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APPLICATION OF GREEN TECHNOLOGY FOR GREY WATER TREATMENT AND ITS REUSE- A REVIEW

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Abstract: Water is the fundamental source of our survival. Day by day population is increasing therefore ultimately it affect on water demand and growing population give rise to generation of wastewater. It creates stress on sanitation and wastewater disposal system. Application of green technology for grey water management can be a better option for its reuse. Proper management of grey water and its reuse can reduce the demand of fresh water for daily purposes. In this paper, various green technology options are studied for grey water treatment and its reuse for various purposes.

IndexTerms **– Water, Grey water, Green Technology, Management and Reuse**

1. INTRODUCTION

Water, the essential need of all living beings is becoming an important matter of concern in this era as the source of water is getting depleted throughout the world. (Sonali Manna, 2018). As population is increasing, demand of fresh water is also increased. Basically,fresh water is majorly required for potable use i.e. for drinking and non - potable use such as toilet flushing, floor flushing, car washing, washing clothes, gardening etc. The fresh water demand required for such non- potable purposes can be reduced, if the treated grey water can be reused for such activities. Reuse of greywater is beneficial at household level as it reduces the load on sanitation system.

Wastewater generated from bathing, washbasins, cooking, washing utensils, laundry etc. is called as grey water. Wastewater coming from toilets, which contains faecal matter and urine is termed as black water. The quality of grey water is substantially different from black water. Treatment for grey water is easier than black water as it contains fewer pathogens.

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1.1 Sources of Wastewater and its type:

Table No. 1: Sources and Types of Wastewater (Lambe and Chougule)

Sr. No.	Sources of Wastewater	Types of Wastewater	Quantity/ day/person
1.	Toilets	Blackwater	3 liters
2.	Bathing	Greywater	20-30 liters
3.	Kitchen	Greywater	5-10 liters
4.	Washing Cloths	Greywater	15-20 liters
5.	Animals	Greywater	10-15 liters

1.2 Composition of Grey water:

The composition of greywater depends on standard of living, use of detergents and chemicals for washing of cloths, car washing and bathing etc. Also there may be variations in quantity of generation of grey water due to the variations in use of fresh water. It is largely depends on the place and time.

Water used in hand washing and bathing generates around 50-60% of total greywater and is considered to be the least contaminated type of greywater. Water used in cloth washing generates around 25-35% of total greywater. Kitchen greywater contributes about 10% of the total greywater volume. It is contaminated with food particles, oils, fats and other wastes. Greywater from kitchen also contains chemical pollutants such as detergents and cleaning agents, which are alkaline in nature and contain various chemicals. **(Lambe and Chougule)**

1.3 Characteristics of Grey water:

There is large variability in characteristics of grey water due to different lifestyle, consumption of water and food habits. Grey water contains suspended solids, different organic substances, metals, inorganic ions, xenobiotic compounds and traces of microorganisms especially E. coli. The typical composition of grey water is given in Table No.2. There is BOD content in kitchen grey water. Grey water from laundry and bathroom grey water contains high COD. Microbial load in grey water is generally less. Washing of faecally contaminated clothes, child care and washing raw meats can lead to faecal contamination in grey water. (Sonali Manna, 2018)

Table No. 2: Typical Grey water Composition (Bhadiyadra 2015)

Sr. No.	Parameter	Concentration
1.	pH	7.3-8.1
2.	Temperature	-
3.	Suspended Solids(mg/L)	76- 1396
4.	Total Dissolves solids (mg/L)	-
5.	Biochemical Oxygen Demand (BOD) (mg/L)	129-2287
6.	Chemical Oxygen Demand (COD) (mg/L)	13-8000
7.	NH_3- N (mg/L)	25-211
8.	Total Phosphorus (mg/L)	2.4- 27
9.	E-coli (MPN/ 100 mL)	$2* 10^5$

2. Treatment of Grey water:

Treatment for raw grey water is essential for its storage and reuse. Untreated grey water pose health threat to human being and their environment. Appropriate treatment for grey water and its reuse is depends on the quality of inlet grey water. Greywater treatment is essential to reduce the concentration of contaminants before its reuse and final disposal.

Treatment for grey water is accomplished by physical, chemical and biological or combination of these systems. Pre-treatment is given to grey water to avoid clogging in further subsequent treatment.

Physical treatment for greywater includes filtration and sedimentation. Filtration includes screen meshes, sand bed filtration, metal strainers and gravel filtration. These treatments can be given as pre-treatment.

Various biological treatment systems have been applied for greywater treatment, which includes Rotating Biological Contactor (RBC), Sequencing Batch Reactor (SBR), Membrane Bioreactors (MBR), Fluidized Bed Reactor (FBR), and Up flow Anaerobic Sludge Blanket (UASB) Reactor.

