An Experimental Approach to Treat Greywater using Activated Carbon of Rice Husk

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Abstract: *Water is the lifeblood of our existence, an essential elixir that sustains all living beings in myriad ways, from nourishing crops to powering industries and quenching our thirst for innovation. The vitality and richness of ecosystems hinge upon the movement of the tide and flow of water's presence. With a staggering 97.2% of our planet's water reserves locked in saline embrace within the vast oceans, the precious 2.8% of freshwater, a mere trickle in comparison, dances between surface waters and hidden aquifers. As humanity burgeons, stretching the seams of global population, the chasm widens between our thirst for freshwater and its dwindling supply. Thus, the clarion call to safeguard our freshwater reservoirs and ingeniously repurpose wastewater echoes across continents.*

Keywords: Carbon, Gray Water.

I. INTRODUCTION

Water is the lifeblood of our existence, an essential elixir that sustains all living beings in myriad ways, from nourishing crops to powering industries and quenching our thirst for innovation. The vitality and richness of ecosystems hinge upon the movement of the tide and flow of water's presence. With a staggering 97.2% of our planet's water reserves locked in saline embrace within the vast oceans, the precious 2.8% of freshwater, a mere trickle in comparison, dances between surface waters and hidden aquifers. As humanity burgeons, stretching the seams of global population, the chasm widens between our thirst for freshwater and its dwindling supply. Thus, the clarion call to safeguard our freshwater reservoirs and ingeniously repurpose wastewater echoes across continents.

From the hilly regions with grass to the urban areas, the renaissance of wastewater recycling surges forth, a beacon of hope amid the parched earth and dwindling aquifers. This aqueous alchemy serves a multiplicity of purposes, from quenching the thirst of parched fields to shielding the sanctity of our environment and public health. A symphony of recycled wastewater orchestrates the saving grace for our freshwater reserves. Its applications, as diverse as the tapestry of human endeavour, span from irrigating fields to adorning urban realms with verdant oases. Rainwater and greywater, hailed as urban saviours, offer a glimpse into a sustainable future.

Wastewater is a type of wastewater that is generated within the household due to human activities. It includes bathtubs, kitchen sinks, bathroom sinks, toilets and laundry wash water sources. This wastewater is also called as domestic sewage. It can be categorized into two categories as Blackwater and Greywater, based on its level of contamination and organic loading.

- Blackwater: Blackwater is the wastewater that is generated from urinals and toilet fixtures. It is highly contaminated with particulate matter and dissolved chemicals. It is very difficult to recycle and reuse black water.
- Greywater: Greywater is generated from laundry machines, showers, bathtubs, kitchen sinks, or any other water which has been used at residence, except from urinals and toilets. It gets its name from its colour, as neither being fresh nor heavily contaminated and also due to its cloudy appearance. It is less contaminated and differently treated compared to black water. It is usually suitable for reuse.

In the dynamic mosaic of India's water landscape, the narrative of abundance juxtaposes the stark reality of scarcity. A canvas adorned with 4000 billion cubic meters of freshwater annually tells a tale of potential, yet only 28% of this aqueous bounty dances into the embrace of utility. The rest dissipates into the ether, lost to the sky's thirst or swallowed

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by the voracious oceans. Groundwater, a hidden treasure trove, contributes 433 billion cubic meters, while surface waters, flowing in majestic rivers and tranquil streams, offer 690 billion cubic meters of liquid sustenance. Yet, the balance hangs on the precarious edge of variability, swayed by capricious rainfall, climatic shifts, and geographical proximity to rivers. As the chronicles of time unfurl, the demand for this elixir surges, from 634 billion cubic meters in the year 2000 to a projected 1093 billion cubic meters by 2025, and a daunting 1447 billion cubic meters by the distant horizon of 2050. Thus, the narrative foretells an impending crescendo of scarcity, where the preciousness of water will resonate louder in the ears of generations to come.

1.1 GREY WATER

Greywater, a humble yet potent elixir, flows from our homes, a testament to our daily rituals and routines. Born from kitchen sinks and shower streams, it embodies the essence of domesticity, a liquid memoir of our existence. Ranging from a modest trickle to a gushing cascade, greywater forms the lifeblood of households, composing a substantial portion of our wastewater tapestry. In the crucible of urbanization and industrial evolution, the imperative to recycle and reuse greywater burgeons, especially in the crucible of developing nations.

Amid the crescendo of population growth, the refrain of climatic tumult, and the urban symphony of progress, the refrain of recycling greywater reverberates with urgency. From nurturing verdant gardens to cleansing the porcelain sanctuaries of our homes, greywater's renaissance paints a portrait of sustainability. As its currents mingle with the vast ocean of sewage, its recycling breathes new life into our waterways, reducing the tide of waste and nourishing the seeds of tomorrow's abundance.

1.1.1 SOURCES OF GREY WATER

In general, 50-80% of the domestic wastewater is greywater, which contributes a larger amount of the total residential wastewater in terms of quantity. Its composition may vary from one house to another depending on the living standards and type of food consumed, mainly constituting water from the kitchen, bathroom, and clothes washing as shown in Fig 1.1.

- Grey water from kitchen: The water utilized in the kitchen accounts for approximately 10% of the total greywater and is noted as the most contaminated form. It is heavily laden with physical impurities such as food particles, fats, oils, and other organic materials, as well as chemical contaminants like soaps, detergents, and cleaning agents. Therefore, kitchen greywater should undergo appropriate treatment before reuse.
- Grey water from laundry: The water employed in laundry activities contributes to approximately 25-35% of the overall volume of greywater. It could contain various substances such as soaps, detergents, paints, oils, and solvents. Additionally, there might be fecal contaminants present, including bacteria and pathogens. The mixture of greywater from laundry can differ between wash cycles, from initial rinse to subsequent rinses, exhibiting varying compositions.
- Grey water from bathroom: Bathroom greywater typically constitutes approximately 50-60% of the overall greywater volume and is generally regarded as the least contaminated type. Among its constituents, soap emerges as the primary chemical pollutant, prevalent in bathing and washing activities. Additionally, contaminants such as those from hair dyes, toothpaste, shampoo, and various cleaning agents contribute to its composition. It's worth noting that bathroom greywater can also harbour traces of faecal matter, particularly introduced during body washing processes as shown in Fig 1.2.

1.1.2 BENEFITS OF RECYCLING GREYWATER

There are several benefits of recycling the grey water out few are discussed below:

- Water Conservation: Greywater recycling reduces freshwater consumption by reusing water from activities like bathing, laundry, and dishwashing for irrigation or toilet flushing.
- Cost Savings: By recycling greywater, households and businesses can lower their water bills by reducing reliance on potable water for non-potable purposes.

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- Environmental Impact: Greywater recycling helps alleviate the strain on freshwater sources, thereby reducing the environmental impact associated with water extraction and treatment.
- Improved Soil Health: Greywater contains nutrients like nitrogen and phosphorus, which can enhance soil fertility when used for irrigation, promoting healthier plant growth.
- Reduction of Wastewater Discharge: By diverting greywater from the sewer system, recycling reduces the volume of wastewater requiring treatment, thereby easing the burden on sewage treatment plants.
- Drought Resilience: Greywater recycling can help mitigate the effects of drought by providing an alternative water source for non-potable uses during water scarcity periods.
- Localized Water Supply: Recycling greywater on-site reduces the need for centralized water distribution systems, promoting more localized water management and resilience.
- Educational Opportunities: Greywater recycling initiatives raise awareness about water conservation practices and encourage responsible water use among communities and individuals.

1.1.3 USES OF RECYCLED GREYWATER

The uses of grey water can be adopted in many fields as follows:

- Landscape Irrigation: Greywater can be used to water gardens, lawns, and landscaping, reducing the need for freshwater irrigation and promoting sustainable landscaping practices.
- Toilet Flushing: Treated greywater can be used to flush toilets, replacing potable water typically used for this purpose and conserving freshwater resources.
- Laundry and Dishwashing: Greywater can be reused for washing clothes and dishes in washing machines and dishwashers, reducing overall water consumption.
- Outdoor Cleaning: Greywater can be used for tasks such as washing vehicles, outdoor surfaces, and outdoor equipment, providing an alternative to potable water for cleaning purposes.
- Cooling Systems: Greywater can be used in cooling systems for industrial processes or air conditioning units, reducing the demand for freshwater in these applications.
- Groundwater Recharge: Treated greywater can be used to replenish groundwater reserves through infiltration or subsurface irrigation methods, contributing to groundwater recharge efforts.
- Construction and Dust Control: Greywater can be used for construction activities, such as dust control on construction sites or mixing with concrete, reducing the need for freshwater in these applications.
- Fire Protection: In some cases, treated greywater can be used for fire protection systems, such as sprinkler systems, where potable water may not be necessary.
- Industrial Processes: Greywater can be utilized in various industrial processes that do not require potable water, such as manufacturing, cooling, or cleaning applications, reducing freshwater demand in industrial settings.
- Educational and Research Purposes: Recycled greywater can be used in educational institutions and research facilities to study water reuse technologies, water quality monitoring, and sustainable water management practices.

