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Development of Low Cost Filter Using Natural Adsorbents

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Abstract: Adequate supply of fresh and clean drinking water is a basic need for all human beings and species. Due to scarcity of water and contamination , millions of people world wise are deprived. There are mainly four types of methods to treat the domestic grey water such as mechanical methods, physical methods, chemical methods and biological methods. Filtration is a biological method and it is the simplest and cheapest techniques for remove, BOD, COD,TDS, and turbidity from domestic grey water when the filtering medias were used as natural adsorbents. It has several advantages, like longer filtration runs, shorter ripening time and better filtrate quality. In my project, a "low cost water purification filter" was developed using the basic ideas of rectangular filter made by glass and some locally available natural adsorbents like sugarcane bagasse, wheat husk, and grass mulch has been used as filter medias. Activated carbon, sand, coarse aggregates were used as base materials .four types of filtration processes are introduced in my project. That is filtration with sugarcane bagasse, filtration with wheat husk, multiple filter, and filter with grass mulch etc. The performance of each filter was analyzed. The main objective of this study is to develop a low cost filtering system which can be implemented effectively in independent houses. This water filtration system made by glass materials and used adsorbents as natural materials, which will focus on cut down the cost of the filtration process.

Keywords: Bio chemical oxygen demand (BOD), Chemical oxygen demand (COD), Total dissolved solids

1. Introduction

Water pollution is one of the serious problem, the world is facing now. In India, the major cause of water pollution is due to increasing population, industrialization and urbanization etc. Collection, treatment and disposal of domestic grey water is the serious issues to be handled for preventing damage to the environment. Waste water generated is treated by waste water treatment plant; include the processes like primary sedimentation, aeration, secondary treatment and chlorination. This form of treatment plants requires high initial investment. Moreover their maintenance cost is high and treatment plant requires large land area. For the functioning and proper maintenance of the plant, skilled labors are required. Overall, the treatment plants are costly. Selection of a wastewater treatment method depends on pollutant origin. The main objective of this study is to develop the low cost filter using natural adsorbents. During 17th century, Sir Francis Bacon made an attempt to desalination sea water by passing the flow through a sand filter. However the experiment was not succeed, but made the beginning of a new interest in this field. The need of purified water is absolutely essential for healthy life and it has great impacts on people's everyday life. Cost efficient water filtration techniques are being developed commonly used to improve taste or to eliminate any undesired matters. In the past, various types of filters have been designed to be more suitable for the rural areas of the countries, but the cost as well as the filter effectiveness is still not satisfactory and further improvement is still required. Pure water is being the biggest issue in India. Most of the people in the rural areas are not able enough to use water filters or buy mineral water bottles. Every household should be able to develop its own water purification system to re use the water. The main advantage of filtration process is that, they maintain high concentration of microorganism resulting in high removal rate. Filtration technology is a low-cost treatment technology based on physical process to treat the wastewater contaminants like BOD, COD, TDS, turbidity, pH etc.

1.2 Filtration

Filtration is an important process and plays a vital role in the treatment of domestic grey water. Filtration essentially consists of passing the water through a filter media to remove the impurities. The main objective of filtration is to remove the suspended and colloidal particles, bacterial pollution, color odor, taste and to change the undesirable chemical characteristics of water.

2. Methodology

2.1Materials

The selection of a suitable material is an important part in the design and operation of filtration process, in order to meet the required effluent quality. In this project, natural adsorbents are used as a filtering medias.

The materials used for the filtration process are wheat husk, sugarcane bagasse, grass mulch, activated carbon, sand and coarse aggregate.

2.1.1 Sugar cane Baggase

Sugar cane bagasse is fibrous material that left after juice extraction. Bagasse contains mainly cellulose, hemi cellulose, lignin, wax, and ash. Sugarcane bagasse was collected from a local juice extractor. For the preparation of the media, sugar cane bagasse was thoroughly washed with distilled water and soaked in 0.1 M HCl solution for 18 hours and then washed with distilled water, to ensure complete removal of all the dirt particles, lignin and coloring materials present. Sugar cane bagasse should be cut into pieces ranging from 1 cm thickness and 4-5 cm length by using vegetable cutter. After that the Bagasse was dried in an oven at 120-130°C.

Figure 1: Sugarcane Baggase

2.1.2 Wheat Husk

The wheat husk was collected from Athani flour mill. It washed with distilled water to ensure the complete removal of the dirt particles. After that, the wheat husk was dried in sunlight and grinded with home mixer. Wheat husk powder passing through IS 2.36 sieve is used for the filtration process.

Figure 2: Wheat husk

2.1.3 Sand

Sand is a loose granular substance typically pale yellowish brown, resulting from the erosion of siliceous and other rocks and forming a major constituent of beaches, river bed, etc. The sand is collected from the market, located at Ollur. Sand passes through IS 2.36 mm is used in this project. The filter medium should be of uniform grain size to make sure that the pores between grains are the same size, so that the filters efficiency should be equal over the bed.

Figure 3: Sand

2.1.4 Coarse aggregates

Gravel support is provided to support the sand bed and to permit uniform drainage of the overlaying sand. This layer allows water to drain freely from the sand bed while preventing sand from escaping to the outlet tank. To accomplish the both purpose ,gravel must be graded. The aggregate which passes through 10 mm IS Sieve and retain on 20 mm IS sieve is used.

Figure: 4 Coarse aggregates

2.1.5Grass mulch

The grass mulch was collected from the residencies located at Perinchery. The grass mulch washed thoroughly with distilled water and dried it in the presence of sunlight, prior used as screening material. In this project dharbha grass mulch is used as screening material.

Figure: 5 Grass mulch

2.1.6 Activated carbon

Activated carbon can be considered as a material of phenomenal surface area made up of millions of pores - rather like "molecular sponge. The activated carbon was collected from house itself. Activated charcoal or activated carbon is a typical form of carbon which is prepared by burning of coal or organic matter like animal bones or coconut shells in controlled conditions. The size of activated carbon used in this project is 2mm to 2 cm.

Figure: 6 Activated carbon

2.2 Methods

2.2.1 Filtration with Wheat Husk for Treating Domestic Grey Water

The domestic grey water was collected in a clean bottle from household of 3 occupants. The performance of the filtration unit is analyzed for 3 days. Filter unit is made up of glass material with a dimension 30x30x45 cm is used for filtration process. Inside of this filter, Layers of materials were filled. The bottom most layers filled with coarse aggregate which passes through 10 mm IS Sieve and retain on 20 mm IS sieve at a depth of 150 mm. The layer above the coarse aggregate, sand is filled. In this project sand passing through 2.36mm IS sieve is used. The depth of sand bed is 60 mm. Layer of wire mesh was placed in between the sand and coarse bed. Layer above the sand bed activated carbon of size ranging from 2mm to 2cm is placed about 30 mm depth. A layer of net wire mesh was placed in between the sand and activated carbon media. At

the top most layer wheat husk powder passing through IS 2.36 mm sieve is filled with a depth about 150 mm. A layer of net wire mesh was placed in between the activated carbon and wheat husk bed. A plastic bucket of 22 L capacity is provided as a feed tank through which the water is sprinkled with the help of a plastic sprinkler. An out let pipe was provided at bottom of the filter.

