Natural Fibrous Materials as Fixed Aerated Beds for Domestic Wastewater Treatment

Sneha G Sasidharan[1], Muhammad Fayis[2]

[1]*M.Tech student, Environmental Engineering in the Department of Civil Engineering, M-Dasan Institute of Technology Ulliyeri, Kerala, India*
[2] *Assistant Professor, Department of Civil Engineering, M-Dasan Institute of Technology Ulliyeri, Kerala, India*

---***---

Abstract – *Water is one of the most important elements involved in the creation and development of healthy life. Since water is such a vital resource for survival of both plants and animals, it is our responsibility to manage this resource. Current and future fresh water demand could be met by enhancing water use efficiency and demand management. Thus wastewater or low quality water is emerging as potential source for demand management after essential treatment. The use of various fixed beds having higher surface area is effective in removing organic matter and nutrients from municipal wastewater. In present study efforts have been made to check the efficiency of two different fibrous material- coconut coir fibre and areca husk fibre at two different packing densities and two different heights as submerged aerated fixed film beds for treating domestic wastewater. The use of agricultural by products in wastewater treatment can necessarily reduce the cost of treatment plant*.

Key Words: Domestic Wastewater, Coconut Coir, Areca Husk Fibre, Fixed Bed Reactor, Packing Density

1.INTRODUCTION

Water is one of the most important substance on earth. All plants and animals must have water to survive. Without water life is not possible on earth. It is most important that the water which people drink and use for other purpose is clean water. This means that the water must be free of germs and chemical and be clear. In order to develop a healthy and hygienic environment, water quality should be monitored such that it lies within the respective standards. Wastewater is liquid waste discharged by domestic residences, commercial properties, industry, agriculture, which often contains some contaminants that result from the mixing of wastewater from different sources. Wastewater obtained from various sources need to be treated very effectively in order to create a hygienic environment. If proper arrangements for collection, treatment and disposal of all the waste produce from city or town are not made, they will go on accumulating and create a foul condition. Therefore in the interest of the community of the town or city it is most essential to collect, treat and dispose of all the wastewater of the city in such a way that it may not cause harm to the people residing in the town. The extent and the type of treatment required, however depends on the character and quality of both sewage and sources of disposal available. Biological methods are invariably employed for the treatment of biodegradable wastewaters. Reduction of strength of domestic wastewater using two different bed materials Coconut fibre and Areca husk fibre as a filter media is the type of treatment adopted. The treatment process consists of high void space media that is submerged in wastewater and typically aerated from beneath. This method of treatment adopted using areca husk fibre and coconut fibre as a filter media follows the principle of trickling filter. Due to biological action, the organic compounds present in waste water get decomposed resulting in reduction of strength of waste water.

2. MATERIALS AND METHODOLOGY

Two natural fibres used in this study are coconut coir and areca husk fibre. Coconut fibre or coir is a hard and tough organic fibre extracted from husk of coconut , the fruit of coconut palm. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. It is inexpensive fibre that is abundant in tropical regions. Coir fibre contain more ligin than other natural fibre which make it as the strongest of all known fibres. Areca husk fibre is versatile natural fibre extracted from mesocarp tissue or husk of the areca fruit. The fibres adjoing the inner layer are irregularly liginified group of cells called hard fibres and middle porsion contain soft fibres. Among all the natural fiber-reinforcing materials, areca appears to be a promising material because it is inexpensive, availability is abundant and a very high potential perennial crop.

2.1 Sampling

Grab samples was collected in plastic cans rinsed with distilled water. Sample was collected from open drainage channels. Samples were analysed for following parameters ie BOD, COD, chloride, sulphate, nitrate, pH, turbidity.

2.2 Experimental Set Up

The reactors used in this study were made of glass which is rectangular in shape and fabricated for down flow mode and for batch operation process. Three reactor of size 150x150x200 mm^3 and thickness 4 mm were fabricated.

First two reactor were filled with coconut fibre and areca husk fibre. Third reactor is a mixed media reactor in which both coconut fibre and areca husk fibre are filled. Aerators were used to maintain the dissolved oxygen inside the reactor . A mesh of size 150x150 mm is placed at height of 50mm from bottom of reactor. Arrangements were made for collection of effluent at bottom of reactor through a tap.

2.3 Start Up of the Reactor

Cow dung is seeded into the reactor along with domestic wastewater. Cow dung to wastewater ratio is 1:1. The fibre in the reactor is allowed to undergo acclimatization for a period of 7 days.

