# “GREY WATER TREATMENT USING VERTICAL GADENING

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***Abstract:*** *Grey water as a type of in-building waste water is nowadays recognized as a substantial alternative source of water. The criteria for effective and safe grey water reuse are determined by the quantity and quality of water, both of which are directly influenced by user behaviour. While many technologies are available for grey water treatment, natural systems like constructed wetlands have shown advantages of low energy requirements together with a simple and cheap maintenance. Grey water provides a wide range of pollution concentrations depending on consumption behaviours, thus it is vital to ensure suitable treatment before future use in order to protect the environment and user health. There have been a variety of treatment systems developed, ranging from basic, low-cost devices that feed grey water directly for application to highly sophisticated and expensive advanced treatment procedures that include sedimentation tanks, bioreactors, filters, pumps, and disinfection units. In this dissertation work the main focus is to treat grey water using low cost method by using vertical gardening where this can also help in having a better environment by having better air quality and also to see if there is reduction in noise.*

***Keywords: Physico-Chemical parameters, grey water, cocopeat , sawdust, vertical gardening***

## 1. INTRODUCTION

Environmental pollution is a global concern because of the harmful effects on public health and the environment. The irresponsible disposal of untreated wastewater into surface waters, soil and groundwater results in polluted water resources and environmental damages such as eutrophication (Parameshwara Murthy P. M.et.al,2016). Grey water as a type of in-building waste water is nowadays recognized as a substantial alternative source of water. The criteria for effective and safe grey water reuse are determined by the quantity and quality of water, both of which are directly influenced by user behaviour. Grey water contributes a wide variety of pollutant concentrations depending on usage practises. (Martina Rysulov.et al, 2018)

## 2. LITERATURE REVIEW

**F. Masi et al. (2015): Vertical Gardens for grey water treatment and recycling in dense urban areas.** The experimental investigation was split into two parts. The first phase looked at the results of green walls that were exclusively filled with LECA. Because the first phase's outcomes were insufficiently satisfying, a second phase was created. In the second phase, the porous media LECA plus sand and LECA plus coconut fibres are investigated in order to extend residence periods and, as a result, green wall treatment performance. The wider range of observed removal rates between Phase I (COD 16–20 percent) and Phase II (i.e. COD removal in the order of 14–86 percent and 7–71 percent for LECA coconut and LECA-sand, respectively) confirms the expected improvements in treatment efficiency, indicating higher treatment potentialities for the new configuration.

For all of the tested samples, the effluent quality met the Indian legislation standards for reuse in irrigation, whereas only the last samples collected during Phase II showed a suitable quality for reuse by flushing toilets.

**Martina Rysuloval et.al(2014) Walls as an Approach in Grey Water Treatment Grey water**, Biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total phosphorus (Ptotal), total nitrogen (Ntotal), ammonium, boron, metals, salts, surfactants, synthetic chemicals, oils and greases, xenobiotic substances, and microorganisms all play a role in waste water parameters. The relevance of the treatment process in grey water systems is shown by the concentration of these contaminants and the water quality. Low-energy and low-maintenance treatment technologies are frequently selected since they are more cost-effective for users. Treatment technologies based on natural processes, such as the vegetated wall, are an example of such technology.

**Mr. Sarang K.Dighe 1, Prof. S. R. Korke (2018): Grey Water Treatment in Vertical Flow Constructed Wetland**

First, Gery Water Treatment was performed, followed by the design of a two-stage vertical-flow constructed wetland system that included vegetation (the presence of common reeds ‘‘Canna Indica”). Repurposing grey water for irrigation reconnects city dwellers and their gardens to the natural water cycle.Constructed Wetland treatment system has proved to be an effective method of recycling the grey water.

The efficiency of the wetland plant Canna indica and waste biomass in the treatment of grey water using a vertical subsurface flow root zone system was investigated in this research. a scale in the laboratory A two-stage vertical flow reed bed was built with biomass adsorbent from newspaper and coarse aggregate as the media, and nine different Canna indicia species were grown. The system was supplied at a 500-liter-per-day pace. As a result, adsorption, filtration, and root zone treatment occur. The raw Grey water and treated water were collected and checked for quality using established methods on a regular basis. On average, the reed bed unit reduces TSS, TDS, BOD, and COD concentrations by 63 percent, 79 percent, 86 percent, and 53 percent, respectively. The treated Grey water can be used for gardening or for flushing the water closet.