1.2 PRESENT STUDY

As the population is increasing day by day there is a shortage of fresh water for the daily demand of the public. This can be reduced by recycling the used water coming from kitchens, laundry and bathroom etc. The greywater is collected from the RYMEC college canteen in a container and brought to the laboratory and preliminary test are conducted to determine the characteristics of the sample. Meanwhile the filter media is prepared using coarse and fine aggregates and activated carbon by rice husk, the carbon is activated with NaoH and KOH solutions. Then the water sample is passed through the prepared filter media and collected and tested again, in which we found that there is an improvement in various characteristics of the greywater. This filtered water can be used for vehicle washing, cooling water in industries, outdoor cleaning, toilet flushing etc.

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1.2.1 OBJECTIVES OF THE PRESENT STUDY

The study on greywater treatment has been initiated with the following comprehensive objectives for the present study:

- To examine the characteristics of collected greywater sample.
- To prepare activated carbon from rice husk.
- To design a laboratory scale greywater treatment unit.
- To analysis the efficiency of greywater treatment unit.

1.2.2 SCOPE OF THE FURTHER STUDY

In the present study includes designing, fabricating and installing a greywater treatment unit at a laboratory scale to study its performance over a period of time for various hydraulic and organic loadings, and to suggest a typical greywater recycling plant for urban households. The project can be taken further by varying the thickness of the filter media and the study can also be done by using different materials for preparation of filter bed and activated carbon, and compare the results with present study to know the working efficiency of the treatment unit.

1.3 CLOSURE

In the current chapter we have discussed about the brief introduction of grey water, sources of water in India, wastewater and its types, sources of wastewater, the benefits of recycling greywater and its uses, objectives and scope of the present study. In the next chapter, details about various journals referred for the present study and the materials used for the filtration of the greywater are discussed.

II. LITERATURE SURVEY AND MATERIALS USED

In the previous chapter we have discussed about introduction of grey water, sources of water in India, wastewater and its types, sources of wastewater, the benefits of recycling greywater and its uses, objectives and scope of the present study. And in the present chapter we will be discussing regarding the journals referred and the materials used for filtration.

2.1 LITERATURE SURVEY

Journals referred for better understanding the concept and procedure of greywater treatment are discussed in below paragraphs.

J. S. LAMBE and R. S. CHOUGULE (2015) studied the treatment and reuse process of greywater coming from households. In this study the authors have studied chemical and biological characteristics of grey water from bathroom, cloth washing, kitchen etc. A brief of generation of grey water from different sources are gathered, they studied the requirement of treating the greywater and reusing it for daily needs of the public. After studying the characteristics of collected greywater, they have developed an optimum method for filtration and treatment procedure at household level and the quantity of greywater generated from households along with there BOD, pH value, alkalinity, solids etc are determined. By using gravel and fine sand as filter media, reduce the freshwater consumption, less strain on septic tank, reclamation of nutrients, saving 750 to 1000 litres of water per day in residential schools/hostels. Recycled grey water is used for toilet flushing and gardening.

AZADEH GHADIMI and L. H. CHANG (2018) has come with an initiative of treating the grey water at industrial scale as the lack of treatment at household scale. Grey water contains bacteria, total suspended solids, oil and grease. Meshes are used to remove all the floating matter, chemicals are used to neutralize the bacteria and increase the size to filter out the coagulated matter, microorganisms are used to convert the bacteria into gas, water, and biomass. The treatment mainly consists of chemical and biological treatment. The design for this project is inspired from the existing industrial scale water recycling system, the existing system are slow sand filtration, membrane bioreactor and water treatment with clarifiers. The design is evaluated by comparing the treated water with standard fresh water for flushing, water quality is compared by measuring the total suspended solids (TSS), chemical oxygen demand (COD). 3D models and prototypes are made to study the greywater treatment efficiently. The grey water treatment package is designed with in 6m^3 including collection tank, slow sand filtrations is designed based on volumetric flow rate and Darcy's law. The COD of treated water is 40 mg/L whereas the required COD for toilet flushing is less than 30mg/L, the turbidity of treated water is less than 5NTU, the total suspended solids treated water is 3.33mg/L. The COD requirement was not able to fulfilled because of the small-scale prototype.

M. Seenirajan, et. al (2018) they probe the treatment of grey water and studied the characteristics like grey water composition, physical characteristics, chemical characteristics of grey water, salinity and sodium absorption ratio (SAR), biological and chemical and oxygen demand (BOD, COD), oil and grease (O AND G), surfactants and other household chemicals anaerobic and anaerobic treatment method, temperature, suspended solids, pH and alkalinity, nutrients. Water is a basic resource for lives on earth. It may use directly or indirectly in every domain, like in agriculture, domestic consumption, urban endeavours and industry. In the natural environment, the diversity and health of the ecosystems is depended on water. They probe grey treatment options like physical, chemical, and biological treatment system. Treating of grey water reduces the effects of its harm and thus increasing its usability, Characteristics of water obtained after conducting test are BOD = 64mg/L, COD = 2078.4ppm, sulphate = 100ppm and total suspended solids = 648ppm. After treatment the water, thus obtained, is clean and safe for use.

Kamal Rana. e.t.al (2014) embarked on a pioneering mission to address the dearth of greywater treatment at the household scale by scaling up operations to an industrial level. Greywater, a repository of bacteria, suspended solids, oil, and grease, posed a formidable challenge. Their ingenious solution employed a multifaceted strategy: employing meshes to sift through the surface, chemicals to neutralize bacteria while enhancing coagulation for effective filtration, and harnessing the power of microorganisms to transform bacterial constituents into gas, water, and biomass. This comprehensive treatment approach seamlessly integrates both chemical and biological methodologies. Drawing inspiration from established industrial water recycling systems such as slow sand filtration, membrane bioreactors, and clarifier-based treatments, their design stands as a testament to innovation. Validation of their approach comes through meticulous comparison of treated water against the gold standard of freshwater, assessing parameters like total suspended solids (TSS) and chemical oxygen demand (COD) to ensure water quality meets stringent standards for flushing and beyond.

A.B. Shelar et al. (2021) delve into a labyrinth of methodological inquiries, navigating through a tapestry of innovative approaches such as stabilization tanks, root zone wastewater treatments, winnowing sieve filtration, Jempeng stone filtration methods, and horizontal flow coarse media filters, among others. Their exploration into greywater generation illuminates the profound impact of societal norms and behaviours on water attributes. By segregating greywater from blackwater, they mitigate the risks posed by pathogens, underscoring the critical role of water usage habits in shaping environmental health. Through a meticulous examination of greywater qualities across various categories, they unveil the nuances of kitchen greywater and its unique characteristics. Employing an array of filters ranging from traditional sand and gravel setups to avant-garde configurations utilizing marbles, jute coir, and even a blend of maize and activated carbon, their innovative filtration systems redefine the boundaries of water purification. Among their arsenal of filtration methods, downstream hanging sponges stand out as a beacon of ingenuity, epitomizing their commitment to pushing the boundaries of water treatment technologies.

2.2 MATERIALS USED FOR THE PRESENT STUDY

The various materials are used in the filtration process. For the present study, materials used for filter media in preparation of a laboratory scale greywater treatment unit are shown in Fig 2.1 and the same are listed below.

- Coarse aggregate
- Fine aggregate
- Rice husk

Coarse aggregate: The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available coarse aggregate having the maximum size of 10 mm was used in our work. The aggregates were washed to remove dust and dirt and were dried to surface to dry condition. The aggregates were tested as per Indian Standard Specifications IS:383-1970. Aggregate filters media are effective in removing sediment and heavy metals from waste water and less effective in removing dissolved nutrients. Gravels constitute the majority of coarse aggregate. Gravel makes good water filters because they form permeable layers. When the sand particles are next to one another, there are tiny spaces between them. Water can pass slowly through these tiny spaces and some of the dirt particles get trapped.

Fine aggregates: The sand used for the experimental programmed was locally procured and conformed to Indian Standard Specification IS:383-1970. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and then was washed to remove the dust. Fine Aggregate are essentially any natural sand particles won from the land through the mining process.

Rice husk: Rice husk are the coatings of seeds, or grains, of rice. The husk protects the seed during the growing season and is formed from hard materials, including opaline silica and lignin. The hull is hard to eat or swallow and mostly indigestible to humans because of its enriched fibre components. Rice husk is a by-product of agricultural products. Rice husk is burned to produce activated carbon that has pozzolan properties. Rice husk can be used for water filtration due to their high silica content, which makes them effective at filtering out impurities present in the water.

