REDUCTION OF STRENGTH OF DOMESTIC WASTEWATER USING NATURAL FIBROUS MATERIAL

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Abstract - *Wastewater is primarily created by manmade and natural processes. Following treatment, sewage may either be dumped into a body of water, such as a lake, stream, river, estuary, or ocean, or onto land. (Gulhane et al., 2014).The present work is intended to study the application of the comparative study between the Areca husk fibre and Agava sisalana(sisal fibre) as a fixed bed for treating domestic wastewater for different parameters such as turbidity, chloride, TSS, TDS and BOD. Column study was conducted. Sample was collected at 15, 30, 45, 60, 75 and 90 minutes at different depth 10, 20, 30, 40 and 45cm in different flow rate 10, 20, 30 and 40ml/min. The maximum removal efficiency was observed at a flow rate of 10ml/min and at an optimum time of 60 minutes at a bed depth of 40cm. And in the comparative study, Sisal fiber was observed to have maximum efficiency with removal efficiency of turbidity, chloride, TSS, TDS and BOD as 79.31%, 75.86%, 63.33%, 76.67% and 75% respectively. This work shows enhanced domestic wastewater treatment ability which is economically feasible and readily available.*

Key Words: Wastewater treatment, Areca husk fiber, Sisal fiber, Removal efficiency

1.INTRODUCTION

The primary source is thought to be water. The water cycle on earth involves the constant processes of evaporation, transpiration, condensation, precipitation, and runoff, with the goal of eventually reaching the sea. Wastewater is the liquid waste that is disposed of after use in home settings, commercial settings, industries, and agriculture. In order to establish a hygienic environment, wastewater obtained from various sources needs to be handled very well. If adequate plans are not made for the collection, treatment, and disposal of all municipal waste, it will continue to build up and create an unfavourable situation where buildings and roads will be damaged due to wastewater buildup in the foundations, endangering the safety of the structures. In general, the main goal of wastewater treatment is to enable human and industry. (Gulhane et al., 2014).

The widening gap between readily accessible clean water sources and the rising demand brought on by population growth and economic development over the past few decades. A sustainable water management strategy necessitates that decision-makers view treated wastewater as a valuable resource rather than a waste product that needs to be expensively disposed of, which increases the focus on greywater utilisation. The water should be recycled or cleaned before being released to natural water sources like rivers or lakes or in open land as groundwater recharge due to the rising demand for groundwater in metropolitan areas and cities. Due to this, the home wastewater has undergone little treatment that is more or less successful and can be utilised for a variety of tasks, including

Biobased fibres or fibres with vegetable and animal origins are examples of natural fibres. This definition covers all naturally occurring cellulosic fibres (such as cotton, jute, sisal, coir, flax, hemp, abaca, and ramie) as well as fibres made of protein, including wool and silk. Asbestos and other naturally occurring mineral fibres that are not bio-based are not included in this list (Lotfi et al., 2019).One such type of treatment procedure used is the weakening of residential wastewater utilising two different bed materials as filter media: Agava sisalana and Areca husk fibre. Due to intrinsic benefits over suspended growth systems, the use of fixed films for wastewater treatment is being investigated more frequently. The goal of the current effort is to examine how the Areca fibre and Agava sisalana as a fixed bed for treating domestic wastewater to know the comparative removal efficiency of BOD, chloride, turbidity, TDS, TSS and analysis of pH and compared with WHO standards.

2.MATERIALS AND METHODOLOGY

Sisal and areca husk fibre were the two natural fibres used in this investigation. The mesocarp tissue or husk of the areca fruit is where the versatile natural fibre known as areca husk fibre is found. Areca appears to be the most promising natural fibre due to its low cost, wide availability, and high promise as a perennial crop. The botanical name for sisal fibre is agave sisalana. Although commonly cultivated in other nations, this kind of agave is endemic to southern Mexico. Rope and twine are made from sisal fibre, which is also used to make paper, textiles, footwear, headgear, bags, and carpets(Vijayalakshmi et al., 2019).

2.1 Sisal Fiber

Agave sisalana has a rosette of 1.5–2 m (4.9–6.6 ft) tall sword-shaped leaves. A few tiny teeth may be present around the margins of young leaves, but they disappear as they ripen. The sisal plant has a lifespan of 7 to 10 years and normally yields 200 to 250 leaves that can be used for commerce. On average, there are about 1000 fibres per leaf. Only around 4% of the weight of the plant is made up of fibres. Given that its production benefits from temperatures over 250°C and sunlight, sisal is regarded as a plant native to the tropics and subtropics, shown in Fig-1(Kavin et al., 2019).