The objective of the study includes

- To assess the Physical & chemical characteristics of domestic grey water.
- To study the use of coco peat with soil in the treatment of grey water by vertical gardening.
- To study the use of Saw dust with soil in the treatment of grey water water by vertical gardening.
- To study the Physical & chemical characteristics grey water after treatment by vertical gardening.
- Comparative study between Coco peat and Sawdust.
- To suggest reuse methods

## 3. MATERIALS AND METHODOLOGY

### 3.1 GREY WATER

The selected Influent grey water was collected from engineering hostel, J B campus Bangalore. The analysis was carried out in Environmental Engineering lab, Department of civil engineering J B campus, Bangalore 560056, Sample was analysed for the following parameters like $BOD_5$, COD, TDS, Turbidity, water temperature, pH

### 3.2 SELECTION OF MEDIA

The experimental set up was consist of 3 rows and 4 columns, the first column consist of soil plus cocopeat alternate layer placed in each pot of first column, the second columns each pot filled with the mixture of soil and cocopeat

**Figure 1 :Soil**

**Figure 2 :cocopeat**

**Figure 3 : mixture of soil and cocopeat**

### 3.3 METHODOLOGY

In the environmental laboratory the physico-chemical characteristics like, Temperature, pH, acidity, and alkalinity. Electric conductivity, total hardness, BOD, COD,Total dissolved solids are carried out to the greywater. And each parameter values are noted down. Greywater is passed through sand filters for preliminary treatment, and the characteristics of the water after passing are reported.

A three cross four(3x4) vertical gardening set up was made inside environmental laboratory of University of Visveswaraya college, the first column named as column 1,the second column as column 2, third column as column 3 and the last column as column 4.The preliminary treated water was transferred to all four columns separately, and collected in separate containers for the first pot planted with fern, second pot with spider, and third pot with singonium pot.

Four columns were arranged with a specific layer where

Column 1: contains coconut peat and soil in layer wise with a separate inlet and outlet

Column 2: contains mixture of coconut peat and soil with a separate inlet and outlet

Column 3: contains sawdust and soil in layer wise with a separate inlet and outlet

Column 4: contains mixture of sawdust and soil with a separate inlet and outlet

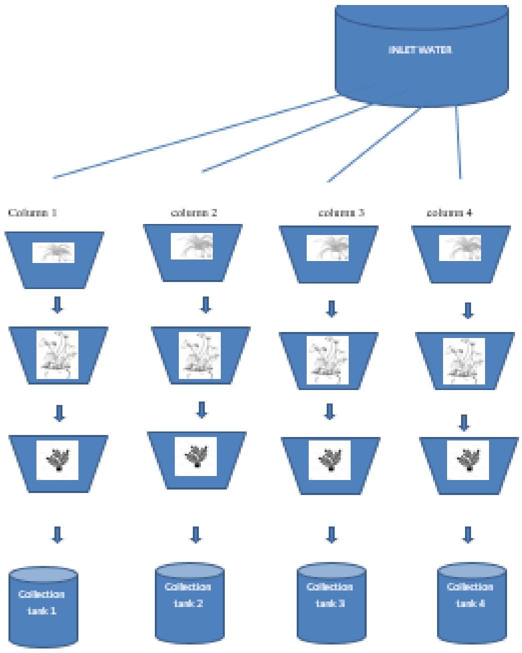


**Figure 7: schematic diagram**

**Figure 8 Vertical Gardening Set Up**

## 4 RESULTS AND DISCUSSION

### 4.1GENERAL

The collected grey water is passed through sand bed filtration for preliminary treatment. The physico chemical characteristics of earlier and after treatment of greywater is examined. The concentration of BOD, COD, TDS, Acidity, Alkalinity, hardness recorded by the effluent water after passing treated with four types of filters.

### 4.2 INITIAL PARAMETER ANALYSIS

The physico-chemical characteristics of grey water are listed in table1. From the table 1 it is observed that, the sample has pH of 6.3,electric conductivity of 522μs/cm ,acidity of 70mg/L, Alkalinity of 68mg/L, Total Hardness of 180mg/L,TDS of 573mg/L water then subjected to the preliminary treatment and later passed through the the all the columns for further treatment.