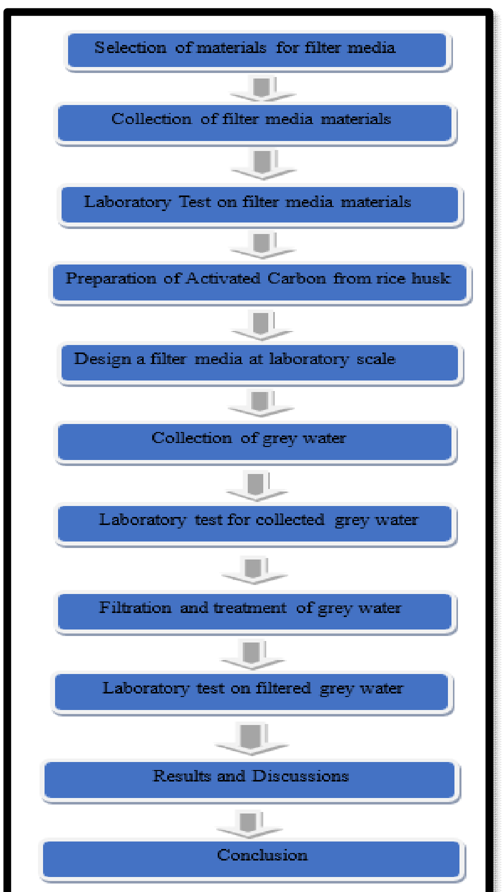
2.3 CLOSURE

In the present chapter we have discussed regarding the literature review and the materials used for the project. In the next chapter we will be discussing about the materials in detail and methodology.

III. METHODOLOGY

In the previous chapter, details of literature survey and materials used in the present study is discussed. In this chapter, methodology adopted in the present study based on is discussed.

Based on the information available from literature survey, a greywater treatment unit can be developed to treat the greywater from urban households. The design of the treatment unit will be based on the quality and quantity of greywater generated. In the present study, a lab scale greywater treatment unit is developed to study its performance in treating greywater. The methodology adopted for the same is presented in below flowchart



3.1 MATERIALS USED FOR FILTER MEDIA IN PREPARATION OF GREYWATER TREATMENT UNIT

Materials used for filter media in the preparation of a laboratory scale treatment unit for the present study are procured from local dealers are as listed below:

- Coarse aggregate.
- Fine aggregate.
- Rice husk.

The detailed discussion on materials used for filter media is discussed in Section 2.2.

- Coarse Aggregate: It is often used as a coarse filter media layer in multi-layer filtration systems. For the present study, 50 kg of coarse aggregate is used.
- Fine Aggregate: It is one of the most commonly used filter media in greywater treatment systems. It effectively removes suspended solids, organic matter, and some pathogens through physical straining and adsorption. For the present study, 25 kg of fine aggregate is used.
- Rice husk: Rice husk is used in the preparation of Activated carbon, as activated carbon highly effective in adsorbing organic compounds, odours and certain chemical traces present in greywater. For the present study, 17 kg of rice husk is used.

3.2 LABORATORY TESTS ON MATERIALS USED FOR FILTER MEDIA

Different tests are conducted on all the materials of filter media for the preparation of a lab scale treatment unit are discussed below.

- Coarse aggregate: Coarse aggregate passing from sieve size 10 mm and retained on 4.75 mm is washed thoroughly with water and oven dried for 24 hours. Specific gravity and water absorption tests were conducted. The results of the laboratory tests on coarse aggregate are tabulated in Table 3.1.
- Fine aggregate: Fine aggregate passing from sieve size 2.36 mm is washed thoroughly with water and oven dried for 24 hours. Specific gravity and sieve analysis tests were conducted. The results of the laboratory tests on fine aggregate are tabulated in Table 3.2.

3.3 PREPARATION OF ACTIVATED CARBON USING RICE HUSK

The procedure adopted in the present study for the preparation of activated carbon using rice husk is as follows:

- Rice husk is soaked in water and washed thoroughly, and it has been sun dried for 2 days as shown in Fig 3.1.
- The sun-dried rice husk is kept in the electrical furnace for 500°C temperature to convert the rice husk into ash as shown in Fig 3.2.
- KoH & NaOH solution is prepared using respective pallets. The prepared solutions are mixed with rice husk ash as shown in Fig 3.3.
- Rice husk ash mixed with KoH and NaOH solution is oven dried for 110°C temperature 48 hours. Further, the sample is spread in tray to achieve room temperature.
- Lumps present in the sample is crushed and passed through 425-micron sieve. The sample is washed with distilled water and oven dried at 110°C for 24 hour and then it is spread in tray to achieve room temperature as shown in Fig 3.4. later it is grinded and passed through 425-micron sieve.

3.4 PREPARATION OF LABORATORY SCALE GREYWATER TREATMNET UNIT

In the present study, three grey water treatment units at laboratory scale are prepared as shown in Fig 3.5. Procedure adapted for the same is described below:

- Three number of water cans are cut into two halves. Two number of 10 mm Dia rods are inserted in the bottom half of each can to support the metal mesh, which is provided to support filter bed.
- Bottom layer of filter bed is of Coarse aggregates having size between 6 mm and 10 mm for a depth of 40 mm in each can.
- Fine aggregate passing 2.36 mm sieve are place above coarse aggregate layer for the depth 40 mm in each can.
- Prepared Activated Carbon is spread above the fine aggregate in two cans (Activated Carbon prepared with KoH in one can and Activated Carbon prepared with NaOH in other can) for a thickness of 40mm.

The outline of the filter bed in three grey water treatment units are as follow:
• Treatment unit 1: Coarse aggregates + Sand.
• Treatment unit 2: Coarse aggregates + Sand + Activated Carbon with KoH.
• Treatment unit 3: Coarse aggregates + Sand + Activated Carbon with NaOH.

3.5 COLLECTION OF GREYWATER

For the present study collected the greywater from RYMEC college canteen Ballari, in a container and brought to the laboratory and preliminary test are conducted to determine the characteristics of the sample. Source of collected grey water was rice washed water, vegetables washed water and from kitchen sinks etc as shown in Fig 3.6.

3.6 LABORATORY TESTS ON COLLECTED GREYWATER

Various laboratory tests were conducted on greywater collected from Canteen, RYMEC, Ballari, to analyse following characteristics:
• pH.
• Turbidity.
• Solids.
• Alkalinity.
• Acidity.
• BOD (Biochemical Oxygen Demand).
• Hardness.

3.6.1 pH

pH indicates the acidity or alkalinity of the sample. It's important to know the pH as it can affect the effectiveness of certain treatment processes, such as biological treatment or chemical precipitation. The Electrometric methods are based on the use of Electrodes, pH can be measured by measuring the voltage produced between two special electrodes immersed in the liquid solution. One electrode, made of a special glass, is called the measurement electrode. Its job is to generate a small voltage proportion to pH (ideally 59.16 Mv per pH unit). The measurement electrode (glass electrode) is so designed that it is constructed of special glass to create the ion- selective barrier needed to screen out hydrogen ions from all other ions floating around in the solution. This glass is chemically doped with lithium ions, which is what makes it react electrochemically to hydrogen ions in solution. This electrode is designed to allow hydrogen ions in the solution to migrate through a selective barrier, producing potential (voltage) difference to the solutions pH as said earlier. The pH scale at various levels from acidic to basic as shown in above Fig 3.7.
• pH 0-6: Acidic.
• pH 7: Neutral.
• pH 8-14: Alkaline or basic.

3.6.2 Turbidity

Turbidity a qualitative characteristic which is imparted by solids obstructing the transmittance of light through a water sample, is an important water quality indicator. Turbidity can be interpreted as a measure of the relative clarity of water and often indicates the presence of dispersed. suspended solids, particles not in true solution such as salt, clay, algae and other microorganisms, organic matter and other minute particles.
Reagents used to determine Turbidity of the sample are as follows:

- Solution I: Dissolve 1.0 gm Hydrazine sulfate and dilute to 100 ml.
- Solution II: Dissolve 10.0 gm Hexamethylenetetramine and dilute to 100 ml.
- Solution III: Mix 5ml of Sol I with 5 ml of Sol II Allow to stand for 24 hours and dilute to 1000 ml. This will have Turbidity of 400 UNITS.
- Solution IV: Standard Turbidity suspension.

