A Project Report on

TREATMENT AND RECYCLING OF GREYWATER IN AIKTC

Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Engineering

By
Shaikh Ayeesha Mohammed Shafi(17CES01)
Mishra Purnanki Shailendra (17CE04)
Naik Janhavi Vikas (17CE05)
Golandaz Nashra Afzal (17CE06)
Under the guidance of

Prof. Irfan Nalband

Department of Civil Engineering

School of Engineering and Technology

Anjuman-I-Islam's Kalsekar Technical Campus New Panvel,
Navi Mumbai-410206

2020-2021

CERTIFICATE

This is to certify that the project entitled **"Treatment and recycling of greywater in AIKTC"**is a bonafide work of **Ayeesha Shaikh, Purnanki Mishra, Janhavi Naik & Nashra Golandaz** submitted to the University of Mumbai in partial fulfilment of the requirement for the award of the degree of "Undergraduate" in "Civil Engineering"

Prof. Irfan Nalband

(Project Guide)

Dr. R. B. Magar

(Head of Department)

Dr. Abdul Razak Honnutagi

(Director, AIKTC)

APPROVAL SHEET

This dissertation report entitled **"Treatment and recycling of greywater in AIKTC"** by **Ayeesha Shaikh, Purnanki Mishra, Janhavi Naik & Nashra Golandaz** is approved for the degree of "Civil Engineering"

Examiners

1. ....

2. ....

Supervisors:

1. ....

2. ....

Date:

Place: Panvel

DECLARATION

We declare that this written submission represents my ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that; we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

SHAIKH AYEESHA 17CES01	…………..
MISHRA PURNANKI 17CE04	…………..
NAIK JANHAVI 17CE05	…………..
GOLANDAZ NASHRA 17CE06	…………..

Date:

ABSTRACT

Safe and sufficient quantity of water is important for a healthy growth of citizenry. The gap between water demand and current water supply is increasing day by day. Proper sanitation, especially decentralized approach, can solve the matter of water system and wastewater management by reuse of greywater. Typically, from an institution, greywater (GW) flow is around 65 % of the total wastewater flow. The light greywater accounts for about 50% of the total GW. Therefore, GW has a high potential for recycling and reuse. The aim of this project is to show the current state of the art in GW treatment and to determine the further scope of research. Treatment systems with different treatment processes are discussed in detail with regard to the efficiency of pollutant removal, sewage concentrations and standards for reuse. Treated greywater can be used for non-potable purposes such as irrigation, toilet flushing, car washing and dust control as well as for recharging aquifers.

CONTENTS

ABBREVIATION NOTATION AND NOMENCLATURE

B	Breadth
BOD	Biochemical Oxygen Demand
C/S	Cross Section
COD	Chemical Oxygen Demand
DIA	Diameter
DO	Dissolved Oxygen
GW	Greywater
L	Length
pH	Potential of Hydrogen
PPM	Parts per million
Q_{max}	Maximum flow
R	Hydraulic Mean Radius of channel
RBC	Rotating Biological Contactor
S	Hydraulic Gradient
TDS	Total Dissolved Solid
TSS	Total Suspended Solid

LIST OF FIGURES

LIST OF TABLES

Chapter 1
INTRODUCTION

1.1 General

Except for toilets, all domestic sewage is called greywater. These include water in showers, bathtubs, dishes and clothes. The amount of greywater varies from family to family. In affluent areas, output can be increased by tenfold. In terms of environmental sanitation, the greywater is separated from the water source of the toilet system, which makes the treatment system simpler than traditional sewage treatment plants.

Greywater is harmless to the environment and sanitation. These problems are usually small and local. However, if handled improperly, greywater becomes a strong source of odour due to its high content of easily degradable compounds. These processes can create anaerobic conditions within a few hours, leading to unpleasant odours. Other treatment goals are to reduce organic pollutants, heavy metals, Pathogens and other microorganisms.

1.2 Composition of greywater

The composition of greywater is very different and reflects the lifestyle of residents and the choice of household chemicals for washing clothes, bathing, etc. Soap and other detergents. Greywater generally contains high levels of easily degradable organic matter such as cooking fat, oil and other residues from soap and other cleaning products. Pathogens only occur in the greywater fraction if they are contaminated with faeces. However, the greywater environment is conducive to bacterial growth, which means that it must be treated before it can be reused. In addition, the untreated greywater becomes slightly anaerobic (exhausted of oxygen), thus producing an unpleasant odour.