The chemical treatment systems used for greywater treatment include coagulation and flocculation, electrocoagulation, adsorption using granular activated carbon (GAC) and natural zeolites, magnetic ion exchange resin (MIEX), powdered activated carbon (PAC) and advanced oxidation processes (AOPs) such as ozonation, and photo catalysis.

The present study discusses the review of various treatments given to grey water.

2.1. Petter D. Jenssen and Lasse Vråle (2003) studied the **Treatment of Grey water using Aerobic Filter followed by Subsurface Horizontal Flow Constructed Wetland in Cold Climates**. A combined vertical flow biofilter followed by a horizontal flow wetland filter is developed in the study. More than 70% BOD removal is possible in the single pass of biofilter using about $0.1m^2$ surface area/person. For the combined biofilter/constructed wetland system the total area requirement is 1-3 m^2/ person and the effluent meets European swimming water standards with respect to indicator bacteria and WHO drinking waterstandards with respect to nitrogen.

2.2. J. S. Lambe and R. S. Chougule studied **Greywater Treatment and Reuse**. In this study, A three-stage greywater filtration system at household level is constructed. Inlet PVC pipe of 63 mm, Inlet chamber with size 30cm x 30cm x 10cm of Brick masonry Cement plaster is constructed. Two treatment chambers are designed such as Treatment chamber 1 with size 30cm x 60cm x 30cm is filled with gravels of size 40 to 60 mm and Treatment chamber 2 with size 40cm x 60cm x 30cm filled with fine sand. Base of all the chambers is constructed with RCC. Out let is providedthrough 63mm (2 inch) PVC pipe. Household greywater filtration system includes Sedimentation, Horizontal filter, Slow sand filter and disinfection process. After treating the grey water through this filtration system it can be reused for Toilet flushing, Irrigation, floor washing and for construction purpose.

2.3.Saroj B. Parjane and Mukund G. Sane(2011)studied **Performance of Grey Water Treatment Plant by Economical Way for Indian Rural Development.**In this study, laboratory scale grey water treatment plant was developed. It was designed for 180 lit/hr capacity. Inlet grey water for this treatment plant was collected from bathrooms, basins and laundries in residential area of college hostel located at Sinnar rural area in Nashik city, India. This treatment plant system is developed for the small college campus in rural areas. It consists four stages of treatment such as primary settling with cascade flow of water, aeration tank, agitation and filtration. Naturally available material is used in filtration such as fine sand, course size bricks bed, charcoal bed, wooden saw dust bed and bed of coconut shell covers. The average organic load in grey water found 327 mg COD/lit. The solids in grey water were found to have about 76% dissolved and 24% suspended particles. The grey water treatment system achieved the removal of 83 % of organic load and 46 % anions and 49 % cations were found to be adsorbed by the natural adsorbents used in filtration. The treated grey water is reused for the purpose of landscaping, gardening, irrigations, plant growths and toilet flushing.

2.4. Randhir Bute et.al. (2017) studied **Treatment of Grey Water Using Technique of Phytoremediation.** In the present study, an artificial sub-surface flow wetland is constructed for the treatment of grey water. Three chambered system is incorporated such as Settling tank, Phytoremediation chamber and collecting tank. Raw grey water is collected from kitchen sinks, bathrooms, cloths and utensils washing. It is settled for 24 hrs in settling tank first and then it is transferred to Phytoremediation chamber. In this chamber, 15 cm layer of coarse aggregate is provided in which the plants of umbrella palm, lemon grass, cannas and dhopa are planted, which acts as treatment unit. The raw water sample and the treated sample were tested on certain parameters in the laboratory. It is observed that BOD and COD reduction is obtained upto 75%. Also, parameters such as nitrogen, iron, sulphate, magnesium, chloride and boron are within the standards of drinking water as per I.S. specifications.

2.5. Dhanu Radha Samayamanthula et al. (2019) studied **Treatment and Effective utilization of Greywater.** In the present study, greywater used for the treatment contains a mixture of equal proportions of water collected from three different sources such as kitchen sink, shower and washing machine in Fahaheel, Salmiya and Farwaniya areas of Kuwait. For the treatment of grey water a column is designed which contains activated carbon, sand and gravel. The quality of the treated greywater was checked for physical, chemical and microbiological parameters as per the standard methods to check the suitability for domestic purposes. Removal efficiency obtained such as 23%, 95%, 52%, 88%, 100% and 100% for pH, colour, TDS, turbidity, total coliform, and E. coli, respectively. This study also concludes that use of gravity filter is eco -friendly, economically viable and effective as compared to other expensive methods.