The procedure adopted to determine turbidity in greywater sample is as follows:

- Prepare Calibration curves in the range of 0-400 units (suitably) by carrying out appropriate dilutions of Solutions I and II above.
- Dilute 10 ml of Solution IV to 100 ml to have turbidity of 40 Units. Similarly prepare Solutions in the range of 10, 15, 20, 25,30,35, 40 etc.
- Then place all the Suspensions in the Sample holder and Read the Meter reading and note down.
- Now plot a Calibration curve between Concentration and Meter reading.
- Take sample or a suitably diluted aliquot and determine its turbidity by visual comparison with the diluted standards or by reading on Turbidimeter.
- Read Turbidity from the Standard curves and apply correction due to Dilution if necessary.
- Report the Units in Turbidity units.

3.6.3 Solids

A solid can be classified as a substance that is rigid with low intermolecular spacing and high intermolecular forces, that binds all molecules within together. Liquids, on the other hand, are less rigid and flow easily. They usually have properties that enable them to flow from higher areas to lower areas.

Solids can be present in liquid sample in different forms, such as:

- Suspended solids.
- Settleable solids.
- Dissolved solids.
- Fixed solids.
- Volatile solids

Suspended solids: These types of solids are capable of remaining in suspension for sufficiently large time duration, hence are declared as suspended solids. In surface water the suspended solids consist of Inorganic matter like silts clay etc and organic matter like algae, vegetation, and various types of floating bodies of vegetative origin. These materials are generally carried by the erosive action of the flowing water. Because of erosion of soil strata through mechanical. The procedure adopted to determine suspended solids in greywater sample is as follows:

- Take an appropriate filter paper and dry it in an oven and weigh the filter paper as M1.
- Take a suitable quantity of sample that is around 100 ml (may vary depending on amount of solids present, 100-500 ml etc).
- Then filter the sample through the filter paper and collect the filter paper carefully and dry it in the oven. Let the weight of filter paper be M2.
- Quantity of suspended solids present in the sample is given by, Suspended solids present= (M2-M1) X 1000/ ml of sample used in mg/L.
- Alternatively suspended solids can also be determined as follows, Suspended solids= (Total solids-dissolved solids) mg/L.

Note: Suspended matter or solids - It is determined generally indirectly as follows: -

Suspended matter mg/L Total solids mg/L-Dissolved solids mg/L If the Glass Fiber filter paper GFC grade (What man make) is available this determination can be done directly. This paper keeps the consistency not only at 105 Deg C but at 600 Deg C also. While using this filter paper a separate filter assembly known as Hartley's filter assembly is made use of.

Settleable solids: This type of solids is capable of settling to the bottom of the container in which the liquid is stored, hence are defined as settleable nature. Usually, this test is held on sewage samples to know the number of settleable solids present per litre of the sewage. The determination of solids helps in estimating the quantity of sludge likely to be produced from the sewage during the course of treatment.

The procedure adopted to determine settleable solids in greywater sample is as follows:

- Take an appropriate filter paper and dry it in an oven and weigh the filter paper as M1.
- Take a suitable quantity of sample that is around 100 ml (may vary depending on amount of solids present, 100-500 ml etc).

- Then filter the sample through the filter paper and collect the filter paper carefully and dry it in the oven. Let the weight of filter paper be M2.
- Quantity of suspended solids present in the sample is given by, Suspended solids present= (M2-M1) X 1000/ ml of sample used in mg/L.
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Dissolved solids: This is made of solids which are dissolved in the given sample and may be organic or inorganic type. In natural water the dissolved solids mainly consist of Inorganic salts like Carbonates, bi-carbonates, chlorides, sulphates etc and with together small amounts of organic matters such as soluble sugars etc, which are in the dissolved form and some dissolved gasses.

The procedure adopted to determine dissolved solids in greywater sample is as follows:

- Take a suitable China dish and prepare its tare weight by standard procedure and note down its Constant Tare weight as M1.
- Take 50 ml/100 ml (Suitable quantity) of sample in a beaker and filter the sample by using Whatman filter paper of specified pore size. Collect the filtrate.
- Then evaporate the Filtrate at 105 Deg Celsius in an electric oven or in a incubator Conveniently.
- Take the weight M2 of the China dish after the complete evaporation of sample.
- The total dissolved solids present in the sample is given by:

Dissolved solids present= (M2-M1) X 1000) / ml of sample used in mg/L.

Fixed solids: Fixed solids refer to the portion of solids in wastewater that remains as residue after heating the sample at a specific temperature. These solids are not vaporized during the heating process and typically consist of inorganic materials such as sand, grit, and minerals, as well as organic materials that are more resistant to decomposition.

Volatile solids: Volatile solids, on the other hand, are the portion of solids in wastewater that is vaporized and lost as gases when the sample is heated at a specific temperature. These solids are mainly organic in nature, comprising organic compounds like proteins, carbohydrates, fats, and other organic matter that can be decomposed by microorganisms under suitable conditions.

The procedure adopted to determine fixed & Volatile solids in greywater sample is as follows:

- Again, take an appropriate amount of sample in a China or platinum Crucible and heat the sample up to 600 Deg Celsius to remove away all the organic contents present in the sample and to leave behind only fixed or inorganic content of the sample.
- Let the empty weight of crucible be M1.
- Weigh the crucible after the evaporation and let the weight be M2.
- Now the number of fixed solids is given by

Fixed Solids present= (M2-M1) X 1000/ml of sample used in mg/lt.

Note: Hence volatile solids are given by volatile solids Total solids Fixed solids.

3.6.4 Alkalinity

Alkalinity refers to the capacity of water to neutralize acids. In a laboratory setting, the procedure for testing alkalinity for grey water sample typically involves titration with a standardized acid solution to determine the amount of acid required to bring the sample to a specific pH endpoint.

Reagents used to determine alkalinity of the sample are as follows:

- Standard H_2SO_4 0.02 N.
- Phenolphthalein indicator.

- Methyl orange indicator.

The procedure adopted to determine alkalinity in greywater sample is as follows:

- Take 50 ml of sample of grey water is taken in a conical flask.
- Add 2-3 drops of Phenolphthalein indicator.
- If pink color develops, titrate with 0.02 N H2SO4 till it the solution turns to color less. Note the volume of H2SO4 consumed. If solution does not change to pink color, it indicates, absence of Mineral Acidity.
- Add 2-3 drops methyl orange to the same flask, solution turns to yellow color and continue titration till the yellow color changes to orange.

3.6.5 Acidity

Acidity refers to the concentration of acid compounds in water, which can affect its pH level and overall quality. In a laboratory setting, the procedure for testing acidity in a grey water sample typically involves titration with a standardized base solution to determine the amount of base required to neutralize the acid content.

Reagents used to determine acidity of the sample are as follows:

- 0.02 N Sodium Hydroxide solution (NaOH).
- Methyl orange indicator.
- Phenolphthalein indicator.

The procedure adopted to determine mineral acidity in greywater sample is as follows:

- Take 50 ml (suitable quantity) in a conical flask and add three to four drops of Methyl orange.
- If color changes to orange red to yellow means the presence of mineral acidity, then titrate the sample against 0.02 N NaOH solution.
- Titrate the sample till the orange red color changes to yellow, which indicates the end point. Note down the burette reading, which will give the value of M. If the color changes directly to yellow the value of M is zero and shows the absence of mineral acidity.

The procedure adopted to determine total acidity in greywater sample is as follows:

- Take 50 ml of fresh sample and add 3-4 drops of Phenolphthalein, titrate the sample against 0.02 N NaOH solution till a slight pinkish color is obtained, note down the burette reading. If the color changes directly to pinkish then value of P is zero.
- Repeat the experiment two to three times for different water any other samples. Carbondixoide acidity (Total Acidity-Mineral acidity).

3.6.6 Biochemical Oxygen Demand (BOD)

BOD measures the amount of dissolved oxygen required by microorganisms to break down organic matter in the sample. High BOD levels suggest a high organic load, which may require biological treatment processes like aerobic digestion or constructed wetlands.

The procedure adopted to determine BOD in greywater sample is as follows:

- Dilute the greywater sample if necessary to ensure that the oxygen demand falls within the detection range of the BOD test. Fill BOD bottles with the diluted sample and a nutrient solution. Incubate the bottles at a specified temperature (usually 20°C) for a defined period (typically 5 days).
- Measure the dissolved oxygen (DO) depletion using a DO probe or titration and calculate the BOD concentration.
- BOD = (DO1−DO2) × Dilution Factor Sample Volume × 1000 Incubation Time.
- BOD= (DO1−DO2) × Sample Volume Dilution Factor × Incubation Time 1000.
- Where: BOD = BOD is the Biochemical Oxygen Demand in mg/L.
- DO1= is the initial dissolved oxygen concentration in mg/L.
- DO2= is the final dissolved oxygen concentration in mg/L after incubation.
- Biochemical Oxygen Demand (BOD) is a measure of the amount of oxygen consumed by microorganisms during the decomposition of organic matter in water.