Fig-1: Reactor Seeded with Cowdung

2.4 Experiment Procedure

First two reactor is filled with coconut coir and areca husk fiber for a known depth and packing density. The third one is mixed media reactor in which both the fibers are filled. Diffused aerators are used to maintain dissolved oxygen level inside the reactors. Initially to start up the reactor cow dung was mixed with waste water in ratio 1:1 for seeding. These reactors were then aerated with diffused aerators continuously for 7 days for acclimatization and development of biomass in both reactors. Initial characteristics of wastewater used for the study is determined. After complete growth of biomass on the surface of fixed beds wastewater is fed through inlet pipe. The sampling is done at an interval of 24 hours up to a contact time of 72 hours. Final characteristics of the effluent are determined.

3. RESULTS AND DISCUSSION

In this present study coconut coir and areca husk fibre are the two natural fibres used. Packing density adopted was 20 kg/m³ and 15kg/m³. Higher removal efficiency was found for the reactor filled with coconut coir with packing density 20 kg/m³ and 10 cm filter media depth in comparison with areca husk fibre reactor and mixed media reactor.

Table-1: removal efficiency of coconut coir reactor with packing density 20 kg/m³ and 10 cm filter media depth

COCONUT COIR REACTOR			
PARAMETERS	DAY1	DAY 2	DAY 3
BOD (%)	37.81	50.62	66.8
COD (%)	44.81	55.5	66.29
CHLORIDE (%)	38.82	56.11	68.11
SULPHATE (%)	48.14	63.73	69.99
NITRATE (%)	53.6	70.5	90
TURBIDITY (%)	95.3	96.3	97.14

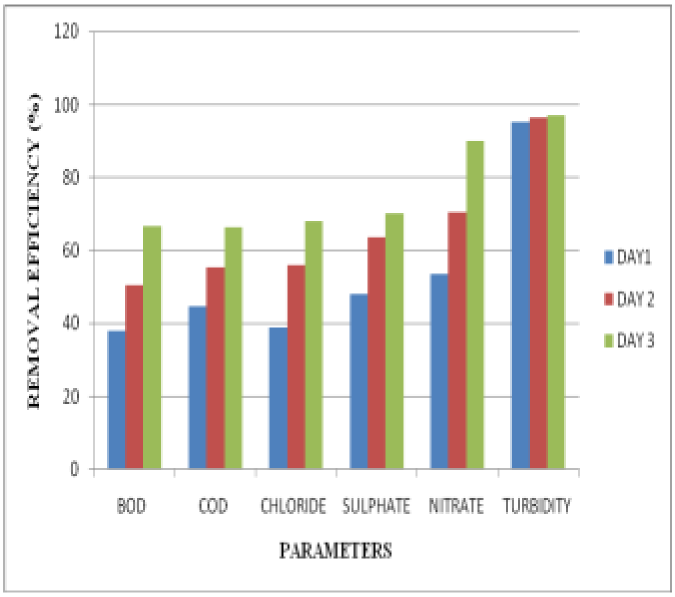

Chart -1: Removal Efficiency Of Coconut Coir Reactor with Packing Density 20 kg/m³ and 10cm Filter Bed Thickness

Table-2: Removal Efficiency Of Areca Husk Fibre Reactor with Packing Density 20 kg/m³ and 10 cm Filter Media Depth

ARECA HUSK FIBRE REACTOR			
PARAMETERS	DAY1	DAY 2	DAY 3
BOD (%)	24.06	33.12	51.56
COD (%)	38.7	48.51	60.92
CHLORIDE (%)	23.52	45.64	55.05

SULPHATE (%)	45.76	60.7	72.36
NITRATE (%)	55.7	71.9	86.1
TURBIDITY (%)	51.66	54.2	57.61

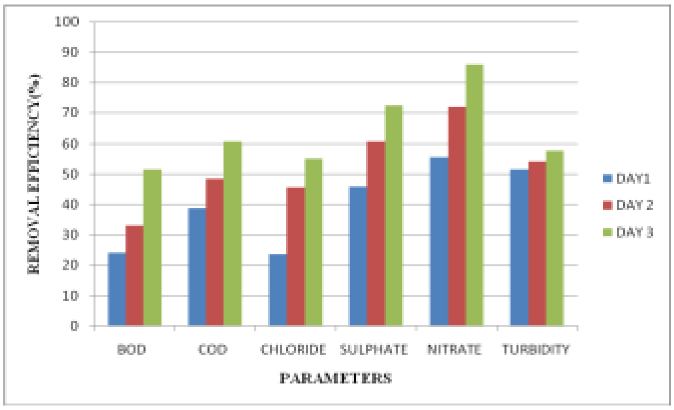

Chart-2: Removal efficiency of Areca husk fibre Reactor with Packing Density 20 kg/m^3 and 10cm Filter Bed Thickness

Table-3: Removal Efficiency Of Mixed Media Reactor with Packing Density 20 kg/m^3 and 10 cm Filter Media Depth