2.6. Amit Gross et. al. (2007) studied **Removal of chemical and microbiological contaminants from Domestic Greywater using a Recycled Vertical Flow Bioreactor (RVFB).** In this study, the recycled vertical flow bioreactor (RVFB) is developed for the removal of chemical contaminants from Grey Water. Synthetic Grey Water, enriched with wastes from a dining hall, was added to experimental RVFB systems. The greywater was recirculated for 2–3 days at which time half of the water was removed from each system and replaced with fresh synthetic GW. RVFB system follows working principles of trickling filter and vertical flow constructed wetland. Effluent coming from RVFB system have reduced concentrations of NO_3-N, total ammonia nitrogen, NO_2-N, total suspended solids, boron, and anionic surfactants to below the levels acceptable for either recreation or irrigation. Effluent from RVFB system have final E-coli concentration that meet the USEPA water quality criteria for recreational water.

2.7. Vijaya V. Shegokaret. al **(**2015) studied **Design and Treatability Studies of Low Cost Grey Water Treatment with Respect to Recycle and Reuse in Rural Areas.** In this research study, laboratory scale grey water treatment system is designed which consists five stages of physical operation such as raw grey water unit, sedimentation, first filtration unit of sand and gravel, second dual filtration and storing unit for treated grey water. Second dual filtration of capacity 5 litres containing granular activated carbon and zea maize fodder. The inlet and outlet samples were analyzedfor the physical and chemical parameters such as total suspended solids, total dissolved solids, turbidity, total hardness, Chemical oxygen demand (COD) and Biochemical oxygen demand (BOD). From the analysis, it was observed that nylon rope filter showed better performance in the filtration stage as compared to dual filters, and individually used activated carbon filter and zea maize fodder filter. This grey water treatment system is significant and efficient for rural communities for treatment and reuse of grey water as it uses the natural and easily available low cost materials, negligible energy demand, low operation and maintenance cost and lesser timeconsuming operation. As per the Indian standard, the treated water could be used for toilet flushing.

2.8. Ishwar Patil et. al (2022) studied **Grey Water Reuse For Toilet Flushing.**This study explains grey water recycling system for treating grey water produced from kitchen drain, washing machines and bathroom drains. In this filtration unit is developed which contains plastic container, coarse aggregate, sand, charcoal and cotton. The collected grey water is passed through filtration unit and final effluent after filtration is tested for parameters like pH, COD, BOD, Turbidity and Total Solid. It was observed that average COD value of greywater sample after treatment is found to be 220 mg/lit .This treated water can be used for car washing, gardening etc. purposes.

2.9. Surjit Singh (2016) studied **Grey Water Treatment and its Application in Cultivation of Plants.** In this study, grey water is treated by primary, secondary and tertiary treatment. The GW sample was collected from the water generated in the bathroom, laundry and kitchen. The total volume of the GW that used for the study was 5lit. Filtration unit is designed which contains coconut shells, wood shavings, pebble, stone chips, activated charcoal and sand. Water sample collected from filtration is treated 5 g of alum and allowed to stand for 24 hrs at roomtemperature. After filtration, aerobic biological treatment is given to the water in which non-pathogenic strains of Aspergillusniger, Penicillium sp. and Pseudomonas spwere mixed with filtered water from primary treatment in the ratio of 1:1 in a flask. Then it passes to the bed reactor treatment. After this treatment, water passes to the process of removal of Nitrogen. Tertiary treatment is given to the water sample for removal of additional suspended solids,

refractory organics, heavy metals and dissolved solids. The laboratory treatment process yielded 85.6% of water post treatment. 100% germination rate was found for treated grey water so that it can be used for irrigation purposes in drought prone areas.

2.10. Kheria M. Essa (2018) studied **Design a Grey Water Treatment System for a Virtual Building Working by Solar Energy**. In this study, grey water treatment system is designed for a government building. This system consists of sedimentation, sand filtration, carbon filtration and collection tank. Treated water can be used directly for irrigation. Inlet and outlet samples were analyzed in laboratory for parameters such as Total Suspended Solids, Total Organic Carbon, Chemical Oxygen Demand and Biochemical Oxygen Demand. It was observed that after carbon filtration COD removal rate was66 %, BOD removal rate was 73 % and TSS removal rate was 60%. Effluent water obtained from this treatment system is of good quality and can be used for irrigation purpose.

3. Advantages of Grey water and its Reuse:

1. Reuse of Grey water reduce freshwater extraction from rivers and aquifers.
2. It is rich in phosphorous, potassium and nitrogen making it a good nutrient or fertilizer source for irrigation.
3. It helps in recharging the ground water.
4. Reuse of Grey water reduces the load on sewage treatment plant.
5. Reduction in generation of wastewater will reduce potential of environmental pollution.