3.6.7 Hardness

Hardness of water is a measure of the capacity of water to precipitate soap. Chiefly the Calcium precipitates soap and Magnesium salts. In conformity with current practice total hardness is defined as the sum of the calcium and magnesium concentrations both expressed as calcium carbonate in mg/L Hard water is generally considered to be water that requires considerable amounts of soap to produce a foam or lather and that produces scale in hot-water pipes, heaters, boilers, and other units in which the temperature of water is increased substantially. It is also known that first the EDTA consumes all Mg ions and then Ca ions and later all other ions as titration continues until MEDTA complex formation is completed.

Reagents used to determine total hardness of the sample are as follows:

- Standard EDTA solution Titrant 0.01 M strength.
- Ammonia buffer solution.
- Sodium hydroxide 2 N strength.
- Eriochrome Black "T' indicator (Total & Permanent hardness).
- Murexide indicator (Calcium and Magnesium hardness).
- Solochrome Black "T' indicator. (Calcium and Magnesium hardness).

The procedure adopted to determine hardness in greywater sample is as follows:

- Take 25 or 50 ml (suitable volume) well mixed sample in a conical flask.
- To the above sample add 2 ml of Ammonia buffer solution followed by a pinch Eriochrome Black "T" indicator.
- Titrate this mixed sample against 0.01 M EDTA solution till the color hanged from wine red to blue. Note down the volume of EDTA run down.

3.8 FILTRATION AND TREATMENT OF GREYWATER

Filtration and treatment of samples are crucial processes in various scientific. These processes ensure the removal of unwanted substances, particles, or contaminants from a sample, enabling accurate analysis, safe consumption, or further processing. Filtration is primarily used to separate solids from liquids or gases. It helps in clarifying the sample by removing particulate matter. As discussed in Section 3.6, preparation of greywater treatment units at laboratory scale are used for treatment of collected raw sample of grey water. Three number of units are prepared with variation in filter bed as follows:

- Greywater treated in Treatment unit 1: Coarse aggregates + Sand.
- Greywater treated in Treatment unit 2: Coarse aggregates + Sand + Activated Carbon with KoH.
- Greywater treated in Treatment unit 3: Coarse aggregates + Sand + Activated Carbon with NaOH.

Four litres of raw greywater is poured in each treatment unit as shown in Fig 3.8 The filtered greywater sample is collected from each treatment unit and their characteristics are analysed by performing laboratory test as discussed in Section 3.6.

3.8 CLOSURE

In this chapter, detailed discussion of the methodology adopted in the present study is discussed. In the next chapter, results and discussion of the work accomplished is presented.

IV. RESULTS AND DISCUSSIONS

Methodology adopted in the present study is discussed in the previous chapter. Results and discussion of the work carried is discussed in this chapter.

Characteristics of raw and treated greywater were analyzed in the laboratory by performing tests. The results and discussion of the same is discussed in below mentioned paragraphs.

4.1 pH

pH is a measure of degree of relative acidity and alkalinity. Raw greywater has pH of 4.96 Mg/L. The value of pH is increased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig. 4.1.

- Greywater treated in Treatment Unit 1 has pH 4.73 Mg/L.
- Greywater treated in Treatment Unit 2 has pH 4.45 Mg/L.
- Greywater treated in Treatment Unit 3 has pH 4.12 Mg/L.

This increase in pH value shows that, the treatment unit is effective to neutralise the acidic content present in raw greywater to some extent. Treated greywater can be utilised in manufacture of cosmetics, as this requires a water having pH between 4 and 7, depending on the product.

4.2 TURBIDITY

Acidity refers to the concentration of acid compounds in water, which can affect its pH level and overall quality. Raw greywater has Turbidity of 148 NTU. The value of Turbidity is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig. 4.2.

- Greywater treated in Treatment Unit 1 has Turbidity 106.4 NTU.
- Greywater treated in Treatment Unit 2 has Turbidity 102.4 NTU.
- Greywater treated in Treatment Unit 3 has Turbidity 91.00 NTU.

Turbidity is a measure of water clarity and is usually measured in NTU (Nephelometric Turbidity) Units. This decrease in Turbidity value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.3 Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand (BOD) indicates the sum of oxygen required by aerobic microbes to breakdown or oxidize the organic substances in a greywater sample. Raw greywater has BOD of 1078 Mg/L. The value of BOD is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig. 4.3.

- Greywater treated in Treatment Unit 1 has BOD 728 Mg/L.
- Greywater treated in Treatment Unit 2 has BOD 611 Mg/L.
- Greywater treated in Treatment Unit 3 has BOD 436 Mg/L.

BOD measures the amount of dissolved oxygen required by microorganisms to break down organic matter in the sample. High BOD levels suggest a high organic load, which may require biological treatment processes like aerobic digestion or constructed wetlands. This decrease in BOD value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.4 ACIDITY

Acidity refers to the concentration of acid compounds in water, which can affect its pH level and overall quality. Raw greywater has Acidity of 1024Mg/L. The value of Total Acidity is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig 4.4.

- Greywater treated in Treatment Unit 1 has Acidity 900 Mg/L.
- Greywater treated in Treatment Unit 2 has Acidity 664 Mg/L.
- Greywater treated in Treatment Unit 3 has Acidity 622 Mg/L.

This decrease in Acidity value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.5 ALKALINITY

Alkalinity refers to the capacity of water to neutralize acids. Raw greywater has Alkalinity of 224Mg/L. The value of Total Acidity is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig 4.5.

- Greywater treated in Treatment Unit 1 has Alkalinity 184 Mg/L.

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- Greywater treated in Treatment Unit 2 has Alkalinity 180 Mg/L.
- Greywater treated in Treatment Unit 3 has Alkalinity 148 Mg/L.

This decrease in Alkalinity value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.6 HARDNESS

Hardness in water, including greywater, is primarily caused by dissolved minerals, particularly calcium and magnesium ions. It is often measured in terms of calcium carbonate (CaCO3) equivalents and is expressed as milligrams per litre (mg/L) or parts per million (ppm).

4.6.1 TOTAL HARDNESS

Hardness of water is a measure of the capacity of water to precipitate soap. Raw greywater has Total Hardness of 1349.2 Mg/L. The value of Total Hardness is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig. 4.6.

- Greywater treated in Treatment Unit 1 has Total Hardness of 1191.2 Mg/L.
- Greywater treated in Treatment Unit 2 has Total Hardness of 1161.2Mg/L.
- Greywater treated in Treatment Unit 3 has Total Solids of 611.2 Mg/L.

This decrease in Total Hardness value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.6.2 CALCIUM HARDNESS

In calcium hardness Raw greywater has Total Hardness of 1247.6 Mg/L. The value of Total Hardness is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig. 4.7.

- Greywater treated in Treatment Unit 1 has Calcium Hardness 989.3 Mg/L.
- Greywater treated in Treatment Unit 2 has Calcium Hardness 970.8 Mg/L.
- Greywater treated in Treatment Unit 3 has Calcium Hardness 574.2 Mg/L.

This decrease in Total Hardness value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.6.3 MAGNESIUM HARDNESS

In magnesium hardness Raw greywater has Total Hardness of 201.9 Mg/L. The value of Total Hardness is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig. 4.8.

- Greywater treated in Treatment Unit 1 has Magnesium Hardness 190.4 Mg/L.
- Greywater treated in Treatment Unit 2 has Magnesium Hardness 101.6 Mg/L.
- Greywater treated in Treatment Unit 3 has Magnesium Hardness 37.2 Mg/L.

This decrease in Total Hardness value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.7 SOLIDS

Solids refer to the sum of all the solid materials present in a substance or sample, typically expressed in terms of mass per unit volume. The test results of different component of solids present in the raw and treated greywater are discussed in below paragraphs.

4.7.1 SUSPENDED SOLIDS

In surface water the suspended solids consist of Inorganic matter like silts clay etc and organic matter like algae, vegetation, and various types of floating bodies of vegetative origin. Raw greywater has Total Suspended Solids (TSS) of 0.6 Mg/L. The value of Total Suspended Solids (TSS) is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig. 4.9.

- Greywater treated in Treatment Unit 1 has Suspended Solids 0.28 Mg/L.

• Greywater treated in Treatment Unit 2 has Suspended Solids 0.23 Mg/L.
• Greywater treated in Treatment Unit 3 has Suspended Solids 0.21 Mg/L.

These materials are generally carried by the erosive action of the flowing water. Because of erosion of soil strata through mechanical. This decrease in suspended solids value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.7.2 SETTLEABLE SOLIDS

This type of solids is capable of settling to the bottom of the container in which the liquid is stored, hence are defined as settleable nature. Raw greywater has Settleable Solids of 4 cm thickness. The value of Settleable Solids (SS) is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig. 4.10.
• Greywater treated in Treatment Unit 1 has Settleable Solids 2.8 cm.
• Greywater treated in Treatment Unit 2 has Settleable Solids 2.4 cm.
• Greywater treated in Treatment Unit 3 has Settleable Solids 2.2 cm.

