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Monograph

on

Grey Water Treatment

Authors

Mrs. Shruti A. Gomkale

Mr. Abhiram Tapas

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PREFACE / ABSTRACT

Any home wastewater generated, but not sewage, is referred to as grey water. The organic loading is the primary distinction between grey water and sewage (or black water). Comparing to grey water, sewage has a substantially higher organic burden.

Authors

Mrs. ShrutiA.Gomkale

Mr. Abhiram Tapas

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ABOUT THE AUTHORS

Mrs.ShrutiA.Gomkale
Assistant Professor
Department of Applied Chemistry
YCCE,Nagpur

Er.Abhiram Tapas

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1. INTRODUCTION

The term "grey water," which is also spelt "grey water" in the United States, or "sullage" refers to wastewater produced in homes or offices from streams free of faeces, i.e., all streams other than those containing toilet waste. Sinks, showers, bathtubs, washing machines, and dishwashers are some places where grey water may be found. Grey water is often safer to handle and easier to clean and reuse on-site for applications like toilet flushing, landscaping or crop irrigation, and other non-potable uses since it contains less pathogens than residential wastewater.

By lowering the need for fresh, clean water as well as the quantity of wastewater that has to be transported and processed, the use of grey water reuse in urban water systems enhances both the supply of water and sewage subsystems significantly. Processed grey water may be used for a variety of purposes, such as irrigation or sewage treatment.

Greywater, being only slightly polluted but representing the larger part of a household's wastewater, can be easily treated and reused in single or apartment houses, offices or tourism facilities, thus tremendously reducing freshwater demand. Greywater usage include flushing toilets, watering gardens and other outdoor spaces, as well as doing laundry and even taking showers. The method of treatment and the standard of the treated greywater will need to be adjusted for the intended uses. Normally greywater is collected seperately in each building or group of connected buildings, treated in a decentralised system and fed into a supply network for service water in the same building. There are a wide range of decentralised treatment techniques and ready made treatment devices available worldwide, not all being marketed in all countries. Among the most successful techniques are sequencing batch reactors (SBR), membrane bio-reactors (MBR), constructed wetlands (CW) and similar systems.

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1.1 WHY THERE IS A NEED TO RECYCLE AND REUSE

Most bathroom sinks, showers, tubs, and washing machines all produce greywater, which is gently used water. No water from the toilet or the washing of diapers has come in touch with faces. Traces of debris, food, grease, hair, and certain home cleaners may be present in greywater. Greywater is a harmless and even useful source of irrigation water for a yard, despite the fact that it may appear "filthy." Remember that while nutrients in greywater are beneficial to plants as fertilizer, they become contaminants if dumped into rivers, lakes, or estuaries. Reusing your greywater keeps it out of the sewage or septic system, preventing it from polluting nearby water bodies in addition to the aforementioned advantages of conserving water (plus money on your water bill). Urban dwellers and our backyard plants are reconnected to the natural water cycle by reusing greywater for gardening.

Greywater may be used most simply by piping it outside and using it to water trees or decorative plants. Vegetable seedlings can also be watered with greywater as long as no comestible parts of the plants are touched. It is crucial to utilise "plant friendly" products in any greywater system, meaning those low in salt, boron, or chlorine bleach. Plants can be harmed by the accumulation of salts and boron in the soil. Check careful for your personal health while you're doing it because "natural" beauty products can include harmful ingredients for people (see resource pages below for details).

1.2 IMPURITIES PRESENT IN GREYWATER

Most bathroom sinks, showers, tubs, and washing machines all produce greywater, which is gently used water. Feces have not been in touch with water, either from using the toilet or from washing diapers. Traces of debris, food, grease, hair, and certain home cleaners may be present in greywater.

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1.3 ANALYSIS OF GREY WATER

After collecting various tests such as pH, turbidity, hardness, dissolved solid, dissolved oxygen, biochemical oxygen demand and chemical oxygen demand.

pH – 5-9

TSS is directly proportional to turbidity

Water hardness is due to presence of calcium and magnesium ions Conductivity is directly proportional to salinity

1.4 TESTING PARAMETER

1.4.1 Total Dissolved solids (TDS)–Total amount of change ion including mineral, sulphate , water metal is called TDS.

1.4.2 Potential of Hydrogen (PH) –It is a measure of hydrogen ion concentration, a measure of acidity or alkalinity of a solution.

1.4.3 Electrical conductivity (EC)–One of the important factors that affects total suspended solids is electrical conductivity (EC) (TDS). Renovated greywater had an average EC and TDS of 4910 S/cm and 3140 mg/L, correspondingly.

1.4.4 Dissolved Oxygen (DO)– The proportional amount of oxygen that is dispersed in wastewater and is accessible to support life, especially live bacteria, is

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known as dissolved oxygen (DO) in biological treatment. A biological floc made up of live bacteria is what is referred to it as a biological treatment since it uses an aerobic treatment process in an aeration system to cleanse effluents wastewater.
Living things require oxygen because it is required for the oxidation of wastes to provide energy for growth. For secondary or biological treatment of wastewater, oxygen control is therefore necessary. Processes for controlling the concentration of dissolved oxygen in the aeration system's activated sludge as well as effluent discharge, reclamation, and recycling.

1.4.5 Biological Oxygen Demand (BOD) -The optimum air flow rate is frequently determined by blending rather than oxygen concentration needs when low Biochemical Oxygen Demand (BOD) wastewater is treated. This holds true for both disseminated air systems and mechanically aerated air systems. Whenever the dissolved oxygen concentration in mixed liquor is 2 mg/L or above, oxygen needs are often satisfied. The ideal dissolved-oxygen levels, however, might differ greatly from one facility to another. In high-purity oxygen processes, low dissolved-oxygen conditions have been noted, with dissolved-oxygen values as high as 10 to 12 mg/L. To find the right dissolved-oxygen concentration for your system, it is advisable to experiment.