MIXED MEDIA REACTOR			
PARAMETERS	DAY1	DAY 2	DAY 3
BOD (%)	32.5	44.68	59.37
COD (%)	42.96	51.66	63.51
CHLORIDE (%)	27.76	50.23	62.35
SULPHATE (%)	43.43	62.17	70.63
NITRATE (%)	51.9	71	87.6
TURBIDITY (%)	87.3	90.59	93.09

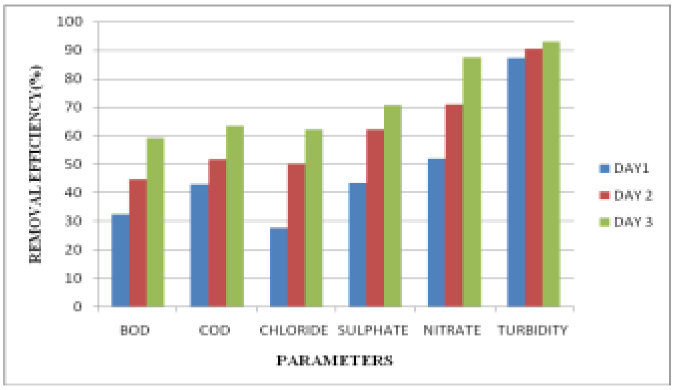

Chart-3: Removal efficiency of Mixed Media Reactor with Packing Density 20 kg/m^3 and 10cm Filter Bed Thickness

Table-4: Removal Efficiency Of Coconut Coir Reactor with Packing Density 15 kg/m3 and 10 cm Filter Media Depth

COCONUT REACTOR			
PARAMETERS	DAY1	DAY 2	DAY 3
BOD (%)	35.8	49.84	64.74
COD (%)	39.67	47.5	61.2
CHLORIDE (%)	42.66	49.33	61.13
SULPHATE (%)	42.57	55.61	62.3
NITRATE (%)	60.46	80.61	89.69
TURBIDITY (%)	93.66	95.24	95.58

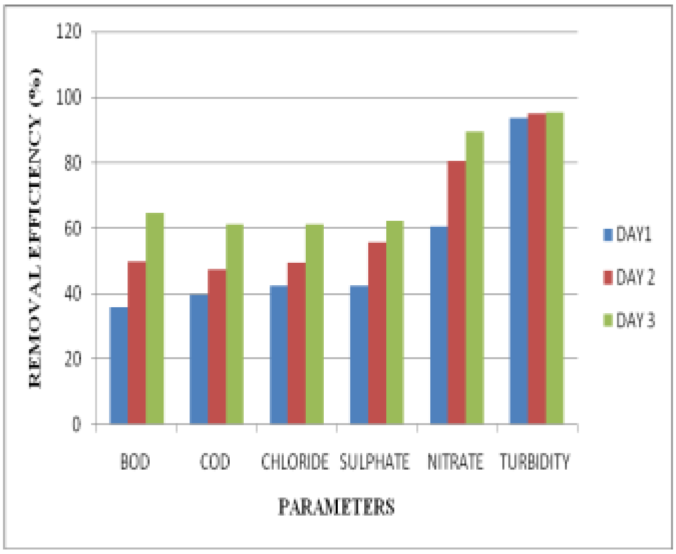

Chart-4: Removal efficiency of Coconut Coir Reactor with Packing Density 15 kg/m^3 and 10cm Filter Bed Thickness

Table-5: Removal Efficiency Of Areca Husk Fibre Reactor with Packing Density 15 kg/m^3 and 10 cm Filter Media Depth

ARECA HUSK FIBRE REACTOR			
PARAMETERS	DAY1	DAY 2	DAY 3
BOD (%)	23.4	31.61	47.41
COD (%)	36.65	40.92	56.4
CHLORIDE (%)	35.6	44	53.92
SULPHATE (%)	37.61	55.23	65.23
NITRATE (%)	61.53	77.69	85.38
TURBIDITY (%)	41.17	63.8	66.85

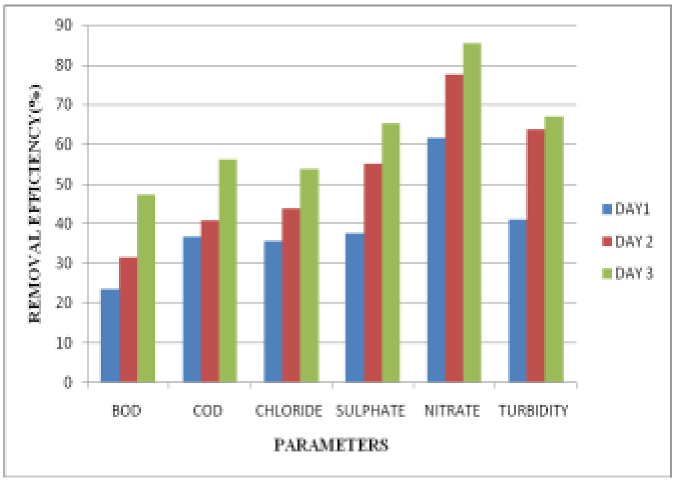

Chart-5: Removal efficiency of Areca Husk Fibre Reactor with Packing Density 15 kg/m³ and 10cm Filter Bed Thickness