The determination of solids helps in estimating the quantity of sludge likely to be produced from the sewage during the course of treatment. This decrease in Settleable solids value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.7.3 DISSOLVED SOLIDS

Solids which are dissolved in the given sample which may be organic or inorganic. Raw greywater has Total Dissolved Solids of 59.6 Mg/L. The value of Total Dissolved Solids (TDS) is decreased after treatment of greywater in all three treatment units as mentioned below and the same is presented in Fig. 4.11.
• Greywater treated in Treatment Unit 1 has Dissolved Solids 52.31 Mg/L.
• Greywater treated in Treatment Unit 2 has Dissolved solids 47.82 Mg/L.
• Greywater treated in Treatment Unit 3 has Dissolved Solids 46.44 Mg/L.

This decrease in Dissolved solids value shows that, the treatment unit is un effective to some extent in raw and treated greywater treatment in laboratory scale.

4.8 CLOSURE

In this chapter, detailed discussion of the results adopted in the present study is discussed. In the next chapter, Conclusion of the work accomplished is presented.

V. CONCLUSION

This present study leads us to the conclusion that, raw and treated greywater filtration have been carried out in 3 different units and several materials are chosen which rice husk used to prepare activated carbon following work have done.

Following are the conclusions made based on the present study carried out on laboratory scale greywater treatment unit:

- Materials used for filter media in preparation of greywater treatment unit are locally available at lesser cost.
- Drastic drop down of pH, Turbidity & BOD is observed in greywater treated in treatment unit 2.
- Acidity, Alkalinity, Solids and Hardness of greywater is moderately deceased after treatment.
- The experimental work can be carried in future by altering the material(s) for preparation of activated carbon and by varying the layer depth of filter media.
- From the results of the experiments conducted, Treatment Unit 2 is efficient compared with treatment unit 1 and treatment unit 3 in treating greywater.

REFERENCES

[1]. Lambe, J.S. and Chougule, R.S., 2015. Greywater-treatment and reuse. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 21.

[2]. Ghadimi, A. and Chang, L.H., 2018. Design and Optimisation of Home Scale Greywater Recycling Package. In MATEC Web of Conferences (Vol. 152, p. 02005). EDP Sciences.

[3]. Seenirajan, M., Sasikumar, S. and Antony, E., 2018. Design of grey water treatment units. Int. Res. J.

[4]. Rana, K., Shah, M. and Upadhyay, A., 2014. Integrated approach towards grey water management. International journal of engineering sciences & research Technology, 3(1), pp.239242Eng. Technol, 5, pp.4243-4250.

[5]. S Christopher 2019, greywater treatment technologies, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249-8958 (Online), Volume- 9 Issue-1S4.

[6]. Shelar, A.B., Kalburgi, M.S.M., Kesare, M.N.D. and Kushwah, M.S.U., 2019. Research Paper on Treatment of Grey Water using Low-Cost Technology For Kushvarta Kund Water. International Research Journal of Engin.

[7]. Sharath, D., Ezana, J.E.D.I.D.I.A.H. and Shamil, Z.E.Y.N.U., 2017. Production of activated carbon from solid waste rice peel (husk) using chemical activation. Journal of Industrial Pollution Control, 33(2), pp.1132-1139.

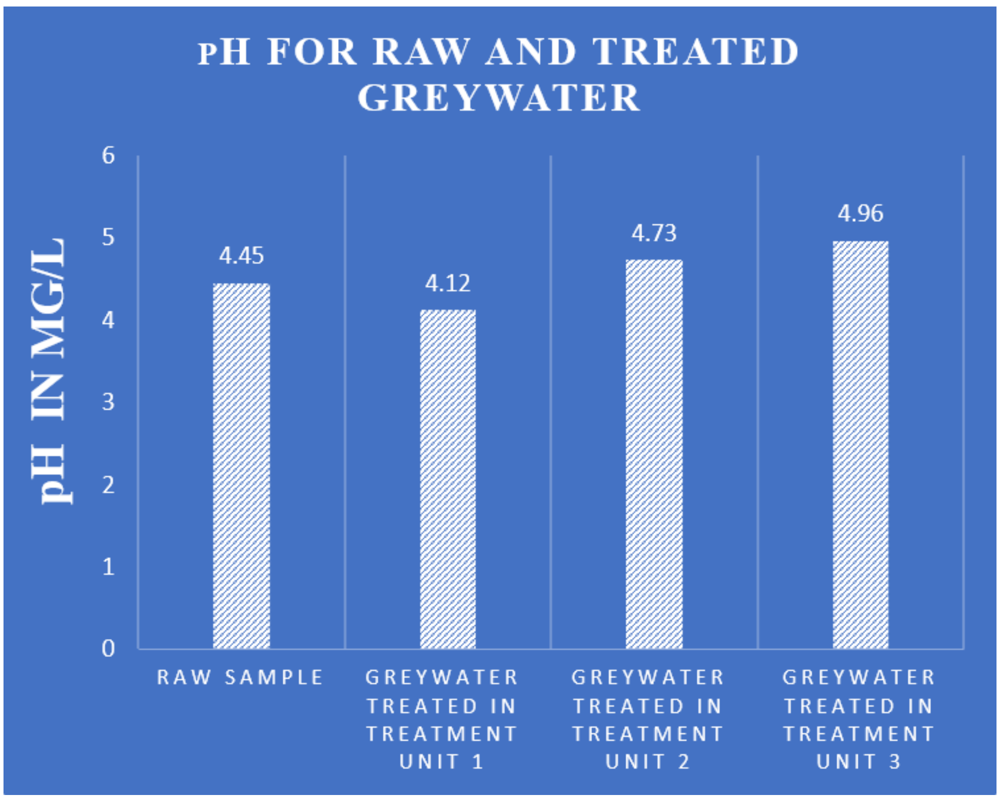

Fig. 4.1: pH for Raw and treated Greywater Samples

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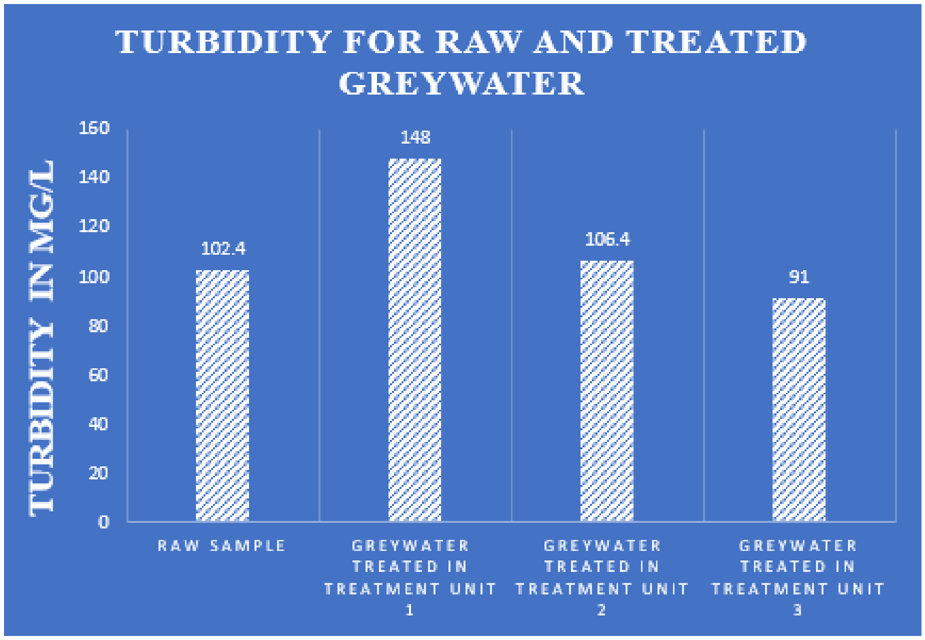

Fig: 4.2 Turbidity for Raw and Treated Greywater Samples.