1.4.6 Chemical Oxygen Demand (COD)-Greywater's typical COD ratios have been around 0.31 and 0.71, indicating shows that over half of the organic matter is biodegradable (Halalsheh et al. 2008). Nevertheless, higher ratios of up to 4:1 have been noted in other research (Boyjoo et al. 2013).

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2. LITERATURE REVIEW

2.1MATERIALS AND METHODOLOGY:-

2.1.1 Syntheticgreywater:-

Thechemicalconfigurationofsyntheticgreywaterhasbeenstatedin Table1(NazeemandMeera,2013).Theformulatedgreywatersamplewasused fortreatment studies.

Table:-2.1Chemicalconstituentsofsyntheticgreywater

S. no	Chemical	Concentration (g/L)
1.	Glucose	0.3
2.	Sodium acetate trihydrate	0.4
3.	Ammonium chloride	0.22
4.	Potassium dihydrogen phosphate	0.075
5.	Di-Sodium hydrogen phosphate	0.15
6.	Magnesium Sulphate	0.05
7.	Cow dung	0.25

NOTE:-THISTABLEFROMDESINEANDDEVOPLEMENTOFGREYWATER

2.1.2. The synthetic grey water:-was prepared by weighing all the ingredients and subsequently mixed with 500 mL water in a blender at low speed for one minute. The feed tank was filled with 20 liters of tap water followed by addition of concentrated ingredient mixture. The grey water was then kept at rest. To ensure complete mixing of the chemical ingredients, the grey water should be kept at rest for at least nine hours or overnight, then the homogenized sample was drawn from the mixture and analyzed for determining basic physicochemical and microbiological parameters.

2.1.3 Real grey water:-Real grey water was prepared by mixing water derived from the bathroom, washing clothes and kitchen in different proportion (J S Lambe et al.,) The domestic source of water comprised of effluent generated

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from hand washing, bathing and washing clothes. Kitchen water was collected from a nearby canteen. All these formulations were mixed to pretend organic and inorganic pollution of grey water. Simulated grey water was analyzed for the basic parameters prior to treatment studies.

2.1.4Treatment method:-The pilot treatment plant had been designed for effective treatment and reuse of grey water. Treatment scheme includes Prefiltration, Electrochemical AdvancedOxidation Process (EAOP) followed by Ultrafiltration. The ceramic membrane was used as an ultrafiltration unit, for addressing the problems associated with high concentration of organic and inorganic constituents, nutrients, oil, and grease. The treatment method influences the oxidative mineralization of organics for making it suitable for recycling. The units of the pilot plant include SS mesh filter, EAOP flow cell, AC to DC power supply, ultrafiltration membrane, membrane housing (SS) with flanges and fitting, magnetic chemical resistance feed pump, rotameters, pressure gauge electrical control panel and sensors.

2.1.5 System configuration:-The SBR generator was made from a 19.0 cm diameter transparent Plexiglas cylinder with a working volume of 5 L and a total volume of 11 L. Two peristaltic pumps, one for influent intake and the other for effluent discharge, were installed in the reactor. For thorough mixing, a mechanical agitator (30 rpm) was used. An aerator that pumped air (5 L/min) via an aeration tank at the reactor cores base was used to aerate the mixture. The schematic diagram of the SBR reactor is shown in Fig. 2. Loading, reactivity, settlement, and effluent discharge are the typical five phases of SBR operations. The timing of the

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sequences was automatically managed by the computer.

2.1.6 Start up of SBR:-In preparation for startup, the reactor was infected with activated sludge from a nearby municipal wastewater treatment facility. The concentrations of mixed liquid suspended solids (MLSS) were held constant at 2.5 0.3 g/L. Prior to the commencement of the studies, the SBR had been run in alternating anoxic-aerobic conditions for 20 days to establish steady state. Without using any controls, the reactor was run at ambient temperature. Two cycles per day were completed by the SBR system. One cycle (12 hours) comprises of 30 minutes of influent feeding, 5 hours of anoxic and aerobic conditions, 1 hour of sludge settling, and 30 minutes of effluent discharge. To reduce sludge formation, a set sludge retention time (SRT) of 10 days was established. Hydraulic retention times (HRTs) of 0.6 and 2.5 days were used. The HRT was set at 0.6 days at the beginning of SBR operation.

2.1.7 Pilot treatment plant

The pilot treatment plant was designed for effective treatment and reuse of grey water. The major components of the pilot plant include an EAOP flow cell, AC to DC power supply, ultrafiltration membrane, membrane housing (SS) with flanges and fitting, magnetic chemical resistance feed pump, rotameters, pressure gauge, electrical control panel, and sensors. As per the design, acompact modular mobile skid was erected using stainless steel 304-grade material, treatment units were mounted inside the skid and pipelines were installed.

2.1.8 Experimental Method

The dimensionally stable anodes are leveraged extensively in lieu of conventional electrodes. These electrodes possess high current efficiency, but the active radicals

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generated cause only partial degradation of waste materials (Oliveira et al., 2007). Presently, boron-doped diamond electrode has also gained great attention of researchers and is utilized on a large scale for EAOP due to certain properties which distinguish it from other conventional electrodes, such as high resistance towards corrosion, high capacity to generate HO radicals and inert nature (García-Espinoza et al., 2018; Svorc et al., 2017). Investigators have tried to alter the amount of electricity applied by increasing it by few amperes and observe its impact on the degradation of waste materials. It was observed that with increment in the applied electricity the degradation rate of waste materials also got enhanced. Also, extending the duration of applied electricity further improved the degradation rate (García-Espinoza et al., 2018).

Grey water was treated in the lab-scale electrochemical cell under batch mode. The electrochemical cell consisted of a powerful, non-selective anode was incorporated in the electrochemical cell to support the generation of hydroxyl radical. The total cell area is 42 cm2. Treated liquid was constantly pumped through the oxidation chamber during the treatment process. Connecting the electrolytic cells to regulated DC power source instigated electrolytic reaction with the advent of the applied current. Treated samples were taken at time 0, 0.25, 0.5, 1, 2, 3 and 4 h, for various qualitative analysis.