Figure: 7 Filtration With Wheat Husk

2.2.2 Filtration With Sugarcane Bagasse For Treating Domestic Grey Water

The material used for the filtration process should be washed thoroughly and dried. Layers of materials were filled inside. In the top most layers, sugar cane bagasse should be placed at a depth about 150 mm. Each pieces of sugarcane bagasse ranging from 1 cm thickness and 4-5 cm length. Below the bagasse layer, activated carbon of size ranging from 2mm to 2cm is placed a depth of 60 mm. Below this layer, a net wire mesh is placed. After that, sand passing through 2.36 mm IS sieve at a height of 60mm is filled. A layer of wire mesh was placed. In the bottom most layer, the aggregate which is passes through 10 mm IS Sieve and retain on 20 mm IS sieve was filled ,at a depth about 150 mm . The domestic grey water was collected in clean bottles from household of 3 occupants. The performance of the filtration unit is analyzed for 3 days to study the percentage removal of BOD_3, COD, TDS, Turbidity and, pH. The performance was analyzed in every 1hr, 2hr and 3 hr retention time.

Figure: 8 Filtration with Sugar Cane Bagasse

2.2. 3 Filtration With Grass Mulch For Treating Domestic Grey Water

Grass mulch is used as a screening material. In the top most layer, grass mulch is filled with a depth of 150 mm. The following base materials (activated carbon, sand, coarse aggregates) are packed with the same depth as filter packed with sugarcane baggase.

Figure: 9 Filtration with Grass Mulch For Treating Domestic Grey Water

2.2.4 Multiple Filtration Unit

The material used for the filtration process should be washed thoroughly and dried. In the top most layer grass mulch of dharba should be placed at a depth of 60 mm. the layer below this, sugar cane bagasse should be placed , the pieces ranging from 1 cm thickness and 4-5 cm length at a depth of 60 mm. Below this layer wheat husk powder passing through IS 2.36 mm sieve is filled with a depth of 60 mm. After that, activated carbon, size ranging from 2mm to 2cm is placed about 60 mm depth. Sand passing through 2.36 mm IS sieve at a height of 50mm is filled. A layer of wire mesh was placed in between each medias. In the bottom most layer, the aggregate which is passes through 10 mm IS Sieve and retain on 20 mm IS sieve was filled ,at a depth about 150 mm.

Figure: 10 Multiple Filtration Unit

3. Results and Discussions

3.1 Influent Characteristics of Grey Water

Table: 1 Characteristics of Grey Water Before Treatment

Grey water characteristics	Influent value
COD	830 (mg/L)
BOD_3	370 (mg/L)
Turbidity	300 (NTU)
TDS	645 (mg/L)
pH	7.95

3.2 Performance of Filtration with Wheat Husk in COD Removal

COD indicates the amount of oxygen required to oxidize the carbonaceous matter. The filter was operated with a different hydraulic retention time of 1 hr, 2 hour and 3 hour to find out the removal efficiency. The performance was analyzed for 3 days.1t was noted that the number of days of filtration increased the percentage of COD removal is also increased. The maximum removal efficiency obtained was 77.79%.

Table: 2 Performance Of Filtration With Wheat Husk In The Reduction Of COD

Days (No)	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage (%)
Day 1	830	1	625.62	24.62
		2	601.43	27.53
		3	574.83	30.74
Day 2	574.83	1	310.45	45.98
		2	270.20	52.99
		3	212.28	62.97
Day 3	212.28	1	60.80	71.13
		2	50.40	76.24
		3	47.11	77.79

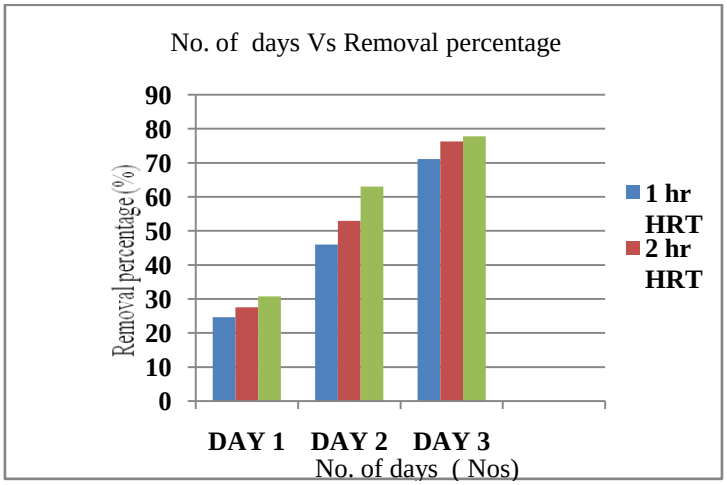

Figure: 11 Performance of Filtration with Wheat Husk in the Reduction of COD

3.3 Performance of Filtration with Wheat Husk in BOD_3 Removal

Bio chemical oxygen demand is the amount of dissolved oxygen essential to break down the organic contaminants by aerobic bacteria. The filter was operated with a different hydraulic retention time of 1 hr, 2 hour and 3 hour to find out the removal efficiency. The performance was analyzed for 3 days. At the end of 1 hour, 2 hour, and 3 hour , the characteristics of the effluent were determined in each day.1t was noted that the number of days increases the percentage removal of BOD_3 is also increase. The maximum removal efficiency was reached up to 78.18%.

Table: 3 Performance Of Filtration With Wheat Husk In The Reduction Of BOD_3

Days (No)	Influent value(mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage (%)
Day 1	370	1	280.26	24.62
		2	273.34	26.12
		3	260.21	29.67
Day 2	260.21	1	170.34	34.53
		2	163.56	37.14
		3	140.56	45.98
Day 3	140.56	1	40.67	71.06
		2	35.56	74.70
		3	30.67	78.18