1.3 Benefits of Greywater Treatment

Greywater recycling not only reduces water consumption, but also the volume of water discharged into the sewage system. Consumers with water meters could therefore save money on both the water supply and the wastewater bills. Greywater recycling offers many ecological advantages, which can be summarized as follows:

- Reduce fresh water consumption

  In many cases, in areas that need irrigation, greywater can replace fresh water, saving money and improving water supply efficiency. The water consumption of residential buildings is almost equally divided into internal water and external water. This means that much less water is obtained from nature.

- Less strain on tank or treatment plant

  The use of wastewater greatly extends the life and capacity of wastewater treatment plants. For municipal treatment systems, by reducing the flow of wastewater, this means higher treatment efficiency and lower treatment costs.

- High effective purification

  In the biologically most active topsoil region, greywater is treated to a spectacularly high level in order to protect the quality of the natural surface and the groundwater.

- Replenish Groundwater

  The use of greywater in excess of the plant's requirements ensures that the groundwater is recharged.

- Plant growth

  Greywater allows a landscape to flourish in which no water would otherwise be available to support plant growth.

- Recovery of otherwise wasted nutrients

  The loss of nutrients through sewage disposal in rivers or oceans is a subtle but very significant form of erosion. The nutrient recovery in greywater helps maintain soil fertility.

1.4 Uses of Recycled Grey Water

Grey water can be untreated or treated to varying degrees to reduce nutrients and pathogens. The allowable greywater depends on the supply of greywater and the degree of treatment. Recycled water is most commonly used for non-potable (not for drinking) purposes, such as

- Watering Gardens
- Fire Hydrants
- Field Irrigation
- Toilet Flushing
- Concrete Mixing
- Laundry

Chapter 2

LITERATURE REVIEW

2.1 Review of Literature

Grey Water Treatment and its application in cultivation of plants: Bodhisattva Roy Neha Pradhan &Team

In this paper three treatments were done such as Primary treatment (Filtration), Secondary treatment (Aerobic Biological treatment, Bed reactor treatment, Biological nitrogen removal), Tertiary treatment (Removal of solid, Disinfection). From the above treatment process of GW in lab scale, it can be concluded that the treatment process was successfully done and the water yield after the treatment process was nearly found to be 85.6%. The pre-designed filter proved that the materials in the filter are efficient in trapping the impurities and can be used in an industrial scale purpose. After the post chemical treatment, the hardness value for the treated water sample was reduced from 150±7.63 ppm to 55±4.04 ppm. Moreover, 100% germination rate was observed in both the experimental plants V. radiata and Vmungo in comparison to untreated GW where only 70% growth rate was observed.

On-site Grey Water treatment and reuse in multi-storey buildings: E. Friedler, R. Kovalio

In this paper the author presents a study of a pilot plant treating light greywater. The pilot plant combines biological treatment (RBC) with physicochemical treatment (sand filtration and disinfection). The pilot plant produced effluent of excellent quality, meeting the urban reuse quality regulations, and was very efficient in TSS turbidity and BOD removal: 82%, 98% and 96%, respectively.

COD removal was somewhat lower (70–75%) indicating that the greywater may contain slowly-biodegradable organics. The RBC (attached growth biological system) was able to retain most of the solids as a result of bioflocculation; further it was proven to have very stable and reliable performance. Faecal coliforms and heterotrophic reductions were very high (100% and 99.99%, respectively) producing effluent that also met drinking water standards. The combination of low organic matter, nutrients and microbial indicators reduces the regrowth and fouling potentials in the reuse system, thus ensuring safe reuse of the treated greywater for toilet flushing.