Fig-1 Sisal Fiber

The manufacture is normally done on a large scale, and the leaves are brought to a central decortication plant where the waste parts of the leaf are washed away using water. Following that, the fibre is dried, brushed, and baled for export. The quality of the fibres depends heavily on moisture content, hence proper drying is crucial. Compared to sun drying, artificial drying has been shown to generate typically superior fibre grades, but it is not always practical in developing nations where sisal is grown(Kavin et al., 2019).

2.2 Areca husk fiber

It originates in the Malaya Peninsula, East India, and is a member of the palmecea family as the species Areca catechu L. East India and other Asian nations are where most industrial farming is done. The hard, fibrous part of the areca nut that protects the endosperm is called the husk. It makes up between 30 and 45 percent of the fruit's overall volume. Areca fibres contain 13 to 24.6% of lignin, 35 to 64.8% of hemicelluloses, 4.4% of ash content, and the remaining 8 to 25% of water content, as opposed to the cellulose depicted in Fig.3.3 above. (Kavin et al., 2019).

Fig-2 Areca husk fiber

The fibers adjoining the inner layer are irregularly lignified group of cells called hard fibers and the portions of the middle layer contain soft fibers(Kavin et al., 2019).

2.3 Experimental Set Up

A mesh is placed at bottom from height of 5cm.It was then filled with fiber for a known depth of 10, 20, 30, 40 and 45cm. It is fabricated for down flow mode and for column operation process. Collection of effluent was from bottom of the setup. Sample was collected through outlet pipe in 15, 30, 45, 60, 75 and 90 minutes to understand the variation in parameters for different time period. Also, since this is a column study, the flow rate was also varied as 10, 20, 30 and 40ml/min.

(a) (b)

Fig-3: (a) Column filled with fiber with gravel base (b) Experimental setup

3. RESULTS AND DISCUSSIONS

In the present study sisal fibre and areca husk fibre was used. Different depth 10,20,30,40 and 45cm at different flow rate 10, 20, 30 and 40ml/minutes was adopted. Higher removal efficiency was found at depth 40cm at 10ml/minutes flow rate for both fibres.

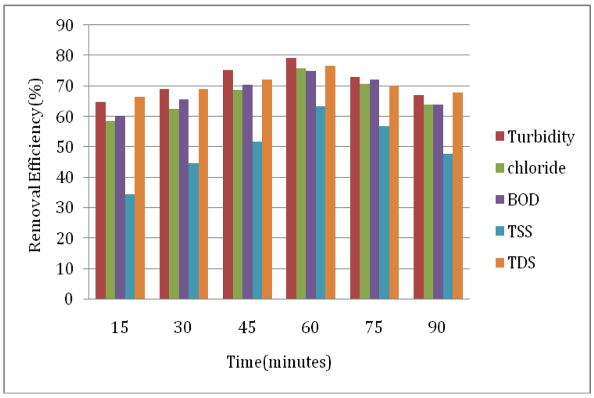

Fig-4: Removal efficiency of parameters using Sisal fibre with depth 40cm at 10ml/min flow rate

From this chart indicates removal efficiency of parameters using sisal fiber. At different flow rate maximum removal efficiency was observed at flow rate 10ml/minutes.

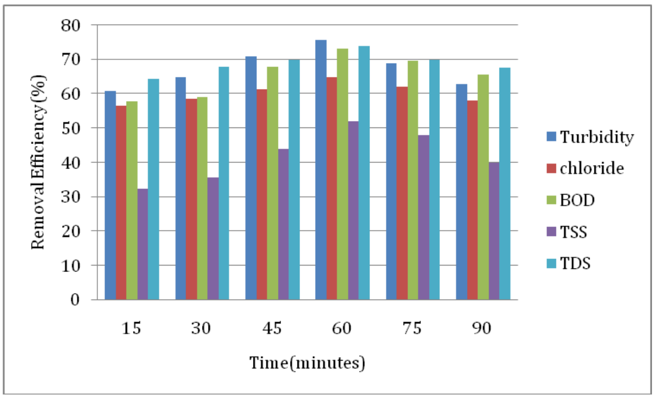

Fig-5: Removal efficiency of parameters using Areca husk fibre with depth 40cm at 10ml/min flow rate

Removal efficiency of turbidity was 75.69% in 60 minute at 10ml/min flow rate. Flow rate decreases removal efficiency increases.

3.1 OPTIMIZATION OF RESULTS

Thus in the overall experimental study the removal efficiency was maximum at a bed depth of 40cm and a flow rate of 10ml/min for both the fibers. The optimized results are shown in Table-1.