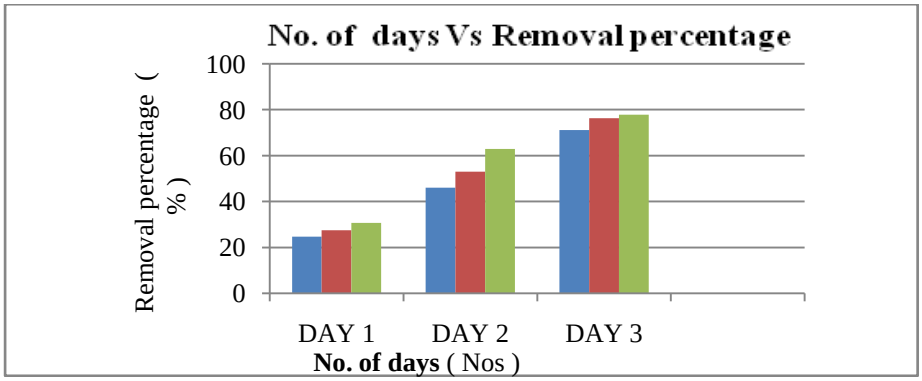

Figure: 12 Performance of Filtration with Wheat Husk in BOD_3 Removal

3.4 Performance of Filtration with Wheat Husk in TDS Removal

Total dissolved solids refer to organic and inorganic contaminant in the waste water.TDS is not considered as primary pollutant. The maximum percentage of removal is shown by 34.62%.In the first day of filtration, the percentage removal of TDS is only about 6. 97% at I hr HRT. But the efficiency of the filter is increased and it came up to 11.55% at the end of the day. The reduction in the value of TDS is very slow and did not showed considerable variation. In the second day the removal efficiency got increased up to 16.72%.And the third day was 34.62%.The effluent standards for irrigation provided by Kerala pollution control board is 2100 mg/L. The value of TDS for the treated water comes in this range; hence it can be used for irrigation purpose.

Table: 4 Performance of Filtration with wheat husk in the reduction of TDS

Days (No)	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage (%)
Day 1	645	1	600	6.97
		2	588.50	8.75
		3	570.45	11.55
Day 2	570.45	1	500.02	12.34
		2	488.78	14.31
		3	475.02	16.72
Day 3	475.02	1	370.00	22.10
		2	365.34	23.08
		3	310.56	34.62

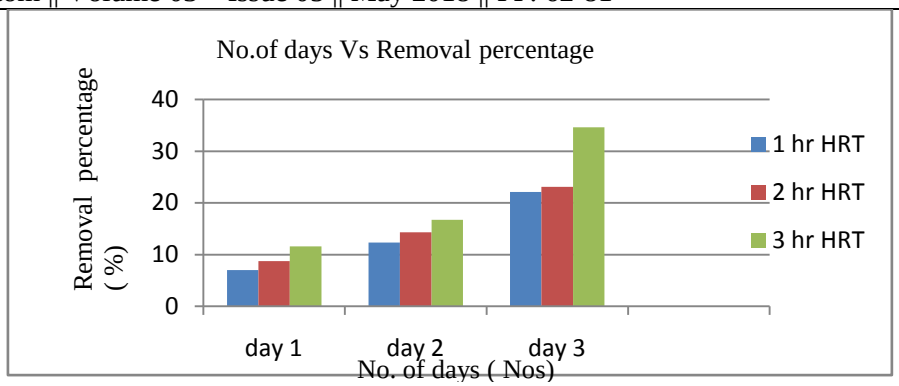

Figure: 13 Performance of Filtration with Wheat Husk in TDS Removal

3.5 Performance of Filtration with wheat husk in turbidity removal

Turbidity is the haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye. The measurement of turbidity is a key test of water quality. As the treatment started in first day, the value of turbidity of the influent is 300 NTU. End of first day 23.33 % removal efficiency is obtained. As the number of retention hours increased the maximum reduction percentage is 30.99% in the 3 hr of HRT. In the last day the removal efficiency is reached up to 75.50% at 3 hr HRT.

Table: 5 Performance of Filtration with Wheat Husk in the Reduction of Turbidity

Days (No)	Influent value (NTU)	HRT (hr)	Effluent value (NTU)	Removal percentage(%)
Day 1	300.00	1	252.S87	16.66
		2	241.35	19.11
		3	230.98	23.33
Day 2	230.98	1	167.79	26.11
		2	168.00	27.94
		3	160.00	30.99
Day 3	160.00	1	91.00	43.31
		2	40.25	74.24
		3	39.00	75.50

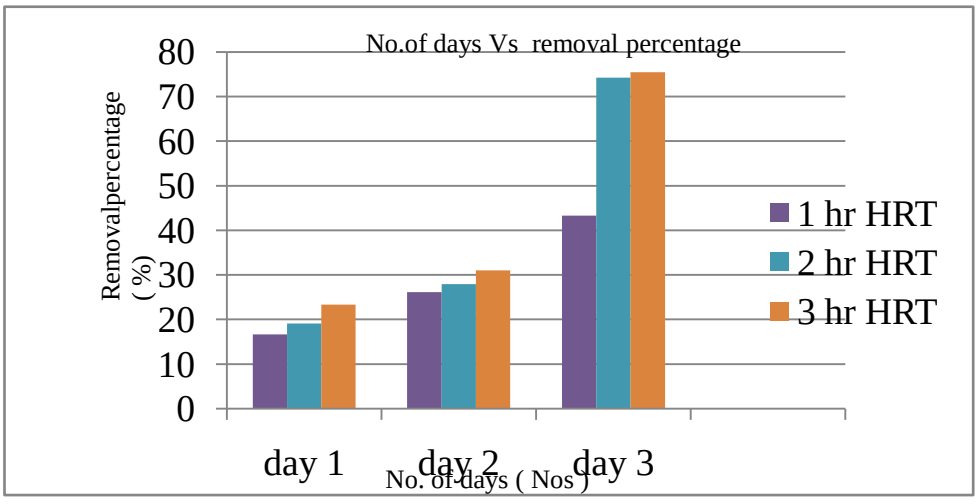

Figure: 14 Performance of Filtration With Wheat Husk In Turbidity Removal

3.6 Performance of Filtration With Wheat Husk In pH Variation

It is the measure of hydrogen ion concentration in a solution. And it is considered as one of the important factor in the biological treatment of water treatment. For irrigation purpose its limit is 5.5 to 9.

Table: 6 Performance of Filtration with wheat husk

No. of Days	Influent value	HRT (hr)	Effluent value
Day 1	7.95	1	7.94
		2	7.93
		3	7.9
Day 2	7.9	1	7.86
		2	7.7
		3	7.4
Day 3	7.4	1	7.34
		2	7.21
		3	7.16

3.7 Filtration With Sugarcane Bagasse In COD Removal

The maximum removal efficiency obtained was 72.90%. The chemical oxygen demand for influent used in the first day of filtration was 830 mg/L. After 3 hour, the value of COD reduced up to 584.83 mg/l. .In the second day the efficiency is increased up to 60.67% and in the third day obtained the maximum efficiency about 72.90%. The effluent standard level provided by Kerala pollution control board for irrigation purpose is 250 mg/L. In the third day its value reduced up to 62.11 mg/l.. So the treated water can be used as irrigation purpose.