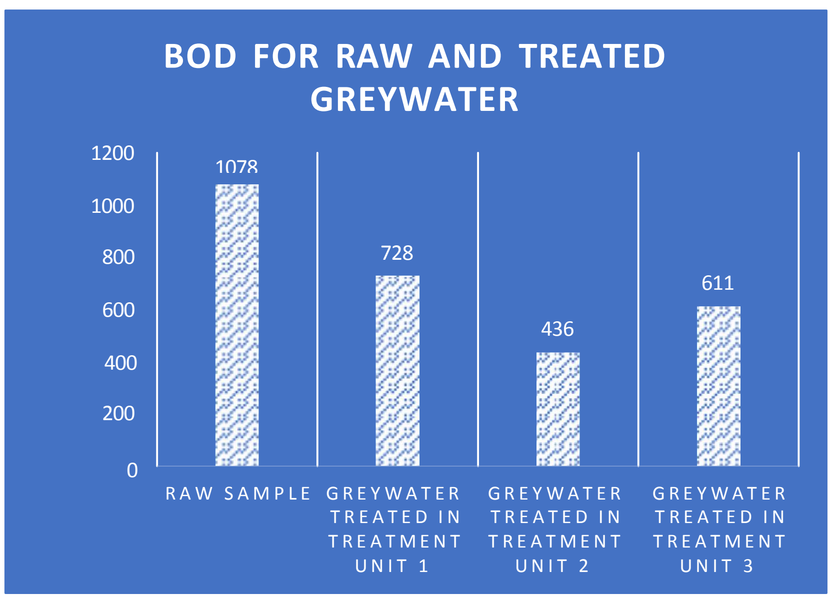

Fig: 4.3 BOD for Raw and treated Greywater samples,

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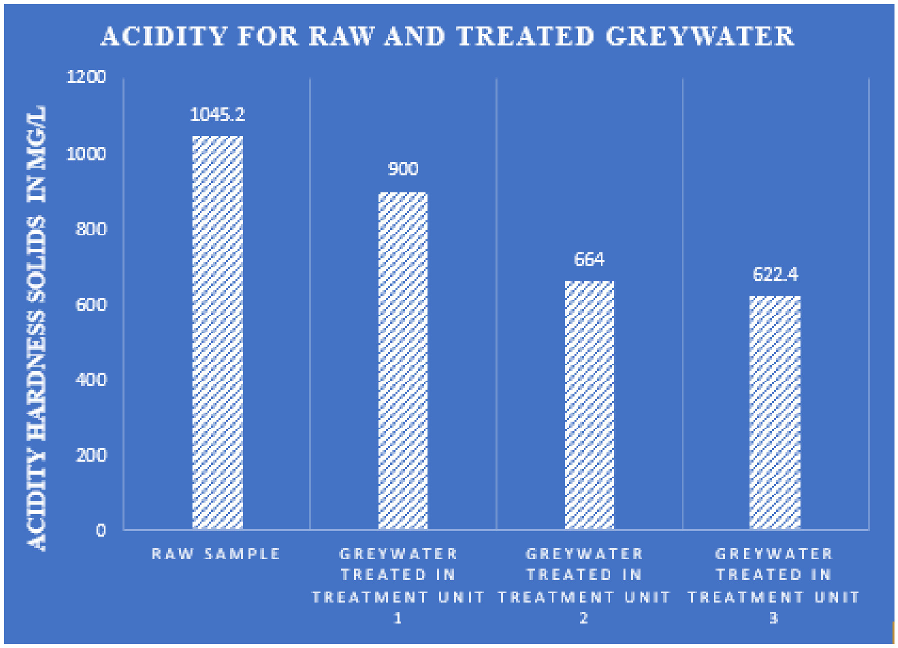

Fig: 4.4 Acidity values of Raw and Treated Greywater samples.

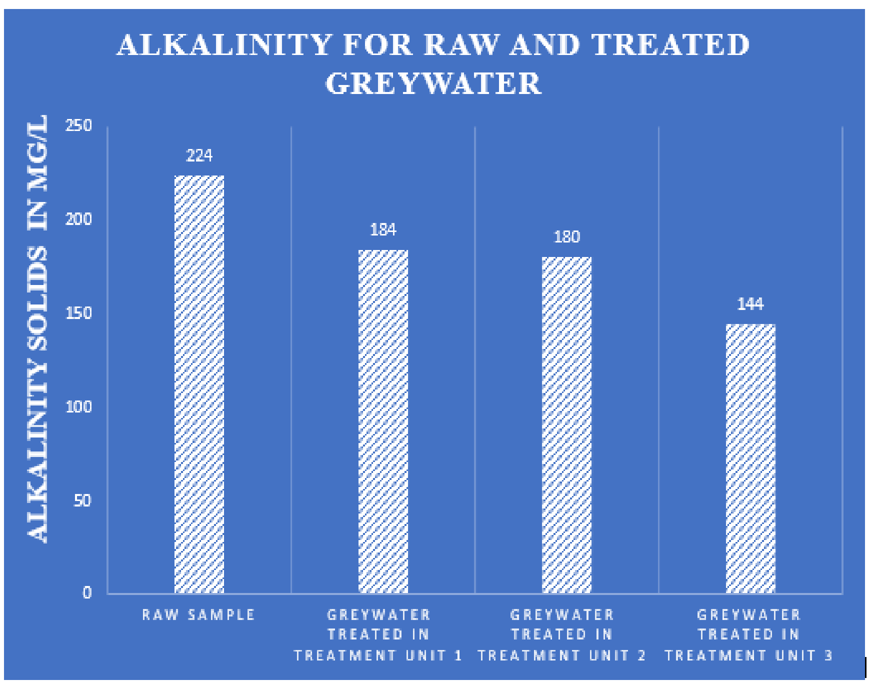

Fig: 4.5 Alkalinity for Raw and Treated Greywater samples.

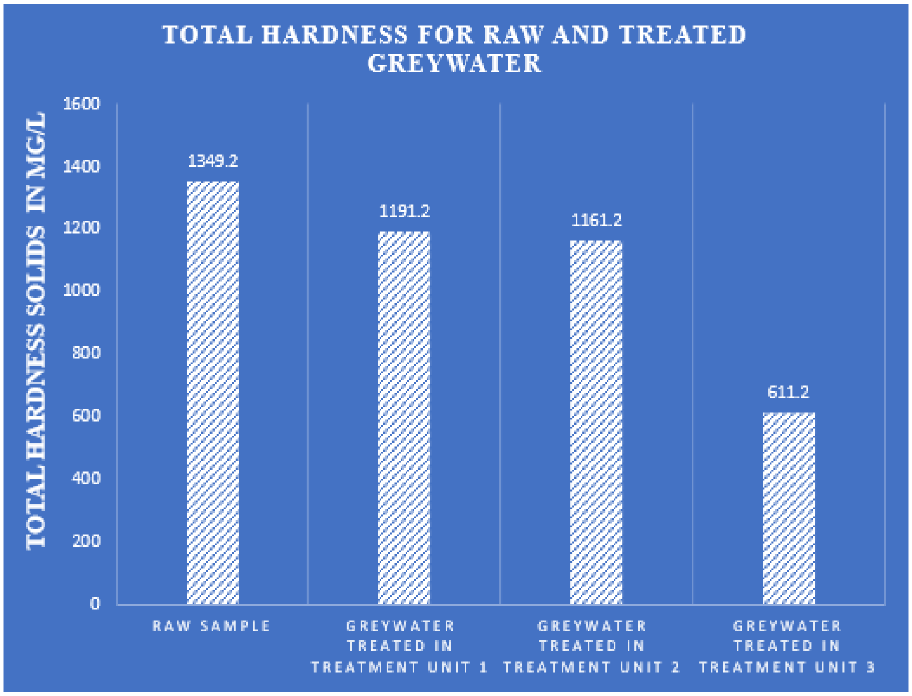

Fig: 4.6 Total Hardness for Raw and Treated Greywater samples.

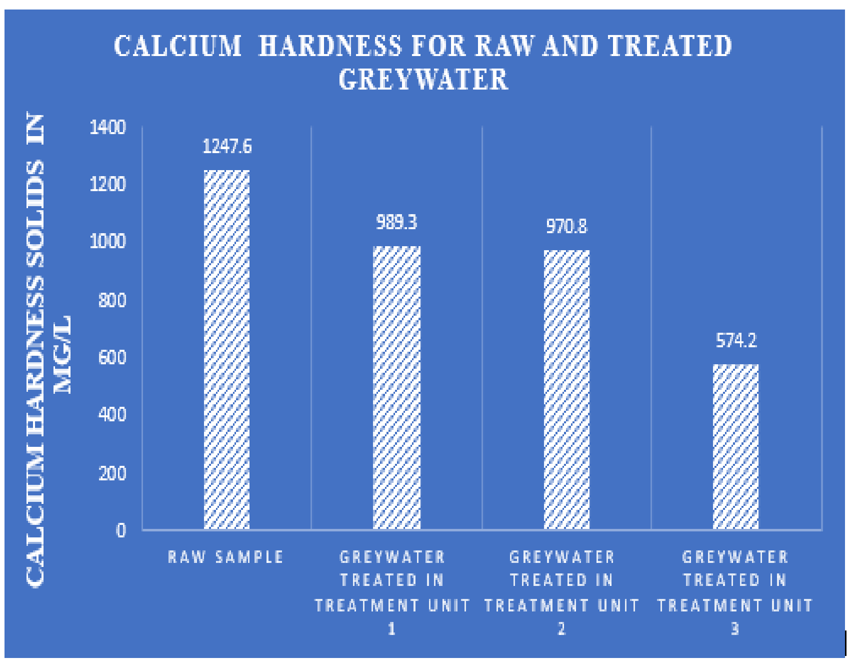

Fig: 4.7 Calcium Hardness for Raw and Treated Greywater samples.

