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Greywater Treatment Using Wetland

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ABSTRACT- Because of human and technical improvements, the demand for freshwater has increased by leaps and bounds globally in agricultural, industrial, and home sectors, resulting in over-exploitation of freshwater resources. The management of wastewater generated as a by-product of these industries' different human activities is a global challenge today. Greywater (GW) is a type of wastewater produced in the domestic sector. Wetlands are locations whereby water covers the soil or is present at or near the soil's surface all year or for variable periods of time throughout the year, including the growing season. Water saturation (hydrology) influences how soil develops as well as the sorts of biological communities that live in and on the soil. Wetlands may provide habitat for both marine and terrestrial organisms. The presence of water over an extended period of time provides conditions that encourage the growth of particularly adapted plants (hydrophytes) and the creation of distinctive wetland (hydric) soils.

The water from the shower, sinks, and bathrooms is commonly referred to as "grey water." With proper treatment, greywater can be used for irrigation, allowing residential and backyard gardens to reconnect to the natural water cycle. "Root zone" is a technique that has proven to be particularly effective in recycling greywater. In this project artificial wetland has been constructed with various layers of materials using root zone technique using following plants Colocassia and canaindica. The greywater was passed through the assembly which had been constructed which consisted of settling tank, wetland unit, filtration unit. The samples of grey water were taken. COD, BOD, TDS, TSS were performed to find out these properties. Then grey water was passed through the assembly and these tests were conducted. The values show us there is decrease in COD, BOD, TSS and TDS. This decrease shows that the grey water can be for gardening purpose in homes.

KEYWORD- COD, TSS, TDS, Grey Water

I. INTRODUCTION

One of the most crucial challenges of the twenty-first century has developed as water shortage. By 2025, 2.7 billion artificial wetlands (CW) are gaining popularity [3]. CW is an environmentally friendly and cost-effective technology. When it comes to GW therapy, it can be utilised on a small size at home all the way up to a huge scale. As a result, it is a proven, feasible solution for GW recycling in the twenty-first century [4]. Treated GW can be reused for gardening, toilet flushing, and other purposes, reducing the need for water. There are varying standards and rules for water reuse in different regions [5]. people are anticipated to be impacted by water shortage[1]. One in three Indians are predicted to experience complete water shortage by 2025 [2]. When compared to other types of wastewaters, the amount of GW created is extremely large. It has a great potential for reuse due to lower pollutant levels and increased biodegradability. Among the various GW treatment options available,

A. Wetlands

Wetlands are areas "where water is the fundamental force influencing the ecosystem and the corresponding plant and animal life." They are seen as an asset because they provide useful products, such as peat, and serve an important role, such as water purification and carbon storage [6].

B. Wetlands in Kashmir

Jammu & Kashmir is renowned around the world for various noteworthy wetlands in addition to its biological, environmental, cultural, and tourist characteristics. There are an estimate 565 lakes and waterbodies in Jammu and Kashmir, with 150 of them in Jammu and 415 within Kashmir, according to limited field research [7].

Figure 1: Wetlands

Figure 1 is showing the wetland present in Srinagar, Jammu and Kashmir and table 1 shows the various wetland reserves in Kashmir.

Table 1: List of Wetland Reserves of Kashmir

S.no.	Name	District	Areas in kms
1	Hokera(Ramsar Site)	Srinagar	13.75
2	Mirgund	Srinagar	4
3	Shallabugh	Srinagar	16
4	Hygam	Srinagar	7.25
5	Malgam	Srinagar	4.50
6	Pampur (Chatlam) /Manibugh/ Kranchoo/ Chandhara	Srinagar	0.25

II. OBJECTIVES

- Using wet land to treat greywater using root zone technique.
- Determining the reduction in Chemical oxygen demand, Biochemical oxygen demand, Total suspended solids and Total dissolved solids

III. MATERIAL AND METHODOLOGY

A. Material

The materials used in this project includes soil, coarse aggregate, Colocassia and canaindica the wetland plants, fine aggregate, saw dust, charcoal, broken bricks which were used as filter media. Other than these materials, plastic pipes and drums were used to make the assembly of the wet land unit. These materials were sourced locally and the plastic pipes and drums were mostly jump. The Colocassia and canaindica were obtained from the wetland area of Nigeen lake.