Integrated approach for grey water treatment: R. T. Pachkor, Dr. D. K. Parbat

An integrated approach is needed to manage the water and waste water treatment so that water supply is kept clean and waste water is recycled for beneficial use in agriculture and industry. An integrated grey water treatment plant was developed to treat grey water generated in the Shrirampur gram panchayat area. The developed laboratory scale integrated model consists of screening, sedimentation, filter-i, filter-ii, aeration and disinfection units, which is a combination of natural physical operations. The area was divided in three zones for the present study. The major zones of the area such as Gokul Residency (Zone-I), Green Park-I (Zone-II) and Amar Nagar (Zone-III) were taken for the present study. The 564 random samples were collected from kitchen and bathroom considering sources of supply as tap water and borewell water in spring, winter and summer seasons. The performance was showed in terms of reduction competency of water pollutants such as COD (84%), BOD (92%), Coliform (98%), TSS (87%), TDS (76%), Turbidity (64%) and Total hardness (70%). This treatment technology can be considered as a viable alternative to conventional.

A study of the microbial quality of grey water and an evaluation of treatment technologies for reuse: Gideon P. Winward, & Team

Grey water was fed to three constructed wetland systems, a membrane bioreactor (MBR), and a membrane chemical reactor (MCR). The constructed wetlands, established during June 2004, included two reed beds. One reed bed was operated in horizontal flow and the other in vertical flow configuration (VFRB). The third constructed wetland comprised a system of shallow troughs filled with clay and gravel media and a variety of aquatic plants. Aeration was provided through the flow of water down weirs at the end of each row and via a porous pipe at the base of the troughs through which air was bubbled for 1 h each day. The constructed wetlands were fed grey water at a rate of 480 L d^{-1}The treated MBR and MCR effluents were extracted by peristaltic pump. Chemical/physical treatment performance: -BOD removal of 86% COD to 21 and 19mg L^{-1}, high suspended solids removal of 90%, Microbial quality of grey water. Grey water is less polluted as compared to black water. Constructed wetland is efficient compared to other system and more feasible for grey water treatment. MBR are also found effective in removing microorganism that were too large than membrane pore size.

2.2 Summary

Based on findings the following treatments can be considered viable alternative to conventional treatment process since this is of very low energy demand, cost effective, highly effective purification and ground water recharge. It is observed that single method is not capable to meet entire reuse standards but most widely used in flow aerobic sludge blanket method.

Chapter 3

METHODOLOGY

Greywater samples were collected from different locations viz, AIKTC canteen, WC (men/women) of engineering building. Tests were performed on the collected samples i.e., sample 1 & sample 2 respectively. pH, Alkalinity, DO and Hardness was found using respective lab tests. Total number of students, teaching & non- teaching staff was found out. Considering the population, the average quantity followed by maximum quantity of sewage was calculated. The results thereby assisted in further designing of the treatment plant.

Table 3.1: Data collected

DEPARTMENT	POPULATION
Mechanical Department	402
Civil Department	408
E XTC Department	207
Electrical Department	156
Computer Department	243
Non-teaching staff	20
TOTAL	1436=1500

(Population of Engineering Building in AIKTC)

TEST PERFORMED

Figure 3.1: Hardness Test

(Apparatus to determine hardness present in sample by titration with EDTA until changes colour from pink to colourless)

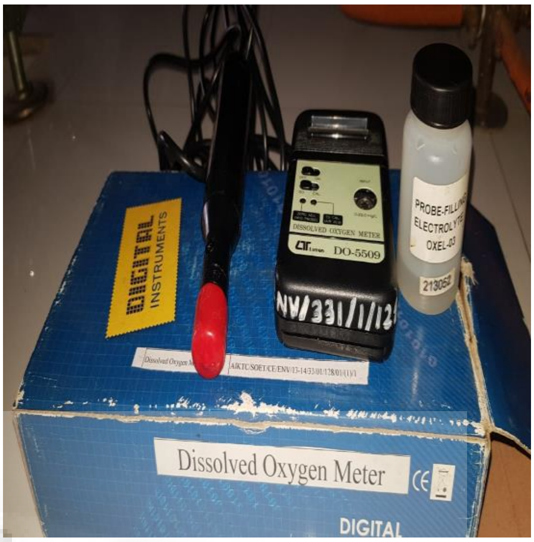

Figure 3.2: DO Test

(It is used to determine the amount of oxygen present in the sample before and after treatment)

Figure 3.3: Alkalinity Test

(It is done by adding P-reagent then add Alk-5 dropwise until colour changes from pink to colourless & with T-Reagent & Alk-10 until colour from green to pink)