**Table 1 Characteristics of Grey water**

| Parameter | Unit | Inlet water |
|---|---|---|
| pH | - | 6.3 |
| Electric conductivity | μs/cm | 522 |
| Acidity | mg/L | 70 |
| Alkalinity | mg/L | 68 |
| Total hardness | mg/L | 180 |
| $BOD_5$ | mg/L | 190 |
| COD | mg/L | 397 |
| Temperature | °C | 18.8 |
| TDS | mg/L | 573 |

### 4.3 PRELIMINARY TREATMENT

The selected preliminary treatment consisted of the sand filter media layer of 90 to 110 cm in depth and placed over a gravel support. The coarse layer of gravel was placed at the bottom and finer layer of sand was placed above that. Grey water is passed through the above mentioned filter layers and the treated water is collected in a tank and the characteristic of water is analyzed which are listed in table 2. it is observed that the sample has pH of 6.1, electric conductivity of 489μs/cm, acidity of 52mg/L, Alkalinity of 54mg/L, Total Hardness of 214mg/L, TDS of 350mg/L, $BOD_5$ of 110mg/L, COD of 317mg/L.

**Table 2 Characteristic of preliminary treated water**

| Parameter | Inlet water | %f removal |
|---|---|---|
| Acidity | 52 | 25.71 |
| Alkalinity | 54 | 20.59 |
| Total hardness | 214 | 28.19 |
| $BOD_5$ | 110 | 42.11 |
| COD | 317 | 20.15 |
| TDS | 350 | 38.92 |

From the table 2, it is observed, BOD reduced by 71%, COD by 62%, TDS by 68%, total hardness by 62%, Acidity 76%, Alkalinity by 55%.. Similarly in the study conducted for Green walls for greywater treatment and recycling in dense urban areas by Fabio masi et al.2016, the removal efficiency of BOD in range of 80% and COD by 70%. The reason may be due to cocopeat has good physical properties like many pore space, high water content, slow biodegradation, low bulk density which help in formation of biofilm that acts as a bio filters.(Fabio masi, 2016.et,all). Fibre is able to absorb and retain water, fertilizes 8 to 10 times and also helps in neutralising pH.

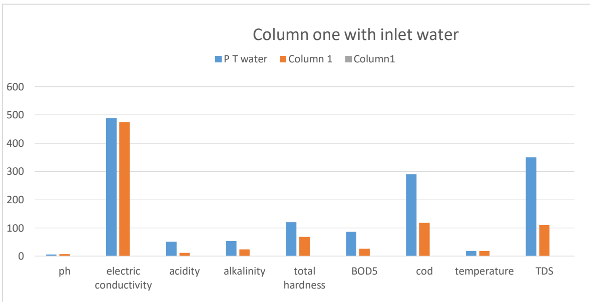


**Figure 9 comparation b/w inlet and column1**

### 4.4 VERTICAL GARDENING BY USING DIFFERENT PLANTS AND METHODS

#### 4.4.1 Column1: Soil and Cocopeat in alternate layers

The water was allowed to pass through the three pots one after the other kept in series (one below the other). treated water is collected at the collection chamber kept below the column 1 of cocopeat. Table 5.3. it is observed that the sample has changed from pH of 6.1 to 6.9, Electric conductivity of 489μs/cm to 474μs/cm ,acidity of 52mg/L to 12 mg/L, Alkalinity of 54mg/L to 55mg/L, Total Hardness of 214mg/L to 68 mg/L ,TDS of 350mg/L to 110 mg/L,$BOD_5$ 110mg/L to 27 mg/L,COD of 317mg/L to 118 mg/L.