A known volume of (20 L) grey water sample was taken in a container and the sample was pumped to flow through electrolytic cell. As electrodes connect to a regulated DC power source, the electrolytic reaction occurs. The experiment was conducted within the stipulated electrolysis time period (3 hours). A scientific investigation conducted in similar lines was referred to gain an idea about the appropriate voltage required specifically for each experiment. During the electrolysis,mples were drawn at 30 minutes interval and the parameters of treated water were determined to leverage standard methods. The pre-treated sample was made to pass through the ceramic membrane in batch mode at specific operational conditions. Final treated water was analysed on the basis of physicochemical and microbiological parameters.

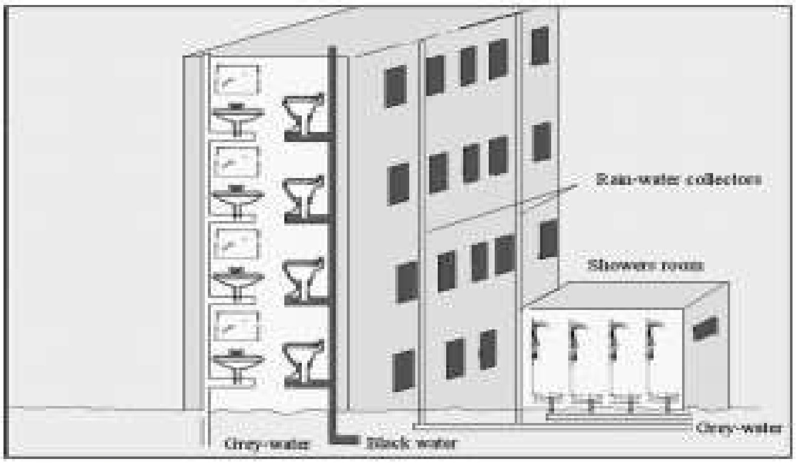

Fig. 1. Schema of streams of wastewaters in students house.

Table:-2.2Characteristicsof wastewaterusedasfeedtoSBR

Table 1
Characteristics of wastewater used as feed to SBR

Parameters	*N*	Min	Max	Average	SD
pH	11	7.5	7.9	7.6	0.4
TSS (mg/L)	16	23	50	33	16
COD (mg/L)	23	25	300	102	86
BOD_5 (mg/L)	11	15	140	97	56
TOC (mg/L)	13	12	67	32.6	32
NH_4-N (mg/L)	14	1.2	15.2	6.7	5.6
NO_2-N (mg/L)	14	ND	0.2	0.0	0.2
NO_3-N (mg/L)	14	ND	1.2	0.2	0.1
PO_4-P (mg/L)	14	2.8	11.3	3.5	4.8
TKN (mg/L)	10	4.2	20	8.1	3.7

N: number of samples.

2.1.1 Analytical procedures:-Standard techniques were used to analyse the parameters for MLSS, total suspended solids (TSS), chemical oxygen demand

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(COD), biochemical oxygen demand (BOD5), ammonium, and sludge volume index (SVI) [6]. Ionic chromatography was used to analyse nitrogen molecules such as nitrates and nitrites (Waters 432). Using the vanado-molybdophosphoric technique, the ortho-phosphate was quantified. Using TOC Analyzer, TOC was discovered (TOC-550A, Shimadzu). Before being supplied to chromatographic columns, samples were filtered via a 0.45 m screen to remove suspended particles.A thorough cycle analysis has been done by monitoring the amounts of COD, N-NO3, N-NO2, N-NH4 and P-PO4 in order to obtain more specific information about the effectiveness of the reactor to pollutant removal.

2.2 USEOFGREYWATERFORIRRIGATINGVEGETABLES

According to Holtzhausen (2005) and Al-Zu'bi and Al-Mohamadi (2008), using residential grey water for agricultural irrigation in small home gardens provides a number of benefits. It reduces the consumption of precious freshwater resources, which is obviously a benefit. According to studies, boosting irrigation sources could result in a roughly 30% decrease in home potable water use (Jeppesen, 1996). Additionally, grey-water irrigation boosts plant growth and agricultural output without affecting the crop's quality, as demonstrated by various research (Day et al., 1981; Rusan et al., 2007; Misra et al., 2009). (Day et al., 1981; Zavadil, 2009). Regardless on how it is handled, grey-water has both good and negative environmental impacts on soils. Grey water, for instance, is frequently dumped on the ground close to habitations in rural regions, posing a number of health and environmental risks, including the contaminating of wetlands and subterranean water supplies as well as the penetration of salts, oils, and grease into the soil (Van Vuuren, 2007). Grey-organic water's content, however, might lead to the

2.2.1 Experimental site:- The Umtata Dam Research Station (31°30’04”S 28°42’24.5”E) north-west of the town Umtata, Eastern Cape Province, was http://dx.doi.org/10.4314/wsa.v41i1.14Available on website http://www.wrc.org.za ISSN 0378-4738 (Print) = Water SA Vol. 41 No. 1January 2015 116 ISSN 1816-7950 (On-line) = Water SA Vol. 41 No. 1 January 2015 chosen asthelearningsite(Fig.1).Rainfall at this location ranges from 800 to 950 mm per year, falling primarily between October and March throughout the summer (Prinsloo and Schoonbee, 1984). The location is perfect for carrying out an experimental investigation of this kind since it provides a secure environment and is overseen by the Eastern Cape Provincial Department of Rural Development and Agrarian Reform. In addition, low-wage Department employees were permitted to construct shack homes right outside the property's yard since they couldn't pay Umtata rents. Together, these homes represent a tiny informal village, illustrating the underserved circumstances found in South Africa's unofficial housing.