Figure 3.4: pH Test

(Digital pH meter was used for testing sample, probe 1st calibrated to pH 7 & then sample was tested)

3.1 Design of treatment plant

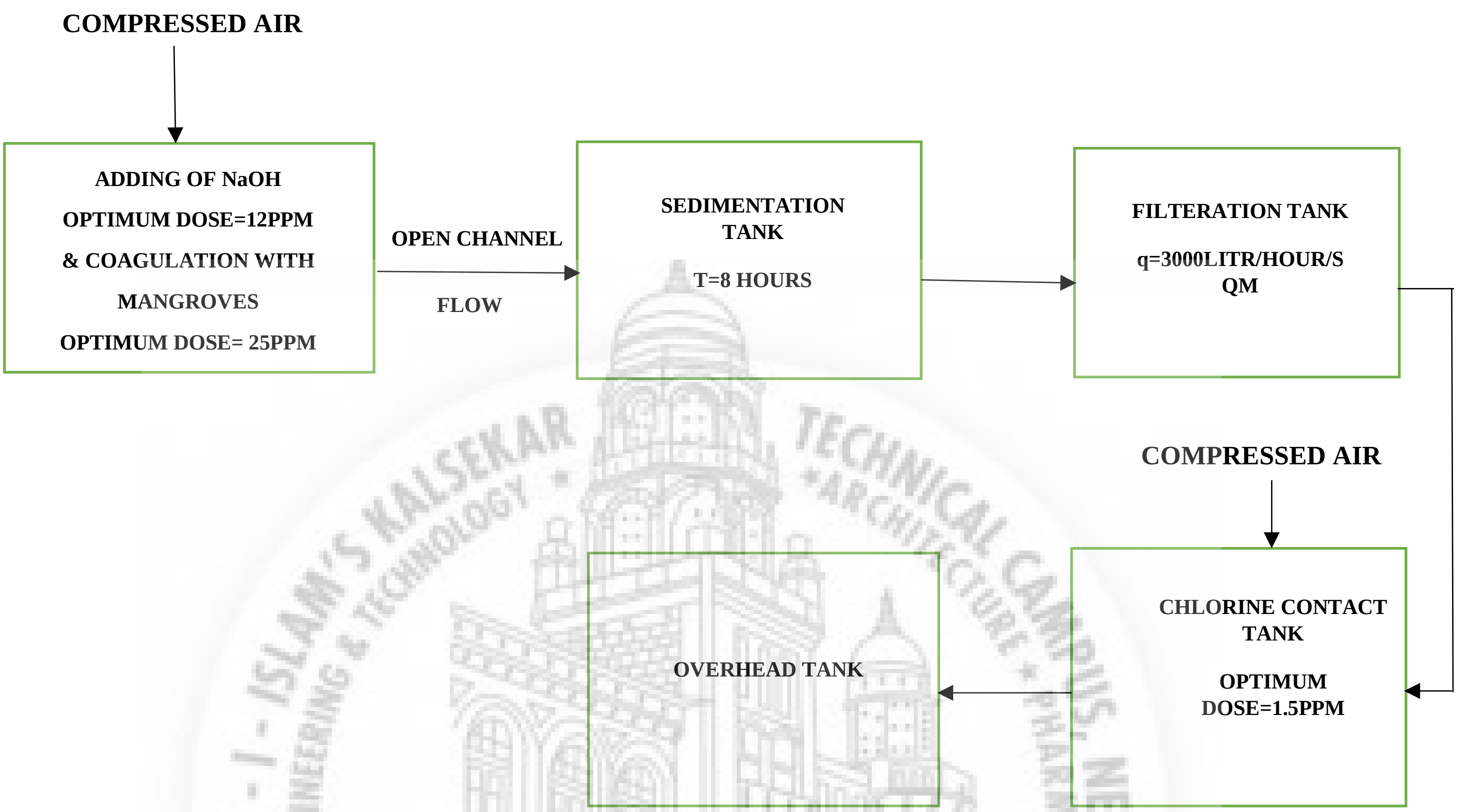

Figure 3.6: Layout of treatment plant

- **Adding of NaOH & Coagulation with mangroves**

  NaOH alkali is added to increase pH and for appropriate coagulation process.