Table : 7 Performance of Filtration with sugarcane bagasse in the reduction of COD

Days ((No)	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage(%)
Day 1	830	1	645.62	22.21
		2	628.43	24.28
		3	584.83	29.53
Day 2	584.83	1	320.45	45.20
		2	280.29	52.07
		3	230.00	60.67
Day 3	230.00	1	80.80	64.86
		2	70.87	69.18
		3	62.11	72.90

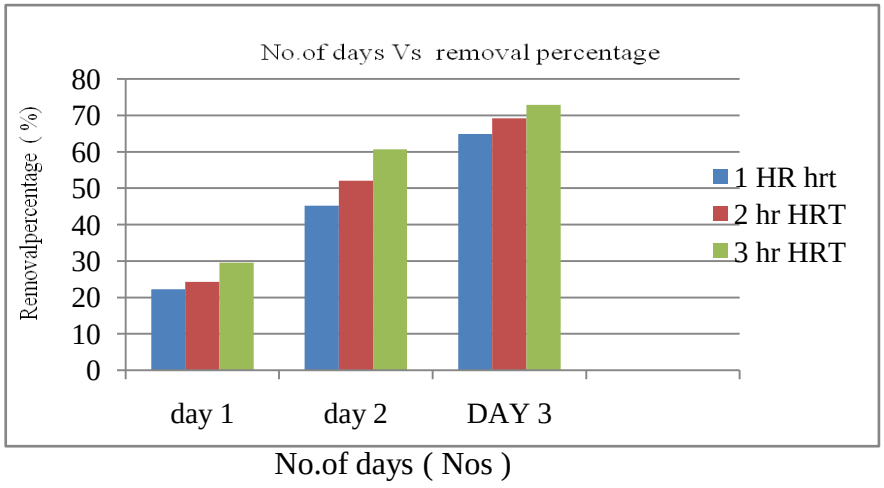

Figure: 14 Performance of Filtration With Sugarcane Bagasse In COD Removal

3.8 Filtration with sugarcane bagasse in BOD_3 removal

The filter was operated with a different hydraulic retention time of 1 hr,2 hour and 3 hour to find out the removal percentage. The performance was analyzed for 3 days. At the end of 1 hour, 2 hour, and 3 hour , the characteristics of the effluent were determined.1t was noted that when the number of days of filtration increase the percentage of BOD_3 removal is also increased. The maximum removal efficiency was reached up to 66.34%

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Table : 8 performance of Filtration with sugarcane bagasse in the reduction of BOD_3

Days (No)	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage(%)
Day 1	370.00	1	290.45	21.50
		2	285.34	22.88
		3	278.17	24.81
Day 2	278.17	1	190.34	31.57
		2	183.59	34.00
		3	150.56	45.87
Day 3	150.56	1	70.20	53.37
		2	60.68	59.72
		3	50.67	66.34

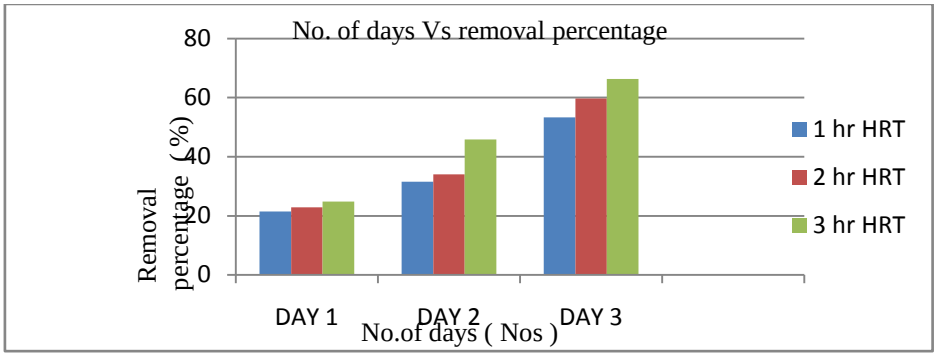

Figure: 15performance of Filtration with sugarcane bagasse in the Reduction of BOD_3

3.9 Filtration with Sugarcane Bagasse In Turbidity Removal

The treatment started in first day the value of turbidity in the influent, is 300 NTU .End of first day 20.67 % removal efficiency is obtained. As the number of retention hours increased then the removal percentage also increases. The maximum reduction percentage is 29.07 % in the 3 hr of HRT in second day. In the last day the removal efficiency is reached up to 46.04% at 3 hr HRT.

Table: 9 performance of filtration with sugarcane bagasse in the reduction of turbidity

Days (No)	Influentvalue (NTU)	HRT (hr)	Effluent value (NTU)	Removal percentage(%)
Day 1	300.00	1	248.87	17.04
		2	246.78	17.74
		3	237.98	20.67
Day 2	237.98	1	180.00	24.36
		2	175.79	26.13
		3	168.78	29.07
Day 3	168.78	1	100.00	40.75
		2	87.89	44.64
		3	85.67	46.04

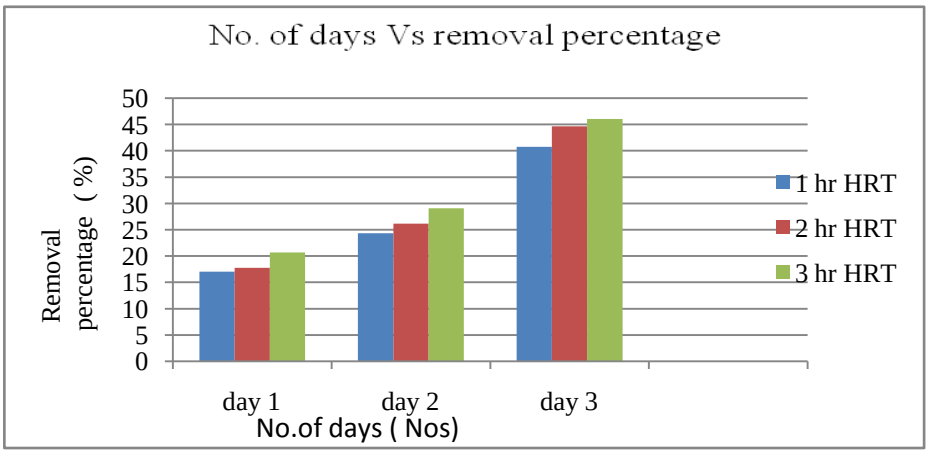

Figure:16 Performance of Filtration with sugarcane bagasse in the Reduction of Turbidity

3.10 Filtration With Sugarcane Bagasse In TDS Removal

The maximum percentage of removal is 73.06% .In the first day of filtration, the percentage removal of TDS shown by the filter with sugarcane bagasse is only about 22.39% at I hr HRT. But the efficiency of the filter is increased and it came up to 34.81% at the end of the day..In the second day, the removal efficiency got increased up to 46.25%.And the third day, it is about 73.06%.The effluent standards for irrigation provided by Kerala pollution control board is 2100 mg/L. The value of TDS for the treated water comes in this range. Hence it can be used for irrigation purpose.