**Table 3 Results of treated water through column 1**

| Parameter | Treated water in column 1 | Percentage of removal |
|---|---|---|
| Acidity | 12 | 76.92 |
| Alkalinity | 24 | 55.56 |
| Total hardness | 68 | 62.62 |
| $BOD_5$ | 27 | 71.82 |
| COD | 118 | 62.78 |
| TDS | 110 | 68.57 |

From the table 3, it is observed, BOD reduced by 71%, COD by 62%, TDS by 68%, total hardness by 62%, Acidity 76%, Alkalinity by 55%.Similarly in the study conducted for Green walls for greywater treatment and recycling in dense urban areas by Fabio masi et al.2016, the removal efficiency of BOD in range of 80% and COD by 70%. The reason may be due to cocopeat has good physical properties like many pore space, high water content, slow biodegradation, low bulk density which help in formation of biofilm that acts as a bio filters.(Fabio masi, 2016.et,all). Fibre is able to absorb and retain water, fertilizes 8 to 10 times and also helps in neutralising pH.

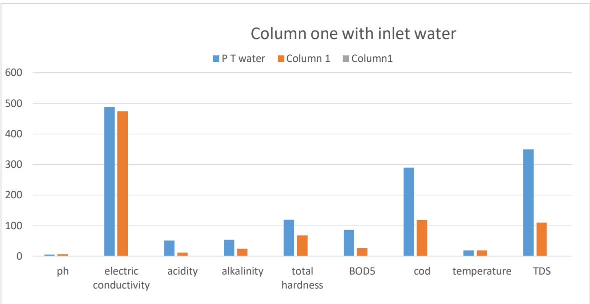


**Figure 10 comparation b/w inlet and column1**

**4.4.2 Column2: Mixture of soil and coconut peat**

It is observed, BOD has reduced from 110mg/l to 40 mg/l, COD 317 mg/l to 130 mg/l, TDS 350 mg/l to 160 mg/l, total hardness 214 mg/l to 80 mg/l, Acidity 52 mg/l to20 mg/l, Alkalinity 54 mg/l to 45 mg/l.

**Table 4 Results of treated water through column 2**

From the table 4, it is observed that Acidity reduced by 61%, Alkalinity by 16%, Total hardness by 62%,$BOD_5$ by 63%,COD by 58% TDS by 54%. The reason may be due to the water retention capacity is slow and depth of penetration is less compared to column one as the coco peat is mixed with soil in the column 2 where as in column one they are in layer.

| Parameter | Treated water in column 2 | Percentage of removal |
|---|---|---|
| Acidity | 20 | 61.54 |
| Alkalinity | 45 | 16.67 |
| Total hardness | 80 | 62.62 |
| $BOD_5$ | 40 | 63.64 |
| COD | 130 | 58.99 |
| TDS | 160 | 54.29 |

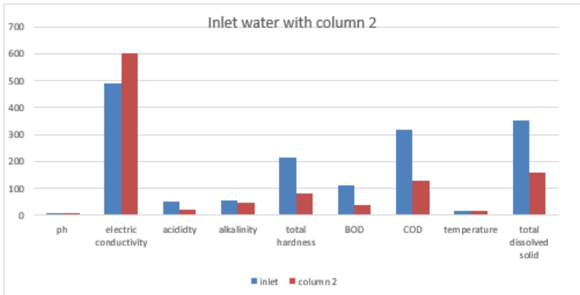


**Figure 11 comparation b/w inlet and column 2**

**4.4.3 coulumn3: Saw dust and soil in layer wise**

The water was allowed to pass through the three pots one after the other, finally water is collected at the collection chamber kept below the column 3, and their parameters listed in table 5.3, it is observed, BOD has reduced from 110 to 51, COD 317 to 145, TDS 350 to 203, total hardness by 214 to 86, Acidity 52 to28, Alkalinity 54 to 24.

**Table 5.Results of treated water through column 3**

| Parameter | Treated water in column 3 | Percentage of removal |
|---|---|---|
| Acidity | 28 | 46.15 |
| Alkalinity | 24 | 55.56 |
| Total hardness | 86 | 59.81 |
| $BOD_5$ | 51 | 53.64 |
| COD | 145 | 54.26 |
| TDS | 203 | 42.00 |