  In coagulation process, mangroves powder is added to untreated water (raw water). When it is mixed with water, the tiny suspended particles stick together or coagulate. These groups of suspended particles stick together and form larger, heavier particles called flocs, which are easier to remove by sedimentation or filtration.

Mixing of NaOH powder and mangroves powder in tank is done by toothed wheel mechanism and then agitate with compressed air.

- **Sedimentation Tank**

Sedimentation is the process of settling suspended substances under the action of gravity. The suspended solids can be particles originally present in the feed water, such as clay or sludge, or they can be flocs usually formed from substances in the water and chemicals used in coagulation. The water and flocs go through the treatment process and enter the sedimentation tank. Here, the water moves slowly, causing a large number of flocs to settle at the bottom, and "clean" water flows out of the tank. The flocs collected at the bottom of the water tank is called sludge.

- **Filtration Tank**

The water from the sedimentation process flows through a filter to remove the particles inside. Filters are made up of layers of sand, gravel, and charcoal. Filtration collects impurities suspended in the water, which improves the effectiveness of disinfection. There are two basic types of sand filters: Slow sand filter and Rapid sand filter. We use a rapid sand filter. The rapid sand filter removes suspended matter from the water. The rapid sand filter is much more common because it has fairly high flow rates and takes up relatively little space to operate.

- **Chlorine Contact Tank**

  Disinfection is carried out by chlorination in a contact tank. During chlorination, chlorine or chlorine compounds such as sodium hypochlorite are added to water. This method is used to kill bacteria, viruses, and other microbes in the water. In particular, chlorination is used to prevent the spread of water-borne diseases such as cholera and typhoid.

3.2 Calculation of different units

- **Maximum Daily Flow**

  Population= 1575 (1500+5% of P)

Table 3.2: Values of per capita water demand & sewage production

SR NO (1)	POPULATION (2)	PER CAPITA WATER IN DEMAND LITER/DAY/PERSON (Q) (3)	PER CAPITA SEWAGE PRODUCTION LITER/DAY/PERSON ($Q^{/}$) =80%of col (3) (4)
1	Less than 20,000	110	90
2	20,000-50,000	110-150	90-120
3	50,000-2 lakhs	150-180	120-150
4	2 lakhs-5 lakhs	180-210	150-170
5	5lakhs-10lakhs	210-240	170-190
6	Over 10 lakhs	240-270	190-200

(Variations in per capita water demand and sewage production with population, in India)

Per capita sewage demand ($Q^{/}$) =90 litres/day/person (Table3.2)

Average quantity of sewage produced (Q_{avg}) =Population x $Q^{/}$

= 1575 x 90

= 141750 litres/day

Q_{avg} = 1.64 x 10^{-3} cumec

Q_{max} = 1.5 x Q_{avg}

= 1.5 x 1.64 x 10^{-3}

Q_{max} = 2.46 x 10^{-3} cumec = 212625lit/day

- **Quantity of NaOH**

Q_{max}=212625lit/day

Assuming dose rate=12ppm

Quantity of NaOH= Q_{max} x Dose rate

= 212625 x 12 x 10^{-6}

Quantity of NaOH = 2.551 kg/day

Cost of NaOH powder= Rs 50/kg

Total cost=2.551 x 50= Rs 127.57/day

- **Quantity of coagulant (mangroves)**

Q_{max}=212625lit/day

Assuming dose rate=25ppm

Quantity of coagulant= Q_{max} x Dose rate

= 212625 x 25 x 10^{-6}

Quantity of coagulant = 5.315 kg/day

- **Sedimentation Tank**

Diameter of pipe= 15cm

Q_{max}=2.46 x 10^{-3} cumec

Assume t=8hrs

We have use Crimp and Burge's formula for calculating velocity

Assume S=1:450, R=d /4

V= 83.47 $R^{2/3}$ $S^{1/2}$

= 83.47 $(0.15/4)^{2/3}$ $(1/450)^{1/2}$

=0.45m/s

Volume= Q max x time

=2.46 x 10^-3 x (8 x 3600)