2.2.2 Soilsampling:-After each growing season, soil samples were collected individually from the patches that had been irrigated with potable water, diluted grey-water (grey-water that had been blended with potable water in a 1:1 ratio), and undiluted grey-water. Across various soil depths inside every plot, namely 0-10 cm, 10-30 cm, 30-60 cm, and 60-90 cm, a total of 32 soil samples per treatment (8 samples per season) have been collected. The presence of Na, Fe, K, Mn, Cu, Zn, Ca, P, Mg, Cd, Pb, Ni, Cr, EC, and pH were then determined in a laboratory using samples of the both water and

soil (KCl).

Assessment of water quality No variations in pH or Mg were found between the potable and grey water treatments (Table 2). Nevertheless, when grey water was

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utilised in the experiment, there have been considerably higher values for Cl-, EC, HCO3 -, Na+, sodium adsorption ratio (SAR), and total dissolved solids (TDS) ($p>0.05$), as well as significantly greater $CaCO_3$ hardness of the potable water. As anticipated, when reduced greywater was evaluated versus the concentrated grey-water solution, all quantities were lower. These findings revealed that, despite being within the maximum of 100 mg/l specified in the South African Water Quality Guidelines, grey water contains increased quantities of Na+ (15 mg/l) and Cl- (16 mg/l) ions (Fatoki et al., 2002). Grey-pH water's of 6.7 is within the normal pH range (6.5-8.4), indicating that it probably qualifies for irrigation (Bauder et al., 2014). The measured EC was within a range of 40 to 200 mS/m, although the increased EC values might raise the danger to human health, vegetation, or soil (Rodda et al., 2011). Grey-water usage resulted in an average EC of 50 mS/m, with at minimum one sample from the analysed samples reaching the top quartile of 70 mS/m.

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3. RESEARCH PAPERS

3.1 DESIGN AND DEVELOPMENT OF GREY WATER REUSE SYSTEM

As of 2016, KurpaKadekoppa had Grey water is an additional water source that has the ability to conserve a sizable amount of precious drinking water. The primary focus of the current work is on treating greywater to prepare it for use in a variety of applications. The oxidative mineralization, disinfection, and filtering of grey water are all included in the laboratory-scale grey water treatment system described in this study. Real grey water plus synthetic grey water have been used in the laboratory size treatability trials. The COD removal efficiency of 85 and 90 percent, the TSS removal efficiency of 98 and 86 percent, and the faecal coliform extraction efficiency of 99 and 96 percent, respectively, showed that the grey water treatment system removed the pollutants effectively. The study's conclusion that the treated water had low turbidity

(1 NTU) and no suspended particles could be extrapolated.

3.1.1 SYNTHETIC GREY WATER

(Nazeem and Meera, 2013).has done The formulated grey water sample was used for treatment studies. Table 1: Chemical constituents of synthetic grey water S. no Chemical Concentration (g/L) 1. Glucose

0.3 2. Sodium acetate trihydrate 0.4 3. Ammonium chloride 0.22 4. Potassium dihydrogen phosphate

0.075 5. Di-Sodium hydrogen phosphate 0.15 6. Magnesium Sulphate 0.05 7. Cow dung 0.25 The synthetic grey water was prepared by weighing all the ingredients and subsequently mixed with 500 mL water in a blender at low speed for one minute. The feed tank was filled with 20 liters of tap water followed by addition of concentrated ingredient mixture. The grey water was then kept at rest. To ensure complete mixing of the chemical ingredients, the grey water should be kept at rest for at least nine hours or overnight, then the homogenized sample was drawn from the mixture and analyzed for determining basic physicochemical and microbiological parameters. 2.2. Real grey water Real grey water was prepared by mixing water derived from the bathroom, washing clothes and kitchen in different proportion (J S Lambe et al.,) The domestic source of water comprised of effluent generated from hand washing, bathing and washing clothes. Kitchen water was collected from a nearby canteen. All these formulations were mixed to simulate organic and inorganic pollution of grey water. Simulated grey water was analyzed for the basic parameters prior to treatment studies. 2.3. Treatment method The pilot treatment plant had been designed for effective treatment and reuse of grey water. Treatment scheme includes Prefiltration, Electrochemical Advanced Oxidation Process (EAOP) followed by Ultrafiltration. The ceramic membrane was used as an ultrafiltration unit, for addressing the problems associated with high concentration of organic and inorganic constituents, nutrients, oil, and grease. The treatment method influences the oxidative mineralization of organics for making it suitable for recycling. The units of the pilot plant include SS mesh filter, EAOP flow cell, AC to DC power supply, ultrafiltration membrane, membrane housing (SS) with flanges and fitting, magnetic chemical resistance feed pump, rotameters, pressure gauge electrical control panel and sensors. Fig. 1: Schematic of grey water treatment Collection tank EAOP cell EAOP treated water tank P

Assessment of the grey-water used to irrigate crops and potential impacts on the soils near Umtata Dam in the Eastern Cape

LL Mzini1 * and K Winter2

Döhne Agricultural Development Institute, Private Bag X45, Stutterheim, 4930, South Africa

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Department of Environmental and Geographical Sciences, University of Cape Town, Private Bag X3, Rondebosch, 7701, South Africa

An innovative field was set up near the Umtata Dam, north-west of the town of Umtata, to test grey-water quality and its impacts on soil nutrient content after 4 sequential growing seasons. This was done in an effort to seek alternative and dependable water sources to desalinate vegetables for backyard gardens. Grey water samples were taken from kitchen and bathroom tubs and washing basins in the unofficial housing complexes close to the Umtata Dam. Before being utilised to irrigate vegetable fields, these specimens were examined. The findings demonstrated that the quality of grey water was "fit for purpose" for use in irrigating edible vegetable plants.