Table-6: Removal Efficiency Of Mixed Media Reactor with Packing Density 15 kg/m³ and 10 cm Filter Media Depth

MIXED MEDIA REACTOR			
PARAMETERS	DAY1	DAY 2	DAY 3
BOD (%)	30.09	41.03	56.53
COD (%)	38.07	43.59	59.25
CHLORIDE (%)	41.14	51.33	59.73
SULPHATE (%)	40.42	57.09	64.28
NITRATE (%)	66.46	81.53	87.84
TURBIDITY (%)	85.06	91.96	94

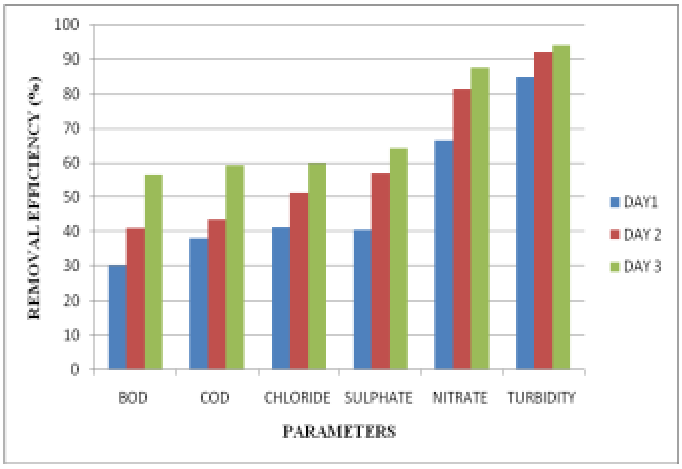

Chart-6: Removal efficiency of Mixed Media Reactor with Packing Density 15 kg/m³ and 10cm Filter Bed Thickness

4. CONCLUSIONS

Reactor with packing density 20kg/m³ results indicate slightly higher removal efficiency of organic matters and nutrients when compared to reactor with packing density 15 kg/m³. Filtration rate is faster in reactor with packing density 15 kg/m³ than the reactor with packing density 20 kg/m³. By comparing all the three reactors coconut fibre reactor shows greater removal efficiency. Considerable reduction in BOD COD and nutrients were achieved. Maximum percentage of removal of BOD, COD, chloride, sulphate, nitrate and turbidity are 66.8%,66.29% ,68.11%, 69.9%, 90%,97.14% respectively.

Instead of conventional media such as plastic, textiles etc use of natural fibrous materials as fixed bed in wastewater treatment equally shows promising removal efficiency of organics and nutrients. The spent fibre are rich in nutrients and can be used as organic manure.

REFERENCES

[1] A R Vinod, R M Mahalingegowda (2012), Treatment of Wastewater Using Different Fixed Beds Reactors- A Pilot Plant Study, International Quarterly Scientific Journal, Volume 11, No 1

[2] A R Vinod , R M Mahalingegowda (2014), A Study on Suitability of Selected Fibrous Packing Media for Sewage Treatment, Journal Of International Academic Research For Multidisciplinary, Volume 2, Issue 2

[3] A R Vinod , R M Mahalingegowda (2012), Studies on Natural Fibrous Materials as Submerged Aerated Beds for Wastewater Treatment, Elixir International Journal

[4] Bharati Sunil Shete, N P Shinkar (2014), Fixed Film Fixed Bed Reactor- Low Cost Approach, International Journal of Civil Structural Environmental and Infrastructure Engineering Research and Development (IJCSEIERD), Volume 4, Issues 4

[5] Bharati Sunil Shete, D R Narendra P Shinkar (2015), Coconut Coir: A Media to Treat the Wastewater, IJPRET, Volume 3

[6] G R Shivakumaraswamy, R M Mahalingegowda, A R Vinod (2013), Domestic Wastewater Treatment In Reactor Filled With Areca Husk Fiber And Pebble Bed, Elixir International Journal.

[7] Gulhane M L, Yadav P G (2014), Performance of the Modified Multi Media Filter for Domestic

Wastewater Treatment, IRF International Conference

[8] Husham T Ibrahim, He Qsang, Wisams Al Rekabi, Yang Qiqi (2012), Improvement in Biofilm Process for Wastewater Treatment, Pakistan Journal Of Nutrition 11(8)

[9] Manoj Prabhakar , Sudipto Sarkar , Laxmi Narayan Sethi, Avinash Kunmar (2015), Ammonia Removal from Aquaculture Wastewater Using Coconut Coir Media in Lab Scale Batch Reactors , Journal Of Energy Research And Environmental Technology (JERET), Volume 2 No 1