Volume =70.84m³

Let L=4B, H=2m

Volume= cross section area x height of tank

70.84 = $4B^2$ x 2

B=2.97=3m

L=4 x 3 =12m

Dimension of sedimentation tank= 12m x 3m x 2m

- **Filtration Tank**

We have designed **Rapid Sand Filter**

Q_{max}=212625 lit/day

Assuming rate of filtration (q_f) as 3000 lit/hr/m^2

$q_f = 3000 \times 24 = 72000 lit/m^2/day$

$As = Q_{max} \div q_f$

$As = 212625 \div 72000$

As=2.95m^2

$L \times B = As$

$1.5B \times B = 1.475$

B=0.99 (approx. 1)

B=1m

$L = 1.5 \times 1 = 1.5m$

Dimension of Filtration tank =1.5m×1m

Design of Underdrainage System

Total C/S area of perforation Ap = 0.2% As

$= (0.2 \div 100) \times 1 \times 1.5$

$\mathbf{Ap = 3 \times 10^{-3}\ m^2}$

C/S area of each lateral pipe$= 2 \times A_P$

$= 2 \times 3 \times 10^{-3}$

$= 6 \times 10^{-3}\ m^2$

$a_l = \pi \div 4 \times dia_l^2$

$6 \times 10^{-3} = \pi \div 4 \times dia_l^2$

$\mathbf{dia_l = 0.087m = 8.7cm}$

Adapting spacing between lateral=0.15m or 15cm

No of lateral (NL)=2×(length/spacing) =2× (1.5/0.15) =20laterals

C/S area of manifold (A_{mf})=2×al

A_{mf}=2×6×10^-3

A_{mf}=0.012 m^2

$A_{mf}=\pi\div4\times dia_{mf}^2$

$0.012=\pi\div4 \times dia_{mf}^2$

dia_{mf}^2=0.124m

Length of lateral pipe= (width- dia_{mf}) /2

= (1-0.124)/2=0.438m

$A_p=3\times10^{-3}m^2$

Adopt $dia_{strainer}$= 0.01m

$a_p=\pi\div4\times0.01^2$

$a_p=7.853\times10^{-5}m^2$

Total no of perforation holes=$A_p \div a_p$

$= (3\times10^{-3}) \div (7.853 \times10^{-5})$

=38holes

No of holes present in each lateral=No of perforation/No of laterals

= 38/20

No of holes present in each lateral = 2 holes

Check= $L_L \div dia_L < 60$

$2.78/0.087 < 60$

$31.95 < 60$

Therefore, ok

- ## Chlorine Contact Tank

We will design circular tank

Volume=70.84m^3(from sedimentation tank)

Let depth=1.5m

C/S Area=Volume/depth=70.84/1.5=47.22m^2

Area= $\pi \div 4 \times dia^2$

47.22= $\pi \div 4 \times dia^2$

Diameter=7.75m

- ## Quantity of Chlorine

Q_{max}=212625lit/day

Assuming dose rate=1.5ppm

Quantity of Chlorine=Q max x Dose rate

=212625x1.5x10^{-6}

Quantity of Chlorine=0.3189 lit/day

Cost of Liquid Chlorine=Rs 25/lit

Total cost =0.3189x 25 =Rs 7.97/day

- **Overhead Tank**

Volume=70.84m^3(from sedimentation tank)

Let depth=2.5m

C/S Area=Volume/depth=70.84/2.5=28.34m^2

Let L=1.5B

L x B=28.34

1.5B^2=28.34

B=4m L=1.5 x 4= 6m

Overhead Tank Dimension=6m x 4m x 2.5m

CHAPTER 4

RESULTS AND DISCUSSION

4.1 RESULT BEFORE TREATMENT

Table 4.1: Result before treatment

TEST	GREYWATER	SULLAGE
pH	5.95	4.87
ALKALINITY	70ppm	180ppm
DO	5.4	4.4
HARDNESS	100ppm	144ppm

(The above table shows test values of GW and Sullage before treatment)

4.1.1 RESULT AFTER TREATMENT

Table 4.2: Result before treatment

TEST	GREYWATER	SULLAGE
pH	6.3	5.1
ALKALINITY	90ppm	190ppm
DO	5.7	4.8
HARDNESS	115ppm	150ppm