Accumulation of graywater Before the study began, grey-water measurements were collected drawn from the shack homes for 3 days in a row. A calibrated HANNA Combo pH and EC, portable metre (model HI 98129), was used to analyse the pH and EC of the these samples. Those tests have been carried out to show the quantity needed for daily irrigation and also the cleanliness of grey water. The average pH and EC values were well below 7 pH and 25 mS/m, respectively, although being variable and at an appropriate standard for irrigation (Bauder et al., 2014). Six samples every season being collected from the collection containers positioned among the unofficial homes for a total of 24 water samples per treatment. Within every plot, a mix of root and leafy crops were sown for each of the four growing seasons (four seasons total) in the correct sequence: lettuce and beetroot, spinach and beetroot, cabbage and onions. Although they were noted, the yield, aesthetic value, chemical composition, and bacterial content (Enterococcus, Streptococcus, and E. coli) of these vegetable crops were outside the purview of the inquiry discussed here. soil analysis After each growing season, soil samples were taken directly from of the plots that had been irrigated with potable water, diluted grey-water (grey-water that had been reduced with potable water in a 1:1 ratio), and undiluted grey-

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water. At various soil thicknesses inside every plot, namely 0-10 cm, 10-30 cm, 30-60 cm, and 60-90 cm, a total of 32 soil samples per intervention (8 samples per season) were collected. The presence of Na, Fe, K, Mn, Cu, Zn, Ca, P, Mg, Cd, Pb, Ni, Cr, EC, and pH were then determined in a laboratory using samples of both soil and water (KCl). At the Döhne Laboratory in Stutterheim, samples were examined. To ascertain cations (Ca, Mg, K, Na, Cu, Mn, Fe, and Zn) using flame atomic absorption spectrometry, and to analyse heavy metals (Cd, Pb, Cr, and Ni) using a graphite furnace, Döhne Laboratory, an AgriLasa (Agricultural Laboratory Association of Southern Africa) member, used the following methodology (Thomas 1982).

Assessment of water quality No variations in pH or Mg were found between the drinkable and grey water procedures (Table 2). Nonetheless, when treated wastewater was utilised in the investigation, there were considerably higher values for Cl-, EC, HCO3 -, Na+, sodium adsorption ratio (SAR), and total dissolved solids (TDS) ($p>0.05$), as well as substantially larger CaCO3 harshness of the potable water. As anticipated, when attenuated greywater was evaluated versus the saturated grey-water mixture, all quantities were lower. These findings revealed that, despite being within the maximum of 100 mg/l specified in the South African Water Quality Guidelines, grey water contains increased quantities of Na+ (15 mg/l) and Cl- (16 mg/l) ions (Fatoki et al., 2002). Grey-pH water's of 6.7 is within the normal pH range (6.5-8.4), indicating that it probably qualifies for irrigation (Bauder et al., 2014).

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3.2 USE OF ESSENTIAL OILS IN THE PURIFICATION OF GREY WATER

Although the antibacterial characteristics of several plant essential oils (EOs) are widely recognised, their application for the disinfection of water has gotten little attention, according to Gideon P. Winwarda (2008). This study evaluated the effectiveness of these alternative "natural" disinfectants for the reuse of grey water. Origanum oil (Thymus capitatus) and carvacrol were shown to exhibit the strongest antibacterial activity after eight EOs and their constituent parts were subjected to toxicity testing. Up to 94 mg L1 of origanum EO had no impact on total coliform levels in grey water over the course of a 30-min contact period, while 468 mg L1 rendered total coliforms undetectable in 100 mL of grey water. It was discovered that EO contact time increased coliform inactivation. Grey water's organic content and particle size have been proven to impair the effectiveness of origanum EO disinfection. Both with and without preceding UV light disinfection, origanum EO inhibited the regrowth of coliform bacteria in grey treated wastewater by reed beds for up to 14 days at a concentration of 468 mg L1.

The ingredients and essential oils were supplied by Sigma-Aldrich (Dorset, UK), and they were used precisely as they were given. However, despite the fact that the original amounts were included within the findings' footnotes for meaningful comparisons with results in the literature, the quantities were converted to mass using the tested substances' specific gravities (Table 1). The origanum oil used in the majority of the research was made using Thymus capitatus L. (Labiatae) Hoffmanns& Link and had a phenol content of 65.4% by weight

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(common name: Spanish oregano; synonyms: Coridothymuscapitatus or Thymus capitatis).

Detoxification with essential oils All water samples and solutions were brought to room temperature via equilibration (1871 1C). To achieve the desired concentration, origanum EO was applied directly to a volume of water sample (p0.5% of total volume) in a pyrex bottle. The sample was maintained in the dark at 1871 °C for 10 seconds while being forcefully shook to ensure that the essential oil was distributed throughout the sample. After the specified contact time, samples were shook erratically for 10 seconds, and the total number of coliforms was counted.

UV sanitization As detailed by Bolton and Linden, UV inactivation tests and collimated beam operation were conducted (2003). Using a magnified image beam apparatus (Wedeco AG, Germany) with four low-pressure UV lamps and a pneumatically controlled shutter, samples were subjected to 254 nm UV-C irradiation. According to uridine actinometry (DVGW, 1997), the applied UV fluence rate was 2.08 mW cm2, and exposure period regulated the UV dosage (or fluence). The UV exposure period was changed to account for the sample's depth and UV transmittance. After UV treatment, samples were transferred to sterile vials and analysed right away, or they may be kept at 571 1C for a period of about two h before being counted for total coliforms.

3.3 BIOLOGICAL TREATMENT OF GREY WATER USING SEQUENCING BATCH REACTOR

M. Lamine (2007) accomplished The purpose of this study was to evaluate how grey harvested rainwater at the outflow of student shower rooms may be treated using sequencing batch reactor

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(SBR) technologies. Given that the effluent contained 20 and 5 mg/L of COD and BOD, correspondingly, the efficiency of the SBR was good. The removal of nitrogen and phosphorus might be enhanced while adjusting to changes in load thanks to the application of two hydraulic retention times (HRTs).

At the bathing room's outlet, the grey water from students' homes was collected. Table 1 lists the properties of the grey wastewater. The widely used calculating software EXCEL performs a statistical analysis to a relatively easy criterion. System configuration (2.2) The SBR reactor was made from a 19.0 cm diameter transparent Plexiglas cylinder with a moment magnitude of 5 L and a total volume of 11 L. Two peristaltic pumps, one for influent feeding and the other for effluent discharge, were installed in the reactor. For thorough mixing, a mechanical agitator (30 rpm) was used. An aerator that pumped air (5 L/min) via an air stone at the reactor's base was used to aerate the mixture. The schematic representation of the SBR reactor is shown in Fig. 2. Filling, reaction, settlement, and effluent discharge are the typical five phases of SBR operations. The timing of the sequences was continuously managed by the computer.