Table-1 Optimization of Results with sisal fiber and areca husk fiber

Parameters	Initial Result	40cm Depth at 10ml/min flow rate			
		Sisal fiber	Areca husk fiber	Removal Efficiency of sisal fiber(%)	Removal efficiency of Areca husk fiber(%)
pH	7.74	7.5	7.51	-	-
Chloride(mg/l)	290	70	102	75.86	64.82
Turbidity(NTU)	96.70	20	23.5	79.31	75.69
BOD(mg/l)	640	154	171	75	73.20
TDS(mg/l)	9000	2100	2356	76.67	73.82
TSS(mg/l)	180	66	88	63.33	51.11

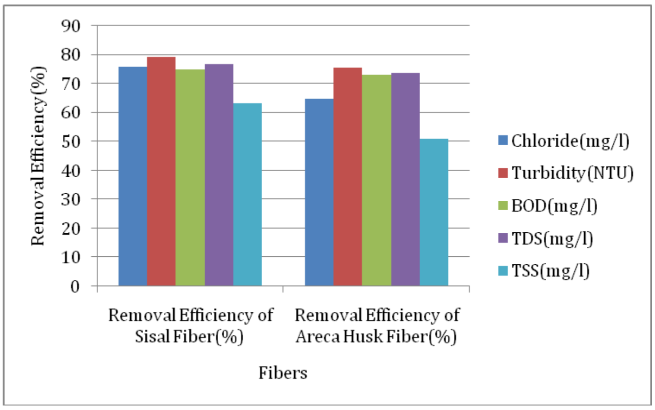

Fig-6: Removal efficiency of both fibers for optimized depth of 40cm at optimized flow rate of 10ml/min

Utility of fibrous materials such as Sisal fiber and Areca husk fiber as fixed media for treatment of wastewater with different depth and different flow rate has been successfully established in above results. From this we can understand that considerable reduction in parameters like turbidity, chloride, BOD, TSS and TDS. After the treatment of wastewater sample using Sisal fiber and Areca husk fiber, the pH was depicted to have no much variation throughout the treatment period in all depth. Removal efficiency was observed more for Sisal fiber compared to Areca husk fiber and steeply increased at 15 minutes then gradually increases up to 60 minutes, thereafter it started decreasing.

4. CONCLUSIONS

From this study, it was observed that reduction in turbidity, chloride, TSS, TDS and BOD was achieved from sisal fiber and areca husk fiber at different depth 10, 20, 30, 40 and 45cmat different flow rate 10, 20, 30 and 40ml/min. The removal efficiency of turbidity was 79.31% at depth 40cm and for areca husk fiber was 75.69%.

Removal efficiency of BOD was 75% in 60 minutes at depth 40cm and 73.2% for areca husk fiber. Removal efficiency of TDS was 76.67% in at depth 40cm and for areca husk fiber is 73.82%. Removal efficiency of TSS was 63.33% at depth 40cm and for areca husk fiber is 51.11%. Removal efficiency of chloride was 75.86% at depth 40cm and for areca husk fiber is 64.82%.

Maximum removal efficiency occurred for turbidity and chloride. For both Sisal fiber and areca husk fiber, the removal efficiency steeply increases upto15 minutes and then gradually increases up to 60 minutes, thereafter it starts decreasing. The maximum removal efficiency was observed at a flow rate of 10ml/min and at an optimum time of 60 minutes. It was also observed that as the flow rate increases, the removal efficiency also decreases indicating that the removal efficiency will be higher for lower flow rate. Also the removal efficiency decreased after 60 minutes which is believed due to the decomposition of fibers. Removal efficiency was observed more in sisal fiber compare to areca husk fiber and water quality parameters reached the standard value as per Central Pollution Control Board(CPCB). This work shows enhanced domestic wastewater treatment ability which is economically feasible and readily available. The treated wastewater can be used for gardening and domestic purposes like washing and cleaning. This method is eco-friendly and can be used as pre-treatment process for wastewater treatment.

REFERENCES

[1] Gowda, R. M. and Vinod, A. R, "Studies on natural fibrous materials as submerged aerated beds for wastewater treatment", *Elixir International Journal,* Volume 51, 2012, Page 10759-10762.

[2] Gulhane, M. L. and Yadav, P.G, "Performance of the modified multi – media filter for domestic wastewater treatment", *Proceedings of 3rd IRF International Journal*, ISBN: 978-93-84209, 2014, Page 15-50.

[3] Kavin, T. and Janagan, S.S, "Studies on natural fiberous as fixed beds for domestic wastewater treatment, *International Research Journal of Engineering and Technology",* eISSN: 2395-0056, Volume: 06, 2019, Issue: 04/ April.

[4] Lotfi, A., Huaizhong, Dao,V,D. and Prusty, G, "Natural fiber-reinforced composites, *Journal of Environmental Engineering",* Volume 11, 2019, Page 10-40.

[5] Vijayalakshmi., Eshanthini., Vanitha., Kumar, S. and Vigneshwaran, "Reduction of strength of domestic wastewater using natural fibrous materials", *Rasayan Journal of Chemistry,* Volume 24, 2019, Page 15-30.