Table: 10 Performance of Filtration with sugarcane bagasse in the Reduction of TDS

Days (No)	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage(%)
Day 1	645	1	500.57	22.39
		2	450.50	30.15
		3	420.45	34.81
Day 2	420.45	1	250.00	40.53
		2	240.00	42.91
		3	225.98	46.25
Day 3	225.98	1	78.89	65.08
		2	70.13	68.96
		3	60.87	73.06

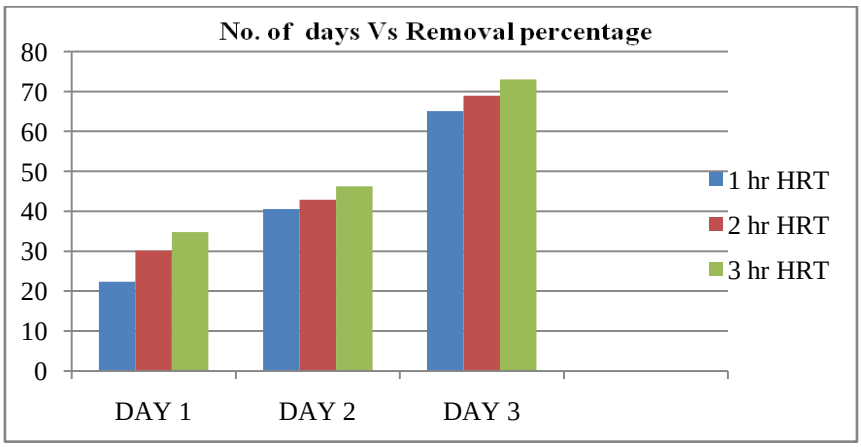

Figure:17 Performance of Filtration with sugarcane bagasse in the reduction of TDS

3.11 Filtration With Sugarcane Bagasse In pH Variation

It is the measure of hydrogen ion concentration in a solution and is considered as the one of the important factor in the biological treatment of water treatment. For irrigation purpose its limit is 5.5 to 9.

Table: 11Performance of Filtration with sugarcane bagasse in the variation of pH

No. of Days	Influent value	HRT (hr)	Effluent value
Day 1	7.95	1	7.96
		2	7.95
		3	7.92
Day 2	7.92	1	7.9
		2	7.89
		3	7.87
Day 3	7.87	1	7.86
		2	7.80
		3	7.78

3.12 Filtration With Grass Mulch In COD Removal

Grass mulch is used in the filtration process only for the screening purpose. Dharbha grass mulch used in this project .So it will removes only TDS .The removal efficiency of COD is very much low when compared to the other 3 cases. The maximum removal efficiency is obtained in third day its about 19.57%.the effluent standard level provided by Kerala pollution control board for irrigation purpose is 250 mg/L. in the third day its value reduced up to only 474.67mg/l from 830 mg/ L. So the treated water cannot be used for irrigation purpose .

Table: 12 performance of Filtration with grass mulch in the reduction of COD

No. of Days	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage(%)
Day 1	830	1	780.68	5.942
		2	764.90	7.84
		3	724.09	12.76
Day 2	724.09	1	620.00	14.37
		2	604.90	16.46
		3	590.23	18.48
Day 3	590.23	1	480.00	18.67
		2	478.90	18.86
		3	474.67	19.57

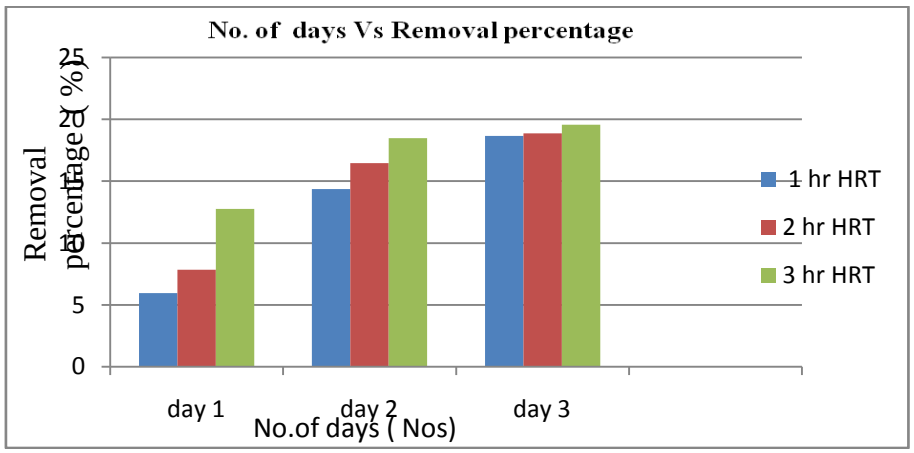

Fig : 18 Performance of Filtration with grass mulch in the Reduction of COD

3.13 Filtration with Grass Mulch in BOD_3 Removal

The removal efficiency of BOD_3 is very much low when compared to the other 3 cases. The maximum removal efficiency is obtained in third day it's about 21.08%.The effluent standard level provided by Kerala pollution control board for irrigation purpose is 100 mg/L. In the third day, its value reduced up to only 199.56 mg/L from 370 mg/L. So the treated water cannot be used for irrigation purpose.

Table: 13 Performance of Filtration with grass mulch in the reduction of BOD_3

Days (No)	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage(%)
Day 1	370.00	1	320.78	13.30
		2	314.90	14.89
		3	310.89	15.97
Day 2	310.89	1	260.00	16.36
		2	258.90	16.72
		3	252.89	18.65
Day 3	252.89	1	200.00	20.91
		2	199.78	21.00
		3	199.56	21.08

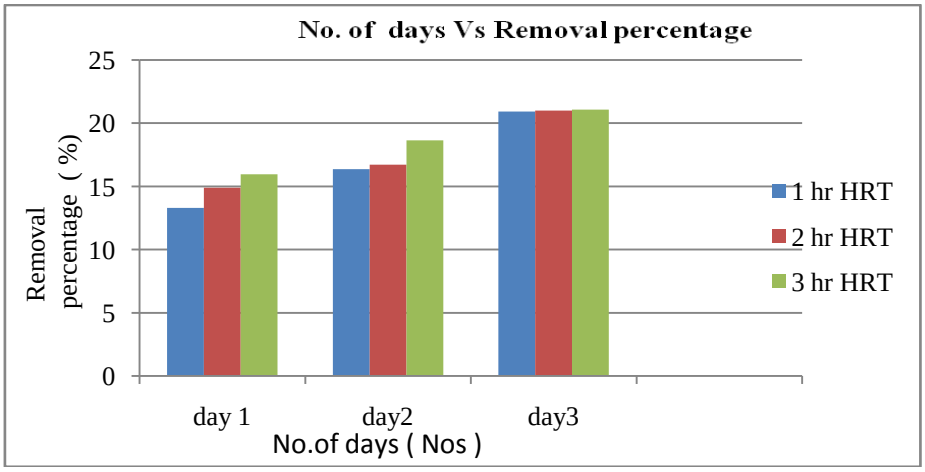

Fig :19 Performance of Filtration with Grass Mulch in the Reduction of BOD_3

3.14 Filtration with Grass Mulch In Turbidity Removal

Turbidity is the haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye. The measurement of turbidity is a key test of water quality. As the treatment started in first day the value of turbidity in the influent, is 300 NTU. End of first day only 8.70 % removal efficiency is obtained. At the end of second and third day the maximum reduction percentage is 16.42 %and 19.65% respectively.