Launch of SBR In preparation for startup, the reactor was infected with activated sludge from a nearby municipal wastewater treatment facility. the amalgam Fig. 1. Diagram showing wastewater streams at a student's home. Table 1: Wastewater characteristics utilised as a feed for SBR N: sample count.

SBR efficiency By testing COD, TSS, BOD5, PO4-P, and nitrogen

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compounds in effluent, the effectiveness of the SBR was originally assessed. Table 2 displays the entire period of the interrogations. High COD removal was attained in the reactor during the whole operational time, and the discharge COD at two HRTs was over 20 mg/L.

3.4 A KINETIC METHOD TO GREY WATER TREATMENT AND REUSE UTILIZING RBC

In order to evaluate the possibilities for water reuse, Ahmet Babana (2010) looked into grey water treatment using rotating biological contactors (RBC). The research examined description of the influent, setup and operation of two RBCs, evaluation of the effluent's conformance for reuse, and estimation of the biofilm dynamics. Models with monod and variable orders were used. We assessed the thickness and weight per unit area of the biofilm. The biofilm matrix experienced simultaneous nitrification and mineralization activities. The clearance efficiencies of CODT and TKN were around 85% and 75%, respectively. The average value of BOD5 in the effluent was 7 mg L1. A classic zero-order, 0° kinetic connection was seen in the reaction. The rate constant for 0° was calculated to be 5.7 1.5. Grey water that had been treated was sterilised using UV light. We evaluated our process to various grey water treatment processes for efficiency, operational simplicity, dependability, and staff needs. Conclusion: RBC may be used to treat grey water in an efficient manner, and the treated effluent can then be utilised to flush toilets. Nevertheless, it is advised that filtering be used to further eliminate biofilm-derived detached particles.

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3.5 RECYCLE OF GREYWATER

Prashant Kumar (2017) has done For any living being water air, sustenance, protect and so on are the essential needs, for which water has the best significance. In old circumstances each individual or family was dependable to orchestrate their water supplies. There were no aggregate endeavours however with time urbanization came into picture and accordingly the aggregate endeavours for arrangement of water began. However, this urbanization created a significant issue of asset depletion like water. In this manner it is of prime significance to oversee water assets in most ideal way so that future era could survive. Two prompt reactions to counter this test are proficient assignment of the rare assets, and improvement and utilization of option wellsprings of water. While 'water markets' are viewed as a way to accomplish proficient portion of the alarm assets, treated wastewater and low-quality water are presently considered as potential wellsprings of water to supplement the freshwater supplies. The last choice that is utilization of recycled water as an option, with a fruitful and very much arranged reuse plan can accomplish manageability of water assets around the globe. Wastewater reuse has been demonstrated to enhance the weight on thewater environment and forestall water contamination. Grey water is one such sort of wastewater produced from household exercises, for example, clothing, dishwashing, and showering which can be reused nearby for utilizations, for example, scene water system, flushing and built wetlands. The aim of this paper is to study the part of greywater reuse in economical water

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administration in urban areas. This paper additionally depicts different ways to deal with reuse and reuse of greywater.

3.5.1 IDEAS FOR GREYWATER REUSE

There are different techniques that can be utilized for Greywater treatment ideal from basic ease gadgets that course greywater specifically to applications, for example, toilets and garden water system, to very intricate and expensive progressed organic treatment forms joining sedimentation tanks, bioreactors, channels, pumps and purification frameworks. There are various greywater frameworks economically accessible, and may incorporate at least one segments including: essential solids division, oil and oil evacuation, filtration, oxygen consuming organic treatment, coagulation and flocculation, and purification. Some of these frameworks can expel contaminations and microbes from greywater and the better frameworks incorporate settling tanks, organic reactors and sand channels, empowering the treated greywater to be put away until required without unfavorable conditions happening (like foul smells, erosion, and so on.) yet the strategy which ought to be taken after must be best and monetary or at the end of the day ideal in nature.

3.6GREY WATER REUSE FRAMEWORK CAN BE EXTENSIVELY ARRANGED INTO TWO

GangwarAshit (2017) has done Essential grey water frameworks: These frameworks specifically reuse basically untreated residential greywater from a solitary family staying for sub-surface grass and

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additionally cultivate watering with negligible treatment. These frameworks don't permit stockpiling or treatment, aside from some surge stockpiling and coarse screening/filtration which expels hair, build up and coarse particles. Greywater preoccupation frameworks which fall under this class, can be both planned into new homes, or retrofitted to many existing homes. Such frameworks utilize a redirection gadget is presumably the easiest and most normal strategy for greywater reuse. Different Diversion Technologies are accessible in the market Advantages Straightforward manual (hand modify or preset) operation ,Very low support necessities (periodmanual screen cleaning) ,Ability to occupy greywater for quick reuse as required or coveted ,Very low capital and working expense. Disadvantages No or restricted (screening) treatment gave, Cannot be put away without danger of smell and different issues Does not murder or lessen the quantity of illness bringing on microorganisms (pathogens) that might be available, Reuse application normally constrained to quick sub-surface water system as it were Optional grey water frameworks In these frameworks greywater must be dealt with and put away for can/urinal flushing as well as grass and garden watering including surface watering strategies. Greywater from all sources after thorough treatment (eg. screening, sedimentation, organic treatment, sand or potentially carbon filtration, film methods and cleansing) plans to accomplish high caliber of the treated greywater. Auxiliary greywater frameworks might be utilized for numerous inhabitance structures. Advantages Potential for high level of natural treatment, High level of operations adaptability to suit shifting greywater strength, Suitable for treating blended

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wastewater for reuse applications if gushing is sifted and sterilized – which additionally permits the reuse water to be put away Disadvantages Complex operational necessities, High working expense, High capital cost Can be liable to process irritates because of high grey water streams.