B. Root Zone Technique Construction And Working

An artificial subsurface bathroom, laundry of the building was collected. The grey water was allowed to remain undisturbed for 24 hours so that particles of bigger size can settle. After that the water was moved into the wetland unit through pipes which had been attached to the whole assembly [5].flow wet land is constructed. The treatment process consists of four chambers. These are put together to form drums and pipes. The chambers are assembled as follows: settling tank, wetland unit, filtration tank and collection tank.

Settling tank = In the setting tank the grey waster which had been acquired from the kitchen,

Wetland unit = The wetland unit was made of different materials which had been laid in three layers to fill the depth of the wetland unit. The materials used were coarse aggregate, fine aggregate and soil. The coarse aggregate was first laid in the unit. The coarse aggregate ranged from 10 mm to 20mm in size. The coarse aggregate was acquired from a crusher. Fine aggregate was placed after coarse aggregate layer. The fine aggregate was sieved through a sieve of 4.75 mm size. Fine aggregate which was used had been acquired from jehlum river. Soil is placed on top of fine aggregate, Filtration tank = The water is allowed from the wetland unit through pipes in to the filter tank. The filter tank is made up of various media from fine sand, wooden chips from saw cutter, clot, charcoal, broken bricks and soil. These are placed one after another making different layer for filtration of smaller particles that come from wetland unit. The grey water is kept in the filtration tank for 24 hours during which water moves slowly through the filter media and finally into the collection tank.

The plants acclimatization was carried over 2 weeks. The tests were carried out for sample period of 20 days.

C. Experimental Procedures

Stages	Description
1.	Designing of wetland unit
2.	Collection of materials, wetland plants and grey water.
3.	Performing following tests cod, bod, tss, tds for greywater.
4.	Assembling all units together and constructing artifical wet land.
5.	Start of treatment process allowing greywater to settle for 24 hours.
6.	Moving water in through wetland then filter.
7.	Collecting water then testing again for cod, bod, tss, tds.
8.	Analyzing the results and comparing them.

D. Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand is the quantity of oxygen used among microorganisms such as bacteria during the aerobic decomposition of organic materials.

Figure 2: Determination of BOD

Figure 2, shows the apparatus used for determining BOD.

E. Chemical Oxygen Demand (COD)

The chemical oxygen demand is the quantity of oxygen needed to oxidise the organic material in water.

Figure 3: COD determination

Figure 3 is showing the apparatus used for determining the COD.

F. *Total Suspended Solids (TSS)*

Total suspended solids, or TSS for short, are waterborne particles greater than 2 microns in size. In contrast hand, a totally disintegrated solid is any particle less than 2 microns (TDS). Algae and bacteria are included in total suspended solids (TSS), but inorganic substances make up the bulk of TSS. Everything that hovers or is "suspended" in liquid, including sand, silt, or plankton, is considered to be a TSS [5].

Figure 4: TSS determination

Figure 4 is showing the apparatus for determining the TSS of water.

G. *Total Dissolved Solids (TDS)*

Total Dissolved Solids, or TDS, refers to the total concentration of dispersed materials in drinking water.

Figure 5: TDS determination

Figure 5 shows the apparatus used for determining the TDS of the grey water.

- **pH of Water**

The pH of water is a measurement of the amount of hydrogen ions present in water. It detects whether the water is alkaline or acidic
pH = -log [H]

- **Design**

The average Indian metropolis requires residential water supply = 135 lpcd
Water after use yields 80 percent wastewater effluent.
Greywater is assumed to be 72 percent of waste water.
The design of wetland unit takes into account the grey water produced.
Domestic water consumption (Qs) = 135 lpcd.
Waste water created (QW) = 80% of Qs = 135 x 0.8 = 108 lpcd.
Produced grey water (QD) = 72% x QW = 108 x 0.72 = 77.76 lpcd.

- **Design Flow**

QD = 0.0778 cubic meter/day/person
5 people per house are considered.
QD=0.0778 x 5 = 0.389 cubic meter /day
Hydraulic conductivity (k) = 247 cubic meter/ day / square meter
Assuming Hydraulic gradient (i) = 0.01
Q = KiA where Q is the discharge and A is cross sectional area.
Cross- sectional area (A) = Q/Ki = 0.389/247x0.01 = 0.157 square metre.
Assume depth (d) = 0.35 m
Width (w) = Area / Depth = A/d = 0.16/0.35 = 0.457 m.
Length = 1.5 x 0.457 =0.685 m.
The wetland block is 0.7 m long, 0.46 m broad, and 0.35 m deep, and it contains two plants, Colocassia and canaindica.
Coarse aggregate layer = 150 cm
Fine aggregate layer = 150 cm
Soil layer = 50 cm

IV. RESULTS AND DISCUSSIONS

A. *Effect on COD*

Table 2: Values of COD for grey water taken from settling tank.