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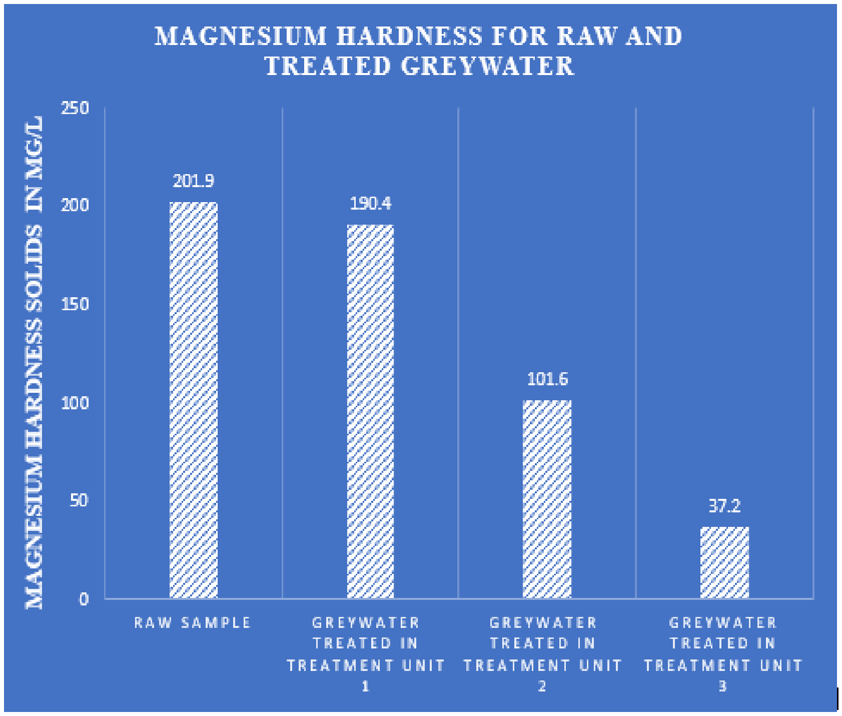

Fig: 4.8 Magnesium Hardness for Raw and Treated Greywater samples.

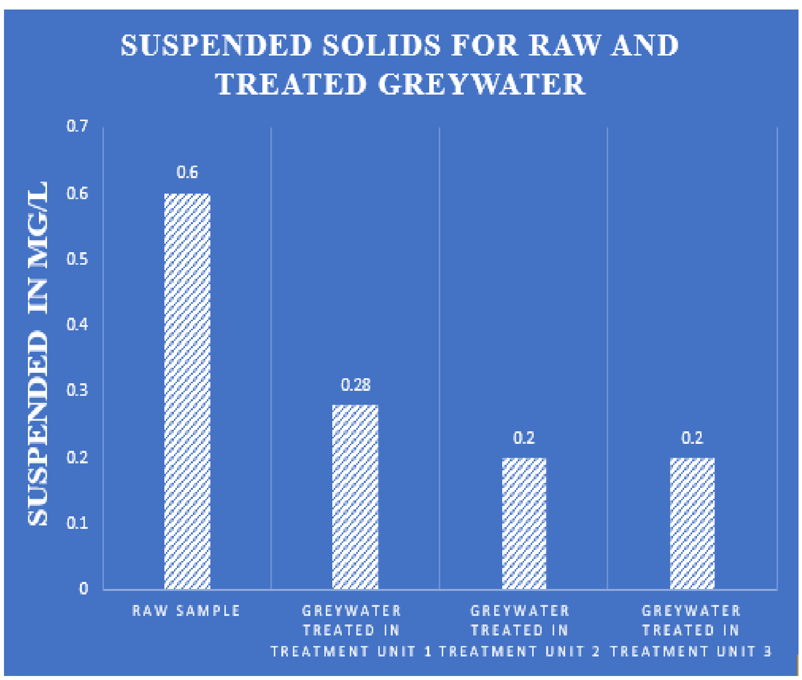

Fig: 4.9 Suspended Solids for Raw and Treated Greywater samples.

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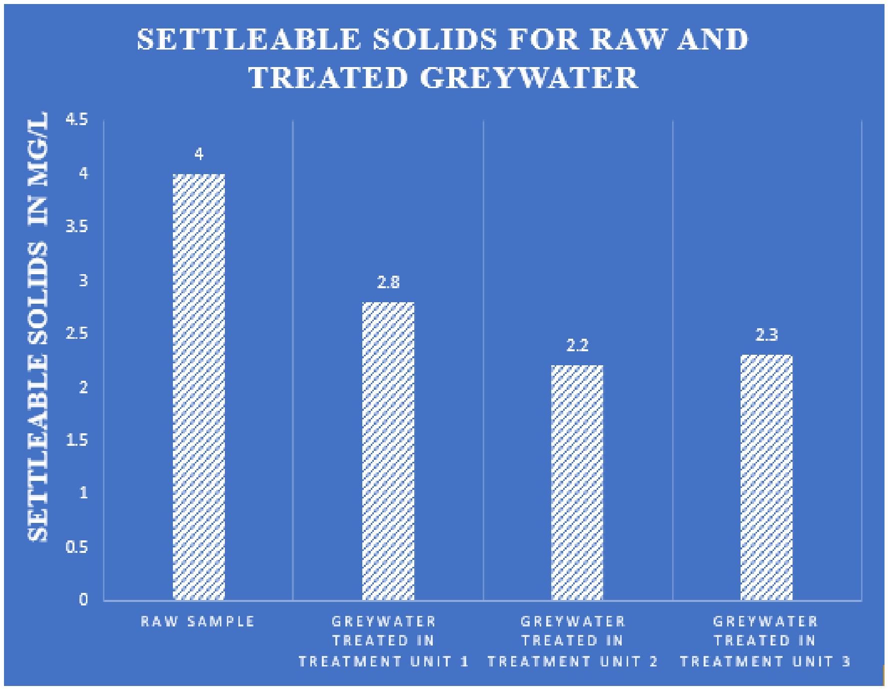

Fig:4.10 Settleable Solids for Raw and Treated Greywater samples

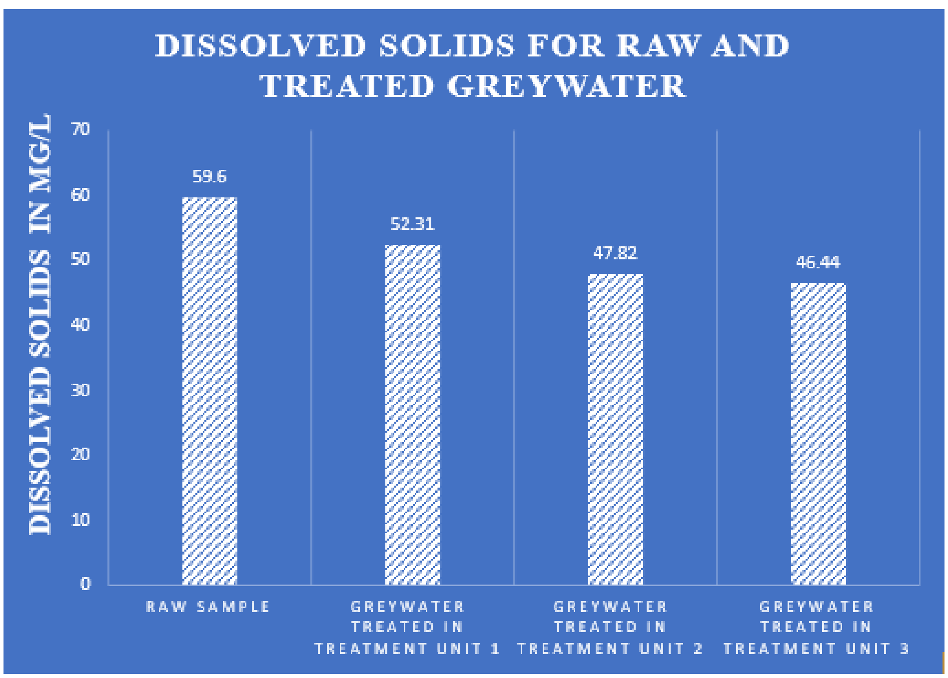

Fig: 4.11 Dissolved Solids for Raw and Treated Greywater samples.