Table: 14 Performance of Filtration with Grass Mulch in the Reduction of Turbidity

Days (No)	Influent value (NTU)	HRT (hr)	Effluent value (NTU)	Removal percentage(%)
Day 1	300.00	1	278.89	7.03
		2	275.89	8.03
		3	273.90	8.70
Day 2	273.90	1	240.00	12.37
		2	238.79	12.81
		3	228.90	16.42
Day 3	228.90	1	187.00	18.30
		2	185.00	19.17
		3	183.90	19.65

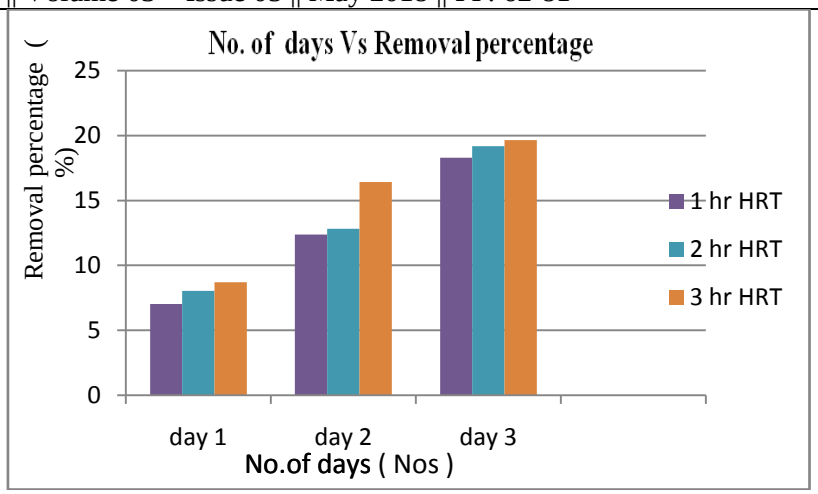

Fig : 20 Performance of Filtration with Grass Mulch in the Reduction of Turbidity

3.15 Filtration with Grass Mulch in TDS Removal

Grass mulch used for the screening purpose. In the first day the TDS removal is 21.92%, 31.70%, 33.26% at 1hr, 2 hr, 3 hr HRT respectively. At the end of second day the removal efficiency is reached upto42.39%. About 64.55% efficiency is obtained at the third day.

Table: 15 Performance of Filtration with Grass Mulch in the Reduction of TDS

Days (No)	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage (%)
Day 1	645	1	503.57	21.92
		2	440.50	31.70
		3	430.45	33.26
Day 2	430.45	1	255.00	40.75
		2	250.00	41.92
		3	247.98	42.39
Day 3	247.98	1	100.90	53.31
		2	90.65	63.44
		3	87.90	64.55

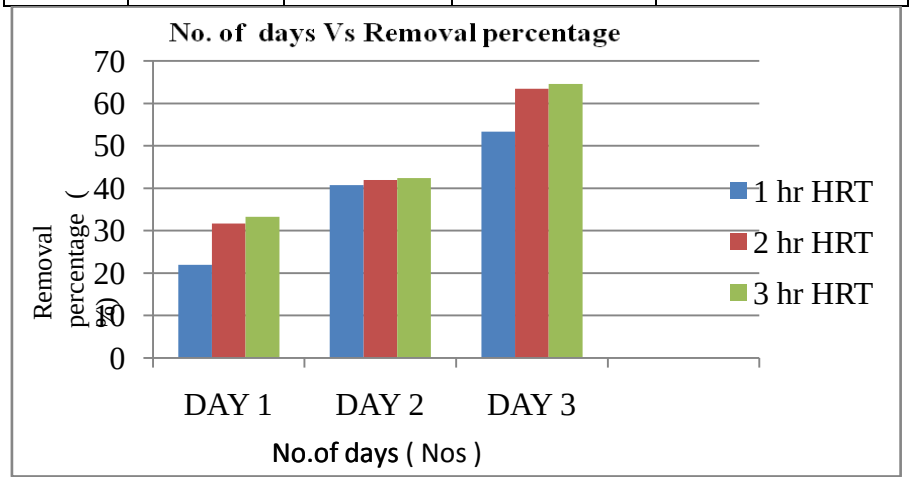

Fig : 21 Performance of Filtration with Grass Mulch in the Reduction of TDS

3.16 Filtration with Grass Mulch in pH variation

It is the measure of hydrogen ion concentration in a solution and is considered as one of the important factor in the biological treatment of water treatment. For irrigation purpose its limit is 5.5 to 9.There is no considerable variations in the pH level.

Table : 16 Filtration with Grass Mulch in pH Variation

No. of Days	Influent value	HRT (hr)	Effluent value
Day 1	7.95	1	7.94
		2	7.78
		3	7.45
Day 2	7.45	1	7.14
		2	7.43
		3	7.21
Day 3	7.14	1	7.20
		2	7.11
		3	7.12

3.17 Multiple Filtration Units in COD Removal

COD indicates the amount of oxygen required to oxidize the carbonaceous matter. The filter was operated with a different hydraulic retention time of 1 hr, 2 hour and 3 hour to find out the efficiency. The performance was analyzed for 3 days. At the end of 1 hour, 2 hour, and 3 hour , the characteristics of the effluent were determined in each day.1t was noted that the number of days of filtration increased the percentage of COD removal is also increased. The maximum removal efficiency obtained was 93.04 %.The chemical oxygen demand for influent used in the first day of filtration was 830 mg/L. After 3 hour the value of COD reduced up to 563.83mg/L. In the second day the efficiency is increased up to 62.97% and in the third day obtained the maximum efficiency about 93.04%. The effluent standard level provided by Kerala pollution control board for irrigation purpose is 250 mg/L. In the last day its value reduced up to 14.76 mg/L. So the treated water can be used as irrigation purpose. Multiple filtration units give more result when compared to the other three cases.