Sample	DF	M	V_B-V_S	COD
1	1	0.025	31	620
2	1	0.025	29	580
3	1	0.025	33	660
Average				620

Table 2 shows the values of COD which were found for three samples of grey water and their average was taken. The grey water used was taken from settling tank.

Table 3: Values of COD for grey water taken from filtration tank

Sample	DF	M	V_B-V_S	COD
1	1	0.025	4	80
2	1	0.025	6	120
3	1	0.025	7	140
Average				113

Table 3 shows the values of COD which were found for three samples of grey water and their average was taken. The grey water used was taken from filtration tank.
There was a reduction in the COD of greywater when we compare the values of the initially calculated COD which was taken from the settling tank and the COD of the grey water taken from the filtration tank. A reduction of 87% in COD can be seen in the first sample.

B. Effect on BOD

Table 4: Values of BOD_5 for initial and final

Sample	BOD_5 initial	BOD_5 final
1	300	82
2	310	88
3	292	75
Average	301	82

The BOD5 for all the samples was reduced when comparing the initial sample taken from the settling tank and the final sample taken from the filtration tank as can be seen in table 4. A reduction of 72.6 % can be seen in the first sample. The same is true for all the other samples.

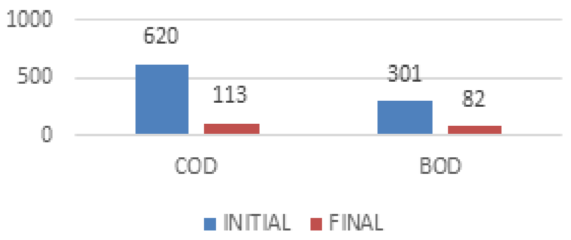

Figure 6: Initial and final values of COD and BOD

The graph 6 represents the values of COD and BOD both for grey water samples taken at the start and at the end. The values of COD and BOD taken initially were both more when compared with of the samples taken at the end of the project. The initial value of COD is 620 and that of final is 113. The initial value of BOD is 301 for initial sample and 82 for final sample.

C. Effect on TDS

Table 5: Values of TDS for grey water taken from settling tank

Description	Weight (g)
Weight (g) W1 of the freshly-cleaned porcelain evaporating dish	36.4329
Weight of the plate plus leftovers (g) W2	36.4501
Remainder weight (g) W	0.0172
Sample Volume, (mL) V	50
Total Dissolved Solids (mg/L) TDS	344

The values need for calculation of TDS can be seen in table 5. The calculation is performed below. The grey water is taken from the settling tank.

Total dissolved solids = Weight of residue $(W_2\text{-}W_1)$ / V
= 36.4501-36.4329/50 = 344 g

Table 6: Values of TDS for grey water taken from filtration tank

Description	Weight (g)
Weight (g) W1 of the freshly-cleaned porcelain evaporating dish	36.4219
Weight of the plate plus leftovers (g) W2	36.4325
Remainder weight (g) W	0.0106
Sample Volume, (mL) V	50
Total Dissolved Solids (mg/L) TDS	212

The values need for calculation of TDS can be seen in table 6. The calculation is performed below. The grey water is taken from the filtration tank.

Total dissolved solids = Weight of residue $(W_2\text{-}W_1)$ / V
= 36.4325-36.4219/50 = 212 g

The value of total dissolved solids in greywater decreased after the water is passed through wetland unit and filtration tank. The value decreased from 344 mg/l to 212 mg/l which is a decrease of about 38.37%.

D. Effect on TSS

Table 7: Values of TSS for grey water taken from settling tank

Description	Weight (g)
Weight (g) W1 of the freshly-cleaned porcelain evaporating dish	36.416
Weight of the plate plus leftovers (g) W2	36.4266
Remainder weight (g) W	0.0118
Sample Volume, (mL) V	50
Total Dissolved Solids (mg/L) TSS	236

The values need for calculation of TSS can be seen in table 7. The calculation is performed below. The grey water is taken from the settling tank.

