water samples increase after filtration with S1 fabric.

Increase in Do levels of water samples filtered with S1 may be due to the nano charcoal present in the fabric which might have absorbed all the organic compounds during filtration. DO level was higher in samples filtered with fabric of 200 GSM than 150 GSM. Filtrate of S4 samples showed low DO increment levels owing to the low content of BCP fiber in the nonwoven. Filtering untreated sewage through the fabric has yielded more than 54% improvement in DO content with all fabric samples compared to treated sewage. A greater difference of DO was observed untreated sewage was filtered than the others water samples. In case of tap water, DO level of the control sample was higher than other two samples. After filtration the tap water showed less variation. The results indicated that the bamboo charcoal had the ability to absorb the chemicals present in the effluent. In all water samples, a decrease level of DO was observed when filtered with 60 per cent of BCP in the fabric. Difference was also observed between samples of different GSM. The main factor contributing to changes in dissolved oxygen levels is the build-up of organic wastes (Babu, 2007) .Thus it can be concluded that BCP fabric can reduced the organic wastes in water.

3.2. Chemical Oxygen Demand

The Chemical Oxygen Demand (COD) test measures the oxygen equivalent consumed by organic matter in a sample during strong chemical oxidation. The COD data of different samples is shown in table 3.

Table.3. COD level of sample

S. No	Sample	Tap water COD (mg/lit)			Treated sewage COD (mg/lit)			Untreated Sewage COD (mg/lit)		
		UF	F	FE (%)	UF	F	FE (%)	UF	F	FE (%)
1	S1	41.15	20.30	50.6	242.0	123.45	49.1	480.0	408.0	15.0
2	S2	41.15	22.57	45.1	242.0	154.32	36.2	480.0	411.52	14.2
3	S3	41.15	38.05	7.5	242.0	230.0	4.90	480.0	430.0	10.4
4	S4	41.15	40.44	2.7	242.0	236.62	2.20	480.0	442.0	7.9
5	S5	41.15	41.15	0	242.0	240.0	0.82	480.0	475.0	1.0
6	S6	41.15	41.15	0	242.0	240.0	0.82	480.0	475.0	1.0

UF – Unfiltered F-Filtered FE-Filtration Effiiciency

COD concentration of unfiltered water sample was higher than other two samples. The filtration efficiency of treated sewage was found to be higher than the untreated sewage which may be due to the high concentration effluents present in untreated sample.

Filtrate with sample S5 and S6 showed poor COD reduction. But COD levels of filtrate using 100% BCP sample was better than filtrate using blended samples. Higher GSM (200) of nonwovens had given good filtration efficiency than lower GSM (150). The COD concentration has reduced after filtration in all samples but highest reduction percentage was found in treated sewage water sample. Bamboo charcoal nanoparticles in the nonwoven could filter the organic compounds which reduced COD level of the sample. But it could not absorb the high concentrated chemicals which were present in untreated sewage. The COD level of treated sewage has decreased after filtering with the nonwovens. Water samples filtered with S1 had shown low concentrations of COD, which might be due to 100% BCP fabric. Samples S3 and S4 which were cotton blended BCP fabric showed low COD reduction while with S5 and S6 non woven sample there was zero reduction. This indicated that higher content of BCP in the fabric could remove higher concentrations of COD level from all water sources.

3.3. Biological Oxygen Demand

Biochemical Oxygen Demand, BOD, as it is commonly abbreviated, is one of the most important and useful parameters (measured characteristics) indicating the organic strength of a wastewater. The BOD data of different sample is given in table 4.

Table.4. BOD level of sample

S. No	Sample	Tap water BOD (mg/lit)			Treated sewage BOD (mg/lit)			Untreated Sewage BOD (mg/lit)		
		UF	F	FE (%)	UF	F	FE (%)	UF	F	FE (%)
1	S1	20	15	25	22	17	22.7	120	82	31.7
2	S2	20	17	15	22	18	18.1	120	85	29.1
3	S3	20	18	10	22	20	9.0	120	92	23.3
4	S4	20	19	5	22	21	4.5	120	95	20.8
5	S5	20	20	0	22	22	0	120	118	1.6
6	S6	20	20	0	22	22	0	120	118	1.6

UF – Unfiltered F-Filtered FE- Filteration Efficiency

The BOD concentration was very high in collected untreated sewage water sample than other samples. The BOD concentration has decreased after samples were filtrated with BCP fabric. Higher percent of reduction efficiency was found with S1 fabric samples. No change was found in BOD reduction in case of water filtered with sample S5 which was a 100 polyester fabric.

There was a significant difference between efficiency of filtrate material of 200 GSM and 150 GSM. S3 and S4 filtrate media showed low rate of reduction in the concentration of BOD levels for all water samples than S1, S2. Highest reduction of BOD was observed in untreated sewage sample with 100% BCP fabric of 200 GSM followed by 150 GSM. Thus it can be stated that BCP nonwoven fabric with higher GSM could reduce the BOD levels apparently

BOD levels were reduced by 30-45% with primary treatment of sewage water by sedimentation method (CPCB 1986 schedule VI). S1 fabric could filter the untreated sewage water sample to a level of primary treatment generally given to sewage water. Generally the treated water by sewage plant which contains BOD level of 100mg/lit can be used on land for irrigation purpose (CPCB). So water sample filtered with S1, S2, S3, S4 showed BOD level between 82-95 gm/lit which could be used for irrigation by simple filtration with fabric containing even 60% BCP. The reduction percentage of BOD with S1 fabric sample was almost equivalent to sedimentation technique followed by the municipal sewage plant.

As 200 GSM BCP fabrics could function in reducing BOD levels to nearly 31 percent by single filtration, additional layer of fabric and 2-3 filtrations might give BOD reduction of 30 mg/lit in sewage water which could be used-Inland surface water as per the Environment Protection Rules (1986).

3.4. Total Dissolved Solids

Table.5. TDS level of sample

S. No	Sample	Tap water (mg/lit)			Treated sewage (mg/lit)			Untreated Sewage (mg/lit)		
		UF	F	FE (%)	UF	F	FE (%)	UF	F	FE (%)
1	S1	953	953	0	914	892	2.40	1030	1000	2.9
2	S2	953	951	0.2	914	886	3.0	1030	1000	2.9
3	S3	953	952	0.1	914	906	0.8	1030	1010	1.94
4	S4	953	953	0	914	910	0.43	1030	1010	1.94
5	S5	953	953	0	914	913	0.10	1030	1025	0.4
6	S6	953	953	0	914	913	0.10	1030	1025	0.4

UF – Unfiltered F-Filtered FE- Filter Efficiency

TDS level of untreated sample was found to be higher than other control samples given in table.5. Tap water has not shown any significant change after filtration. Water filtered using 100% polyester sample of S5 and S6 showed no reduction in TDS level after filtration. Among all samples highest percentage of TDS reduction was found in treated sewage, filtered with S2 non woven sample. TDS level reduced in untreated sewage filtered with S1 and S2. There was no change found in the TDS level reduction with the GSM of the fabric samples. Blended sample S3, S4 showed poor TDS reduction. 100% BCP filter sample of 200 GSM had a slight impact in the TDS level of water sample.

4. CONCLUSION

Treated and untreated sewage water sample was filtered with nonwoven containing different percentage of BCP fiber. The developed BCP nonwoven fabrics have reduced COD concentration, BOD concentration, TDS level and increase the DO level in the filtered water. But in case of 100 % polyester and blends the filtration efficiency was lesser than 100% BCP fabric. The results indicated that 100% BCP fabric showed good filtration properties which could be suggested as sewage filtration material.

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