Table: 17 Performance of Multiple Filtration in the Reduction of COD

No. of Days	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage(%)
Day 1	830	1	610.65	26.62
		2	580.43	30.06
		3	563.83	42.24
Day 2	563.83	1	300.00	46.79
		2	230.20	59.17
		3	200.86	62.97
Day 3	212.28	1	50.80	76.06
		2	30.40	85.67
		3	14.76	93.04

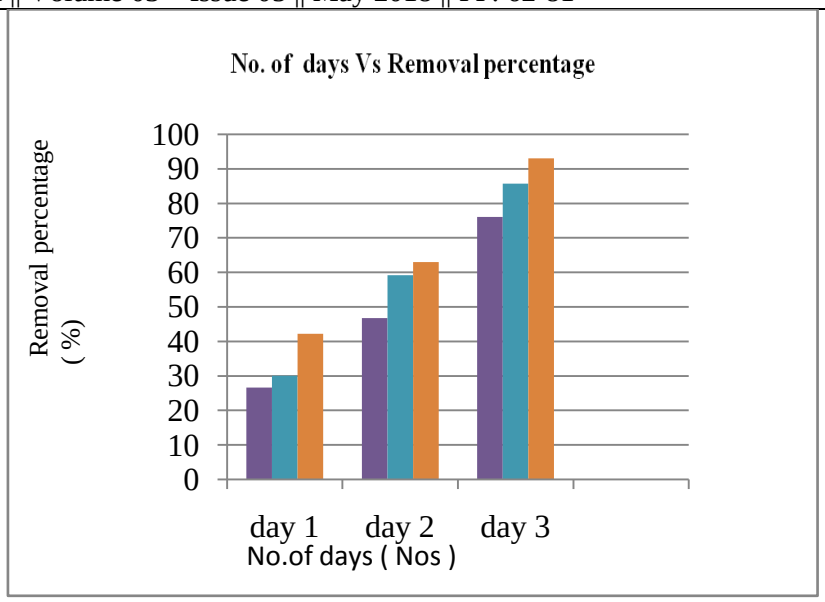

Fig : 22 Performance of Multiple Filtration in the Reduction of COD

3.18 Multiple Filtration unit In BOD_3 Removal

Multiple filtration units give more result when compared to the other three cases. Bio chemical oxygen demand describes the amount of dissolved oxygen essential to breakdown organic contaminants through aerobic bacteria. The filter was operated with a different hydraulic retention time of 1 hr,2 hour and 3 hour to find out the efficiency. The performance was analyzed for 3 days. At the end of 1 hour, 2 hour, and 3 hour , the characteristics of the effluent were determined in each day.1t was noted that the number of days of filtration increased the percentage of BOD_3 removal is also increased. The maximum removal efficiency was reached up to 91.43 % .The bio chemical oxygen demand for influent used in the first day of filtration was 370 mg/L, after 3 hour the value of BOD_3 reduced up to 230.20 mg/L. In the second day the efficiency is increased up to 45.89 % and in the third day obtained the maximum efficiency is reached up to 91.43%.

Table : 18 Performance of Multiple Filtration in the Reduction of BOD_3

Days (No)	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage(%)
Day 1	370	1	260.26	29.65
		2	253.34	31.52
		3	230.20	37.78
Day 2	230.20	1	140.34	39.03
		2	135.56	41.11
		3	124.56	45.89
Day 3	124.56	1	30.78	75.28
		2	27.89	77.60
		3	10.67	91.43

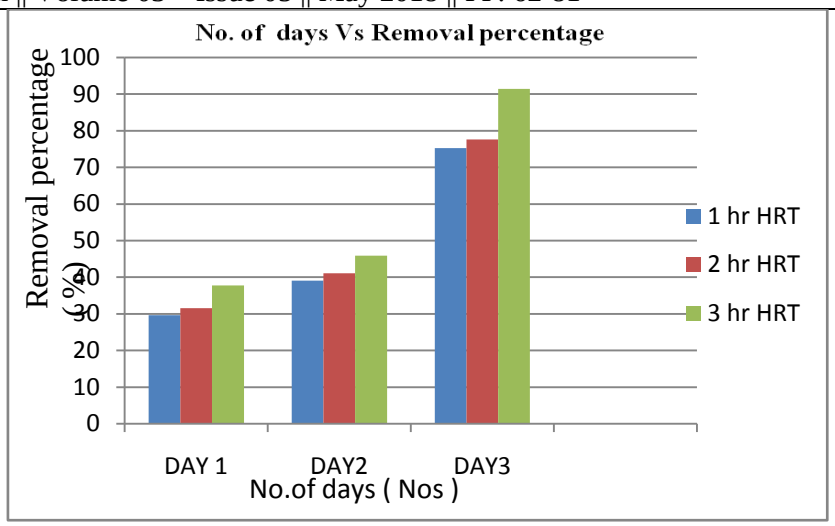

Fig: 23 Performance of Multiple Filtration in the Reduction of BOD_3

3.19 Multiple filtration units in turbidity Removal

Turbidity is the haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye. The measurement of turbidity is a key test of water quality. As the treatment started in first day the value of turbidity in the influent, is 300 NTU. End of first day 33.30 % removal efficiency is obtained. As the number of retention hours increased the maximum reduction percentage is 39.12% in the 3 hr of HRT of second day. In the last day the removal efficiency is reached up to 82.17% at 3 hr HRT.

Table : 19 Performance of Multiple Filtration in the Reduction of Turbidity

Days (No)	Influent value (NTU)	HRT (hr)	Effluent value (NTU)	Removal percentage(%)
Day 1	300	1	230	23.33
		2	220.67	26.44
		3	200.09	33.30
Day 2	200.09	1	130.00	35.02
		2	125.78	37.13
		3	121..81	39.12
Day 3	121..81	1	38.00	68.80
		2	27.78	77.17
		3	21.71	82.17

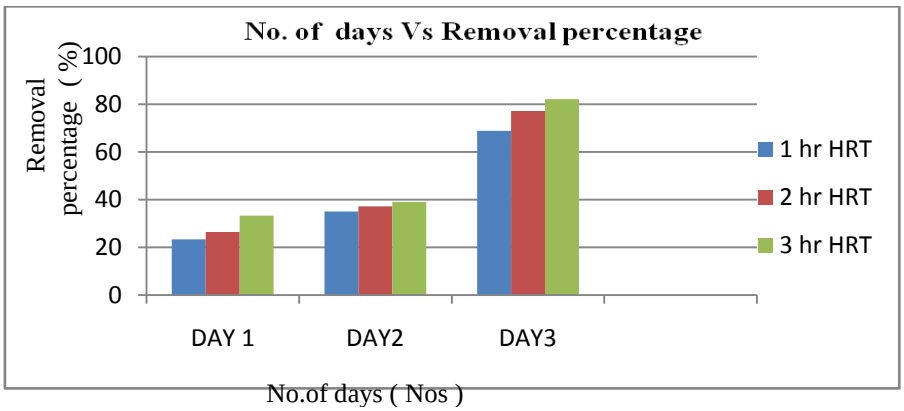

Fig : 24 Performance of Multiple Filtration in the Reduction of Turbidity

3.20 Multiple filtration units in TDS Removal

The maximum percentage of removal is shown by 73.47%. In the first day of filtration the percentage removal of TDS shown by the multiple filtration units is only about 24.40% at 1hr HRT. But the efficiency of the filter is increased and it came up to 34.19% at the end of the day. In the second day the removal efficiency got increased up to 47.70%. And the third day it was about 73.47%. The effluent standards for irrigation provided by Kerala pollution control board is 2100 mg/L. The value of TDS for the treated water comes in this range hence it can be used for irrigation purpose.