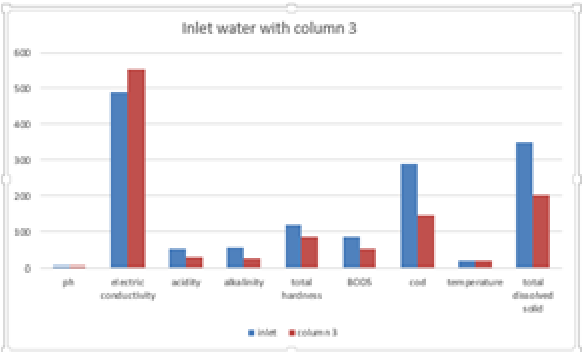


**Figure 12 Comparation b/w inlet and column3**

### 4.4.4 Column4: Mixture of soil and Saw dust

**Table 6 Results of treated water through column 4**

| Parameter | Preliminary treated water | Treated water column 4 | Percentage of removal |
|---|---|---|---|
| Acidity | 52 | 28 | 46.15 |
| Alkalinity | 54 | 52 | 3.70 |
| Total hardness | 120 | 85 | 60.28 |
| $BOD_5$ | 86 | 59 | 46.36 |
| COD | 290 | 154 | 51.42 |
| TDS | 350 | 210 | 40.00 |

From the table 6, it is observed, BOD has reduced by 46% COD by 51% Total dissolved solids by 40%, total hardness by 60%,Acidity by 46%,and alkalinity by 5%.The reason may be sawdust have poor water holding capacity, high porosity and it does not allow the sunlight pass through it. And it has 60% of carbon content acts as adsorbent and helps in filtrations process.

### 4.5 DISCUSSIONS

The wastewater flows vertically through the bed (Tilley et al., 2014). Because the vertical flow built wetland provides an aerobic environment, high levels of nitrification, BOD, COD, and other pollutant removal have been attained. Vertical flow built wetland land area requirements are 1–3 m2 /PE, which is less than HFCW but requires more upkeep (DBT, 2019).

The physical process involves sedimentation of suspended particles in the wastewater, which results in pollution removal. Sedimentation will increase as the wastewater retention duration increases.). The sedimentation process involves the gravity-driven settlement of particles, which results in the particles being deposited at the tank's bottom. The sedimentation method reduces organic materials while also removing coliform germs (Carter and Norton, 2007; Dotro et al., 2015).

Vertical subsurface flow constructed wetlands represent a valid mitigation tool for greenhouse gas emissions, entailing a reduction of about 50% in emissions compared to traditional wastewater treatment plants (WWTP) (Pan et al., 2011).

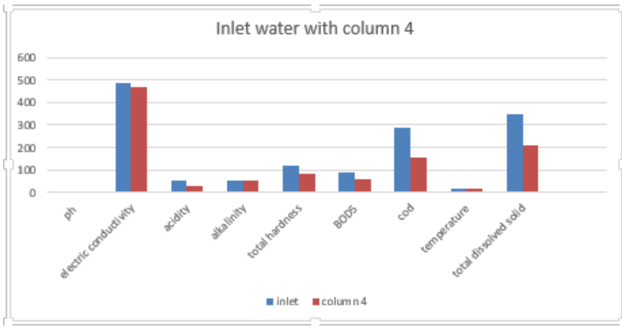


**Figure 13 comparation b/w inlet and column 2**

cocopeat has good physical properties like many pore space, high water content, slow biodegradation, low bulk density which help in formation of biofilm that acts as a bio filters.(Fabio masi, 2016.et,all). Fibre is able to absorb and retain water and also helps in neutralising pH. Due to cocopeat being flexible and loose the oxygen and sunlight easily reach in depth so that roots of plants will be more active and productive. During this process, carbon from organic molecules will be converted into carbon dioxide, which result in bulkiness reduction of the organic forms which can be absorbed directly by plants (Wilson 1989: prabhu and Thomas 2002)

Cocopeat is considered as a good growing media component with acceptable pH, electrical conductivity and other chemical attributes. However, cocopeat has been recognized to have high water holding capacity which causes poor air-water relationship, leading to low aeration within the medium, thus affecting the oxygen diffusion to the roots. Physical properties of cocopeat is highly dependent on it processing technique and handling and the air capacity and water retention of the material may vary from 11-53% and from 50-81% respectively. Incorporation of coarser materials into cocopeat could improve the aeration status of the media. Yahya Awang.et.al, 2009.

Sawdust have poor water holding capacity, high porosity and it does not allow the sunlight pass through it. And it has 60% of carbon content acts as adsorbent and helps in filtrations process.