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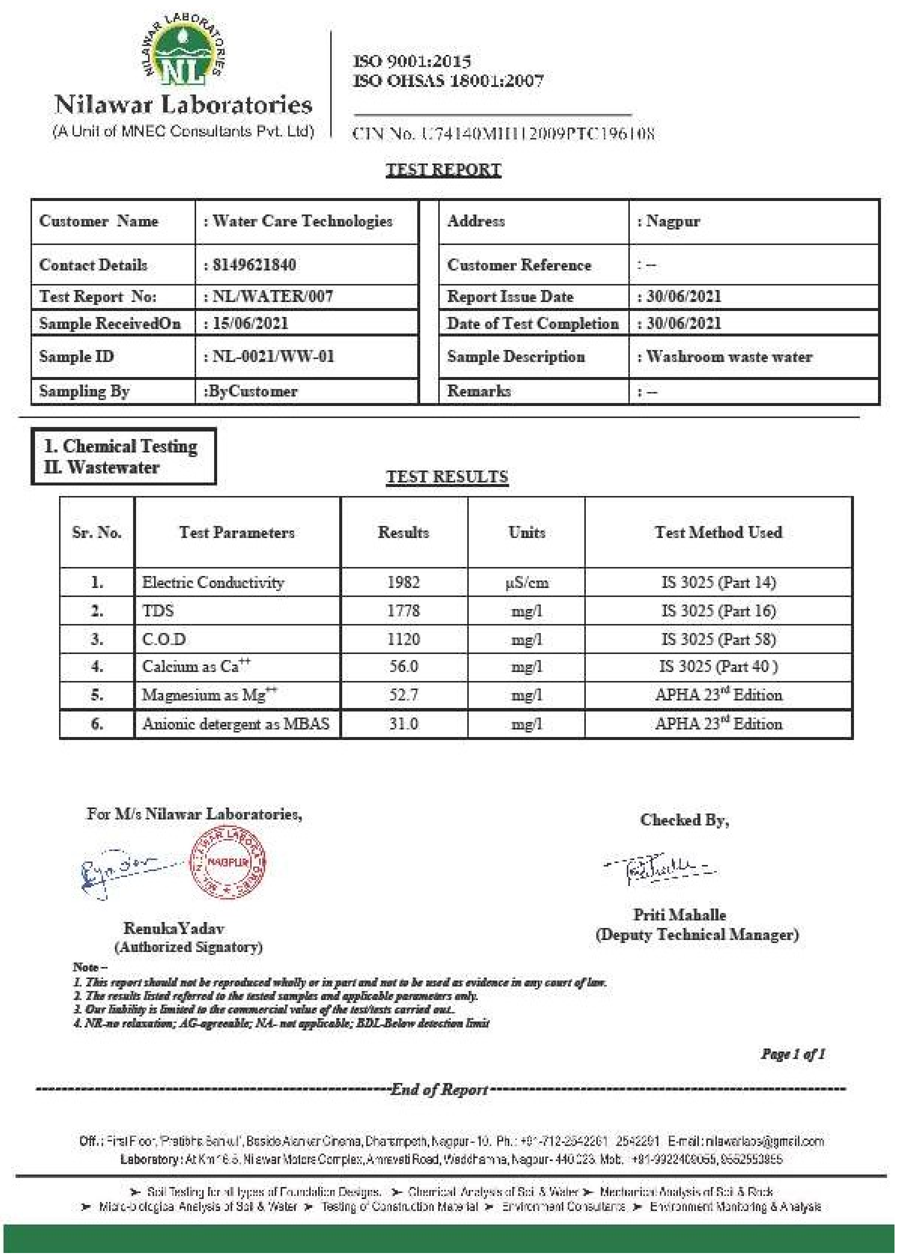
4 REPORTANDDESINING

4.1TESTING REPORT



Nilawar Laboratories
(A Unit of MNEC Consultants Pvt. Ltd)

ISO 9001:2015
ISO OHSAS 18001:2007

CIN No. U74140MH2009PTC196108

TEST REPORT

Customer Name	: Water Care Technologies	Address	: Nagpur
Contact Details	: 8149621840	Customer Reference	: --
Test Report No:	: NL/WATER/007	Report Issue Date	: 30/06/2021
Sample ReceivedOn	: 15/06/2021	Date of Test Completion	: 30/06/2021
Sample ID	: NL-0021/WW-01	Sample Description	: Washroom waste water
Sampling By	:ByCustomer	Remarks	: --

I. Chemical Testing
II. Wastewater

TEST RESULTS

Sr. No.	Test Parameters	Results	Units	Test Method Used
1.	Electric Conductivity	1982	µS/cm	IS 3025 (Part 14)
2.	TDS	1778	mg/l	IS 3025 (Part 16)
3.	C.O.D	1120	mg/l	IS 3025 (Part 58)
4.	Calcium as Ca^{++}	56.0	mg/l	IS 3025 (Part 40)
5.	Magnesium as Mg^{++}	52.7	mg/l	APHA 23rd Edition
6.	Anionic detergent as MBAS	31.0	mg/l	APHA 23rd Edition

For M/s Nilawar Laboratories,

RenukaYadav
(Authorized Signatory)

Checked By,

Priti Mahalle
(Deputy Technical Manager)

Note –
1. This report should not be reproduced wholly or in part and not to be used as evidence in any court of law.
2. The results listed referred to the tested samples and applicable parameters only.
3. Our liability is limited to the commercial value of the test/tests carried out.
4. NR-no relaxation; AG-agreeable; NA- not applicable; BDL-Below detection limit

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-------------------------*End of Report*-------------------------

Off.: First Floor, 'Pratibha Sankul', Beside Alankar Cinema, Dharampeth, Nagpur - 10. Ph.: +91-712-2542261 2542291 E-mail: nilawarlabs@gmail.com
Laboratory: At Km 16.5, Nilawar Motors Complex, Amravati Road, Waddhamna, Nagpur - 440 023. Mob. +91-9922400055, 9552553855

➢ Soil Testing for all types of Foundation Designs. ➢ Chemical Analysis of Soil & Water ➢ Mechanical Analysis of Soil & Rock
➢ Micro-biological Analysis of Soil & Water ➢ Testing of Construction Material ➢ Environment Consultants ➢ Environment Monitoring & Analysis

Fig.no1testing report

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4.2EVALUATION OF REPORT

As the report shows that Chemical Oxygen Demand (COD), Electric Conductivity (EC), Total Dissolve Solid (TDS) and detergent level is high in the sample tested. So, we want to design a system which will minimize the level of impurities stated above.