Table: 20 Performances of Multiple Filtrations in the Reduction of TDS

Days (No)	Influent value (mg/L)	HRT (hr)	Effluent value (mg/L)	Removal percentage (%)
Day 1	645	1	487.57	24.40
		2	455.50	29.37
		3	424.45	34.19
Day 2	424.45	1	247.00	41.80
		2	235.00	44.63
		3	221.98	47.70
Day 3	221.98	1	74.89	66.26
		2	67.13	69.75
		3	58.87	73.47

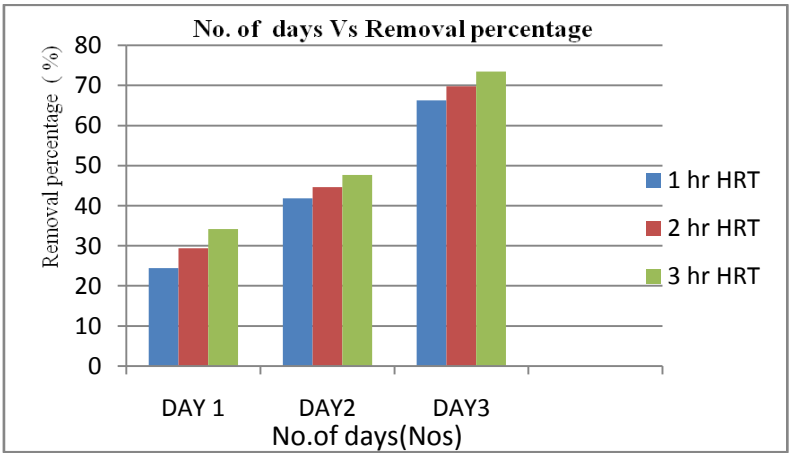

Fig : 25 Performance of Multiple Filtration in the Reduction of TDS

3.21 Multiple Filtration Units In pH Variation

It is the measure of hydrogen ion concentration in a solution and it is considered as one of the important factor in the biological treatment of water. For irrigation purpose its limit is 5.5 to 9.The treated water can be used for irrigation purpose.

Table: 21 Multiple Filtration Units in pH Variation

No. of Days	Influent value	HRT (hr)	Effluent value
Day 1	7.95	1	7.93
		2	7.91
		3	7.9
Day 2	7.9	1	7.87
		2	7.7
		3	7.4
Day 3	7.4	1	7.30
		2	7.24
		3	7.15

3.22 Comparison of Performance of Different Types of Filters

Multiple filter gives maximum removal efficiency when compared to all other filters. The removal efficiency of COD is 93.04 %. BOD, Turbidity, and TDS removal is 91.43%, 82.17%, 73.47 % respectively. Poor result obtained when the grass mulch filter is used for treating the domestic grey water.

Table: 22 Comparison of Performance of Different Types of Filters

Types of filter	COD Removal (%)	BOD removal (%)	Turbidity removal (%)	TDS removal (%)
Filter with wheat husk	77.9	78.18	75.5	34.67
Filter with bagasse	72.9	66.34	46.04	73.06
Filter with grass mulch	19.57	21.08	19.65	64.55
Multiple filter unit	93.04	91.43	82.17	73.47

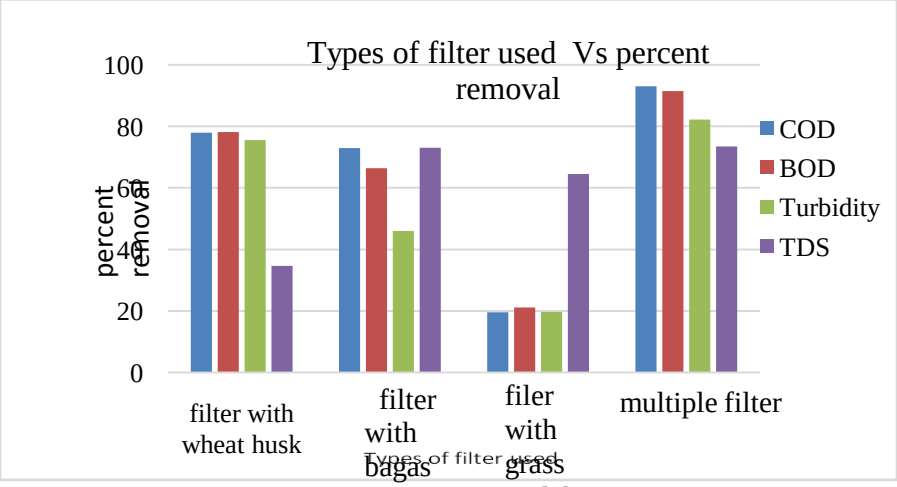

Fig : 26 Comparison of Performance of Different Types of Filters

4. Total Cost of the Filter

The cost of all the adsorbent media and filter, which is used for the project excluding the labor cost, maintenance cost is tabulated. Total cost is around 500 rupees for the development of filter for the house hold. But in the actual case the minimum cost of the filter is about 5000 rupees when it is purchased from a shop.

Table: 23 Material Cost of Different adsorbent media and filter used in experimentation

Material	Amount used for experiment (kg)	Rate per kg In rupees	Total cost In rupees
Wheat husk	5	12	60
sand	10	12	120
Activated carbon	5	nil	nil
Sugarcane baggase	10	nil	nil
Coarse aggregate	10	15	150
Grass mulch	0.6	nil	nil
Feeder tank, glass material and its fixation	-	-	150

Conclusions

Domestic grey water was treated by four types of filtration techniques using the materials like wheat husk, sugarcane bagasse, grass mulch and multiple filter. In all filtration methods, base materials used such as activated carbon, sand and coarse aggregates. Effects of retention time variations and effects of increasing No. of days are studied. The main objective of this study is to develop a low cost filtering system which can be implemented effectively in independent houses. The importance of treatment and reuse of waste water comes when water scarcity is considered.

The following conclusions were obtained in this study.

- The three filtration techniques used in this study was found to be efficient and economical. And the treated water can be used for irrigation process. Only the filtration with grass mulch showed poor results. Hence it is not recommended.
- Total cost of the filter unit is around 500 rupees, which is a low cost water treatment unit.
- The effluent provided by each filter follows the general effluent standards for irrigation by Kerala Pollution Control Board, except the filter unit with grass mulch. The grass mulch could not reduce the effluent characteristics to the limit of standards provided by Kerala Pollution Control Board except in the case of TDS. Hence it is not recommended.
- Multiple filter showed good removal efficiency for the removal of COD, BOD_3, Turbidity, TDS, is about 93.04%, 91.43%, 82.17%, and 73.47% respectively.
- These systems of waste water treatment offer of waste water offer several advantages compared to conventional treatment system. This includes simple in construction, less skill to operate, lower construction and maintenance cost, utilization of natural materials.

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