4. Conclusion:

This study reviewed that grey water can be treated using various physical and biological treatments like Aerobic filter, constructed wetland, sedimentation, sand filtration, carbon filtration, activated carbon filter,Recycled Vertical Flow Bioreactor (RVFB) and Phytoremediation chamber. Quality of Grey water obtained through this treatments which is useful for various purposes like irrigation, car washing, gardening, floor washing, toilet flushing and for construction purposes. Filtration is the most commonly used treatment for grey water. Materials required for filtration are locally available. Application of such green technologies is become an economically and environmentally friendly solution for water management. Reuse of grey water can be considered as alternative solution for conservation of water resources. Encouraging to installgreywater treatment systemsthrough various aspects like rules and regulations, public awareness programmes at rural and urban level will solve water scarcity problems of that area.

5. References:

[1] Sonali Manna, (2018), “Treatment of Gray Water for Reusing in Non-potable Purpose to Conserve Water in India”, International Journal of Applied Environmental Sciences, Vol. 13, No. 8.
[2]J. S. Lambe and R. S. Chougule, “Greywater- Treatment and Reuse”, Journal of Mechanical and Civil Engineering, ISSN: 2278-1684.
[3]Jatin G. Bhadiyadra, and Minakshi V. Vaghani (2015), “A Review on Applicability of Photocatalyst Titanium dioxide for Treatment of Greywater”, Int. Journal of Engineering Research and Applications www.ijera.com ISSN: 2248-9622, Vol. 5, No. 3.
[4]Petter D. Jenssen and Lasse Vrale (2003), “Treatment of Grey water using Aerobic Filter followed by Subsurface Horizontal Flow Constructed Wetland in Cold Climates”, Second International Conference on Ecological Sanitation, Germny.
[5]Saroj B. Parjane and Mukund G. Sane (2011), “Performance of Grey Water Treatment Plant by Economical Way for Indian Rural Development”, International Journal of Chem Tech Research, Vol. 3, No. 4.
[6]Randhir Bute, Ekta Waghmare, Ajay Sarode , Amit Chandekar, Abhijit Sawwalakhe and Kailash Bondre (2017), “Treatment of Grey Water Using Technique of Phytoremediation”, International Research Journal of Engineering and Technology, Vol. 4, No. 3.
[7] Dhanu Radha Samayamanthula, Chidambaram Sabarathinam and Harish Bhandary, (2019), “Treatment and effective utilization of greywater”, Applied Water Science.
[8] Amit Gross, Drora Kaplan and Katherine Baker (2007), “Removal of chemical and microbiological contaminants from Domestic Greywater using a Recycled Vertical Flow Bioreactor (RVFB)”, Ecological Engineering, Vol. 31.
[9]Vijaya V. Shegokar, Dilip S. Ramteke and Pravin U. Meshram (2015), “Design and Treatability Studies of Low Cost Grey Water Treatment with Respect to Recycle and Reuse in Rural Areas”, International Journal of Current Microbiology and Applied Sciences, Vol. 4, No. 8.
[10] Ishwar Patil, Pranit Pawar, Heramb Pawar and Rohit Yadav (2022), “Grey Water Reuse For Toilet Flushing”, International Research Journal of Modernization in Engineering Technology and Science, Vol. 4, No. 4.
[11] Surjit Singh, Neha Pradhan, Nupur Ojha, Bodhisattva Roy and Sutapa Bose(2016), “Grey Water Treatment and its Application in Cultivation of Plants”, Asian Journal of Microbiology, Biotechnology, Environmental Science, Vol. 18, No. 4.
[12] Kheria M. Essa, Hashem A. Mahdi and Mohammed H. Mohammed (2018), “Design a Grey Water Treatment System for a Virtual Building Working by Solar Energy”, Engineering and Technology Journal, Vol. 36, No. 1.
[13] Abeer Albalawneh and Tsun-Kuo Chang (2015),Review Of The Greywater and Proposed Greywater Recycling Scheme For Agricultural Irrigation Reuses, International Journal of Research- Granthaalayah, Vol. 3
[14] Instruction manual for recycling using grey water.pdf.
[15] WHO and UNICEF JMP website homepage, WHO, Geneva and UNICEF, New York, June 10, 2012.
[16] Peavey H. S., Rowe D.R. (1985), “Environmental Engineering”, McGraw-Hill Book Company.
[17] Dr. P. N. Modi, (2006),”Wastewater Engineering”, Standard Book House.
[18] Hammer M.J. (1998), “Water and Waste water Technology”, Prentice-Hall of India Pvt. Limited.
[19] National Environmental Engineering Research Institute (NEERI), (2007) “Greywater Reuse in Rural Schools”, Wise Water Management, Guidance Manual.
[20] Solid and Liquid Waste Management in Rural Areas: A Technical brief note by unicef.
[21] Website:-www.everwater.com.au www.greywater.com.