4.2.1 CHEMICAL OXYGEN DEMAND:-

The quantity of oxygen that can be absorbed by processes in a measured environment is indicated by the term "chemical oxygen demand" (COD). It is frequently stated as the mass of oxygen used over the volume of the solution, or milligrammes per litre (mg/L), in SI units. The quantity of organics in water may be easily measured with a COD test. Taking into account the quantity of oxidizable contaminants present in surface water (such as lakes and rivers) or wastewater is the most typical application of COD. Similar to biochemical oxygen demand, COD is helpful for assessing the quality of groundwater by giving a measure to assess how an effluent would affect the receiving body (BOD).

4.2.2 ELECTICAL CONDUCTIVITY:-

Greywater's electrical conductivity has been determined from the measured among 14 and 3000 S/cm (Ciabatti et al. 2009; Prathapar et al. 2005). Due to dissolved minerals, high electrical conductivity is typically linked with groundwater sources and places where there is a shortage of water.

4.2.3 TOTAL DISSOLVED SOLID:-

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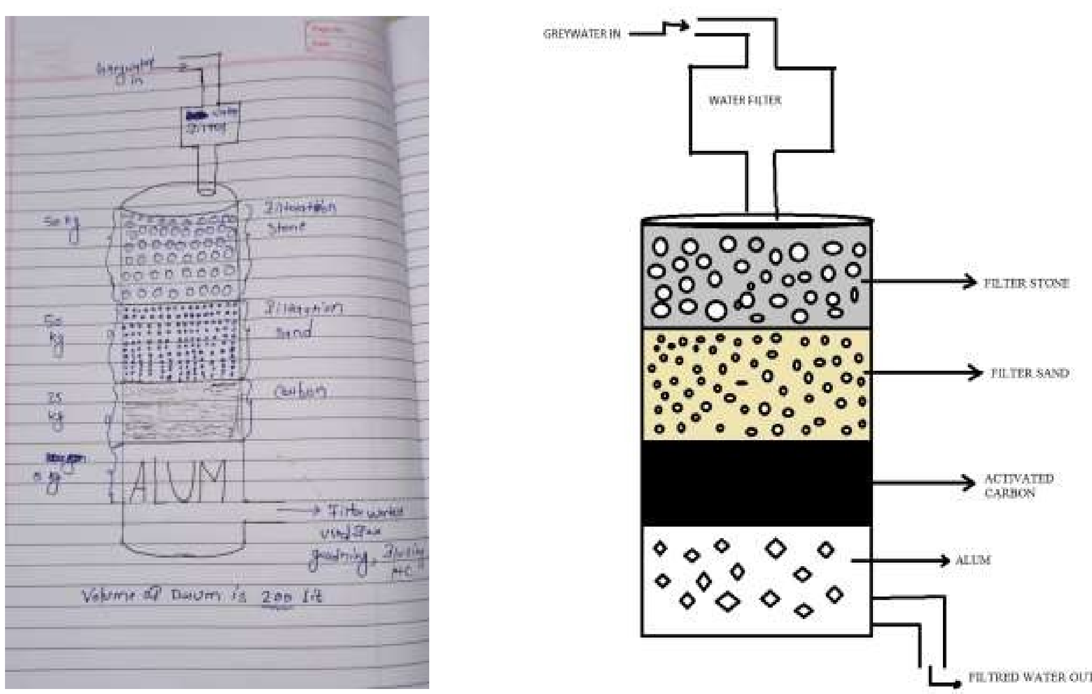
The pH was decreased from 10.29 to 7.94, and the TDS of processed greywater was decreased from 4910 to 1508 mg/L, which would be likewise lower than that of the TDS in groundwater including both aquifers.

4.3MODEL FOR GREYWATER TREATMENT



figno.2modeldesign

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4.4. ACTUALMODELPICTURE

Fig.no3actualmodel design

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4.5 DESCRIPTION:-

- The system consists of a drum of 200 liters volume.
- Water filter is used for filtering the suspended solids and the filtered water is sent to the drum.
- In the filter impurities like human air, some solid material is separated.
- Firstly, the grey water is passed through a layer of filtered stone. In this the remaining suspended impurity which gets along with the water is retained.
- Then the water further passes through a layer of filtered sand.
- Then the water gets along through a bed of activated charcoal. Here the impurity having the electrical charge gets attached to charcoal.
- Finally the grey water passes through the main coagulant, that is the alum. Here the TDS, COD level is minimized.
- Then a drain is provided for the outlet of grey water which can be used for gardening and flushing purpose.

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CONCLUSIONS:-

According to the study's findings, the concentrations of nutrients and heavy metals in the grey-water samples were significantly lower than those recommended by the World Health Organization for the secure use of grey-water (WHO, 2006), and they were also within the target water quality range (TWQR) allowed by South African irrigation guidelines (DWAF, 1996). However, grey water must be diluted in order to reduce the salt level and increase the quality of irrigation water in order to prevent long-term dangers to the land and ecosystem. It is also advised that additional research be done on the dilution rates of potable water and grey water. Additional than the 1:1 ratio employed, no other dilution rates were to be determined in this investigation.

Note:-thisconclusion isonlyfor useofgreywaterirrigatingvegetables.

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