(The above table shows test values of GW and Sullage after treatment)

Figure 4.1: Test Results

(Values of pH and Hardness test)

CHAPTER 5
CONCLUSION

- During this project different experiments were performed like pH, Alkalinity, DO, Hardness, etc. Below are the results for before and after treatment.
- The pH of greywater and sullage was found to be 5.95 & 4.87 respectively. As both the samples are highly acidic, these cannot be used for irrigation & laundry purpose. But after treatment the pH of greywater and sullage was found to be 6.3 & 5.1respectively. This water can be used for flushing.
- The alkalinity of water as evaluated for greywater and sullage was found to be 70ppm & 180ppm respectively. But after treatment the alkalinity of water as evaluated for greywater and sullage was found to be 90ppm & 195ppm respectively.
- The DO as evaluated for greywater and sullage was found to be 5.4 & 4.4 respectively. But after treatment the DO as evaluated for greywater and sullage was found to be 5.7 & 4.8 respectively.
- The hardness of water for greywater and sullage was found to be 100ppm & 144ppm respectively. But after treatment the hardness of water for greywater and sullage was found to be 115ppm & 150ppm respectively.
- If we have used greywater without treatment, it may cause unpleasant smell, infection. But we have treated greywater & sullage water and converted into a reusable form. This water after conversion can be used maximum for a week for different purpose such as gardening, flushing, performing experiment in different labs.

REFERENCE

[1] Santosh Kumar Garg, 2017, "Sewage Disposal and Air Pollution Engineering", Khanna Publisher, Environmental Engineering Vol II

[2] Surjit Singh, Neha Pradhan, Nupur Ojha, Bodhisattva Roy and Sutapa Bose, 2016, "Grey Water Treatment and its application in cultivation of plants", Asian Jr. of Microbiol. Biotech. Env. Sc. Vol. 18, No. (4): 2016: 1043-1053 © Global Science Publications.

[3] E. Friedler, R. Kovalio, 2005, "On-site Grey Water treatment and reuse in multi-storey buildings".

[4] R. T. Pachkor, Dr. D. K. Parbat, "Integrated approach for grey water treatment Volume 5 Issue IV, April 2017 IC ISSN: 2321-965.

[5] Gideon P. Winward, Lisa M. Avery, Ronnie Frazer-Williams, Marc Pidou, Paul Jeffrey, Tom Stephenson, Bruce Jefferson.

[6] March JG, Gual M, Orozco F (2004) Experiences on greywater re-use for toilet flushing in a hotel. Desalination 164:241–247.

[7] Al-Hamaiedeh H, Bino M (2010) Effect of treated grey water reuse in irrigation on soil and plants. Desalination 256:115–119.

[8] Hernandez Leal L, Temmink H, Zeeman G, Buisman CJN (2011) Characterization and anaerobic biodegradability of grey water. Desalination 270:111–115.

[9] Lamine M, Bousselmi L, Ghrabi A (2007) Biological treatment of grey water using sequencing batch reactor. Desalination 215:127–132.

[10] Prof. A. B. Shelar1, Ms. Shradha M. Kalburgi May 2019 Research Paper on Treatment of Grey Water using Low-Cost Technology for Kushvarta Kund Water International Research Journal of Engineering and Technology (IRJET).

FUTURE SCOPE

- Use of Mangroves

  Mangroves used in the treatment unit are to attain economy at the stage. As per future scope of the project alternatives can be used.

- Use of Sedimentation tank

  For cleansing sedimentation tank racking arm or agitation can be considered. Accordingly, sludge can be pumped out using mud or diaphragm pump.

ACKNOWLEDGEMENT

We would like to acknowledge the great contribution and support we received in this endeavour from our project guide **Prof. Irfan Nalband** and the head of department of Civil Engineering **Dr. R. B. Magar**, for this project "**TREATMENT AND RECYCLING OF GREY WATER IN AIKTC**".

Our special thanks to **Dr. Abdul Razzak Honnutagi, Director, AIKTC, New Panvel** for his encouragement during the project, we are also thankful to all teaching and non-teaching staffs of Civil Engineering Department.

Finally, we thank all the unmentioned names and invisible hands who helped us in bringing this project report to the present form.