Total suspended solids = Weight of residue $(W_2\text{-}W_1)$ / V
= 36.4266-36.416/50 = 236 g

Table 8: Values of TSS for grey water taken from filtration tank

Description	Weight (g)
Weight of the clean porcelain evaporating dish (g) W_1	36.4178
Weight of the dish and the residue (g) W_2	36.4283
Weight of residue(g) W	0.0083
Volume of the Sample (mL) V	50
Total Dissolved Solids (mg/L) TSS	166

The values need for calculation of TDS can be seen in table 8. The calculation is performed below. The grey water is taken from the filtration tank.

Total suspended solids = Weight of residue $(W_2\text{-}W_1)$ / V
= 36.4283-36.4178/50 = 166 g

The values of Total dissolved solids were less for greywater for water taken from the filtration tank when compared with greywater from the settling tank. The reduction in TSS is about 29.6%.

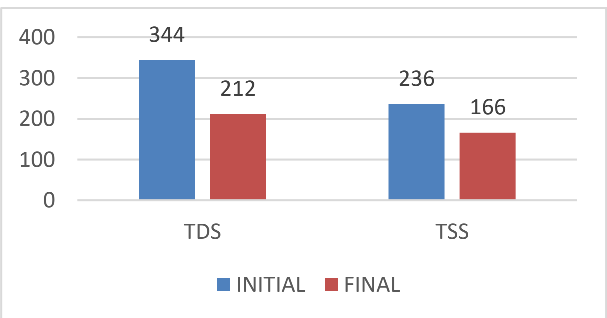

Figure 7: Initial and final values of TDS and TSS

The values of Total dissolved solids and Totals suspended solids are represented in the Figure 7. There is a decrease in the value of TDS and TSS. The initial values for TDS and TSS are 344 and 236 respectively. After the experiment the value for TDS and TSS are 212 and 166 respectively. Thus, a drop in their values can be seen.

E. Effect on pH

Table 9: Values of pH for initial and final water samples

Sample	ph initial	ph final
1	9.02	7.20
2	9.08	7.26
3	8.98	7.17
Average	9.02	7.21

The value of Ph for grey water sample taken from the settling tank is 9.02 as shown in table 9. The sample taken from the filtration tank, has a value of 7.21. The settling tank is the initial sample and filtration tank is the final sample as can be seen in table 9.

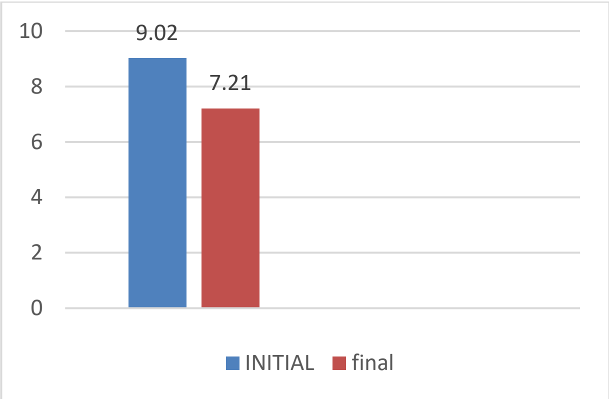

Figure 8: Initial and final values of pH

From the figure 8, it can be seen that the value of pH decreased after the treatment of greywater through the wetland unit.

V. CONCLUSION

This project details the use of root zone technique in constructed wetland for the treatment of greywater. Greywater obtained from a building was treated through this method. The whole assembly consisted of settling tank, wetland unit, filtration tank. The wetland unit consisted of various layers of coarse aggregate, fine aggregate, soil and wetland plants. The wetland plants that were used were Colocassia and canaindica. The tests that were performed on both treated and untreated greywater samples were COD, BOD, TDS and TSS. The treated sample after 20 days were used. The tests results show that there is a decrease in all these properties. The decrease in COD was measured at 87%. The decrease in BOD was measured at 72.6%. The decrease in TDS was measured at 38.37%. The decrease in TSS was measured at 29.6%.

Thus, the technique can be used to treat greywater which can be used for purposes other than drinking such as for irrigation, gardening. The method cost less compared to other methods of treatment, costs less to keep it operational and maintain. Compared to other methods of natural treatment of water this technique showed better results.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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