### 4.5.1 pH

The Ph of water sample is recorded by the study before and after treatment is shown in figure 14 the resultant shows that lowest pH is shown in before treatment and and somewhat increased in all column to neutralise the water. Overall it reveal that water sample is slightly acidic.

### 4.5.2 BOD

The result shows that highest BOD level is detected before the treatment applied with 100mg/L, while lowest is recorded from soil and cocopeat alternate layer which is 27mg/L is shown in figure15, This indicates that nearly 70% of organic matter removed and.Beside that the other three column shows better result within the permissible limit of discharge standards.

### 4.5.3 COD

COD is the amount of oxygen required to chemically oxidize organic and inorganic matter. COD gives an estimation of the amount of organic and inorganic matter present. In Figure 14, it shows that high level of COD recorded before the water sample is treated with 350.27 mg/L. On the other hand, all the water samples that gone through the treatments have shown a good finding where the COD concentrations recorded are lower than the standard ranging from 54.8 to 186.8 mg/L. This indicates that all types filtrations tested in this study have a potential in removing organic and inorganic matters in the column one with the highest percentage reduction of 71%.

### 4.5.4 Total dissolved solids

further analysis was carried out to examined the total dissolved solids the water sample before and after treatment with four columns, From figure 15 the results shows that water sample are high with TDS before treatment as well as filter media, However the TDS concentration recorded by column one filter activated carbon have reduced the pollutants in the effluent concentration of 68% reduction.

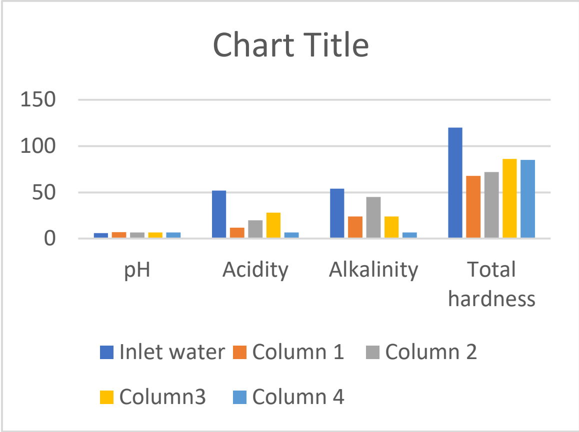


**Figure 14 Variation of Alkalinity, Acidity and Total hardness**

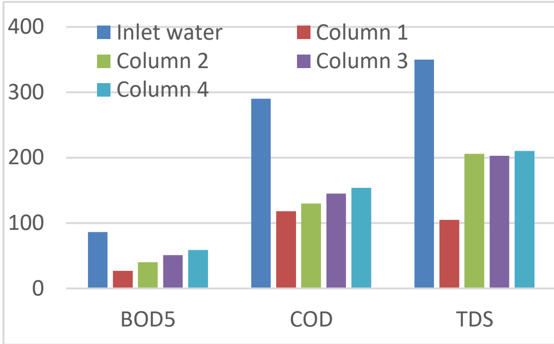


**Figure 15 Variation of BOD,COD,TDS**

### 5.1 CONCLUSIONS

1. The Physical & chemical characteristics of domestic grey water were analyzed
2. The use of coco peat in the treatment of grey water was anlayed and see that there is column1 and column2 BOD reduction was see around 71% in Column1 and column2 it was 63% thus column1 have good treatment capacity.
3. The use of saw dust in the treatment of grey water was analyzed and water gets treated almost equal in column 3 and column 4.In accurate bod removal of 53% in column 3 and nearly 45% in column
4. When efficiency Coco peat and Sawdust checked coco peat gives good results.
5. The treated water can be reused for gardening purpose as it is in permissible limit
6. Cocopeat filters are considered secondary treatment technology and used following treatment from a primary treatment mechanism (e.g., septic tanks, anaerobic baffled reactors, sewage lagoons, etc.).
7. Due to low cost technology and minimal space constraints cocopeat filters have the potential to be used in lieu of a variety of other comparable secondary treatment mechanisms (e.g., constructed wastelands, alternative media filters, etc.).
8. Cocopeat filters have a potential life expectancy of up to 8 years with an expected usable life of 3 years before requiring media replacement

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