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A Review on Greywater Treatment by using Coconut Shell

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ABSTRACT

Wastewater is any water that has been contaminated by human use and activities. Wastewater is used water from any combination of domestic, industrial, commercial or agricultural activities and any sewer inflow or sewer infiltration. Therefore, wastewater is a after product of domestic, industrial, commercial or agricultural activities and use. Also there is scarcity of water situation going on since ages in the entire country. Therefore there is a need to make into use the waste water by treating it by such means that another system should not get disturb and also those means should be affordable and easy to apply in practical work. The issue of greywater management – which is defined as all sources of domestic wastewater excluding toilet wastewater – is gaining more and more importance, especially in developing countries where improper wastewater management is one of most important causes for environmental pollution and fatal diseases. In recent years not only the threats of improper greywater management have been recognised; there is an increasing international recognition that greywater reuse, if properly done, has a great potential as alternative water source for purposes such as irrigation, toilet flushing and others. The present study reviews the recent developments in grey water treatment using coconut shell.

KEYWORDS- Greywater, Coconut Shell, Wastewater, BOD, COD, TSS

1. INTRODUCTION

1.1 Background of the study

Grey water is the waste water that is produced from the households stuff or office buildings from the channels without feces i.e. the water not from the toilets. Grey water contains less pathogen compared to the toilet water. The water collected is free from all types of feces and excretion process. This project proposes a sustainable greywater filtration system for residential-scale water reuse. Recycled greywater can be used in toilet water, outdoor irrigation, car washing, and clothes washing, reducing the demand for potable water. Although pilot-scale systems have been demonstrated for greywater recycling, residential-scale applications remain unexplored, as treatment options on a residential scale are limited.The extent of industrial wastewater generation is largely unknown. Globally, information focusing on the volume of wastewater produced by industry is very deficient. The water may be recycled within a plant or by another linked industry, or it may be simply discharged, returning it to the hydrological cycle for others to use. The study showed that about 80% of the water turns out as wastewater. Out of the wastewater produced, 62% is greywater, 25% is dark grey water 13% is blackwater (Ministry of Urban Development, Thiruvananthapuram, 2011). When separately collected, sullage can be conveniently treated and restored to the original characteristics of tap water (Taydeet al., 2015). Sullage water is the wastewater free from fecal contamination generated from households, institutes and offices. Since, Water is one of the most abundant resources but still around 700 million people face a shortage of water. Due to inadequate access to clear water, approximately 200000 people die every year (Shelaret al., 2019). Although India occupies 3.29 million km2 of geographical area and supports 15% of the world's population with 4% of the total water resources (Lambe and Chougule, 20). Thus, it clearly shows that water scarcity, inappropriate sanitation and waste water pollution are important issues. Due to rapid increase in population and development, there is an urgent need to look after alternative approaches for water availability. Water supply and waste water management problems can be solved by using a decentralised approach which can be done by reuse of greywater (Ghaidiak and Yadav, 2013). Bark and charcoal filters can be used for grey water treatment which helps in reducing their organic amount to irrigation level. This is due to the property of bark filters to remove microorganisms. Whereas, charcoal has a large specific surface area due to which it helps in removal of BOD 5. Similarly, a sand filter provides high nitrification but low nitrogen removal (Dalahmeh, 2013). In the following work, initially activated charcoal is prepared from coconut shell and colour removal of grey water takes place by its treatment with chemically activated charcoal due to which change in physicochemical properties has been observed.The purpose of this project is to prepare a cheap, cost efficient, simple, affordable and sustainable treatment of grey water for household purposes. Activated charcoal and sand filters were evaluated for the purpose of grey water filtration. The treated grey water can be used for non-potable purposes such as irrigation, car washing, urinals and toilet flushing, fire protection, etc. To achieve this objective samples were collected from households and series were collected from households and series of treatments such as pH, TDS, Alkalinity, BOD, COD were carried out. We have compared the results of effluent (chemical and physical properties) from slow sand filtration and slow sand filtration aided with Activated Charcoal filter. Thus, from the results an attempt has been made to prepare a household model for the treatment of Grey water by using activated charcoal and then reusing it for various purposes. This project will help to understand a new approach of an environmental friendly household filtration techniques.

Characteristics of greywater:A large compilation of data concerning physical and chemical characteristics of greywater was done by (Eriksson et al., 2002). Generally greywater is divided in four greywatercategories based on its origin: bathroom, laundry, kitchen and mixed origin. In this semester work the characteristics are based on the compilation of (Ledin et al., 2001a), which is not as extensive as (Eriksson et al., 2002), but partially uses the same sources, so giving the same ranges of values. (Casanova et al., 2001) showed in their study about the Casa del Agua in Arizona that the overall microbial, chemical and physical quality of untreated household greywater lies somewhere between raw wastewater and secondary effluent.

Parameters affecting the characteristics of greywater: The composition of greywater depends on several factors, including sources and installations from where the water is drawn:

- quality and type of the water supply (groundwater well or piped water)
- type of distribution net for drinking water - type of distribution net for greywater (because of leaching from piping, chemical and biological processes in the biofilm on the piping walls)
- activities in the household (lifestyle, custom and use of chemical products)
- installation from which greywater is drawn (kitchen sink, bathroom, hand basin or laundry wash)
- type of source: household or industrial uses like commercial laundries
- geographical location
- demographics and level of occupancy
- quantity of water used in relation to the discharged amount of substances

Greywater exhibits significant variations in composition; within a specific sample group, within an individual showering or bathing operation and also between reported schemes. The variation between the schemes reflects differences in washing habits both in terms of product type and concentration used by an individual. The relatively small scale of the majority of greywater schemes means that the variations seen from an individual can have a pronounced impact on the overall characteristics of the greywater to be treated (Jefferson et al., 2001). The composition of greywater also varies with time because of the variations in water consumption in relation to the discharged amount of substances.

An important effect has the chemical and biological degradation of the chemical compounds, within the transportation network and during storage. Chemical reactions can take place during storage and transportation of greywater, and thereby cause changes in the chemical composition of the water. Biological growth may lead to increased concentrations of microorganisms including faecal coliforms. This may also cause new organic and inorganic compounds to be produced as metabolites from partly degraded chemicals present in the greywater. The presence of nutrients such as phosphate, ammonium/ nitrate and organic matter will promote this microbial growth (Eriksson et al., 2002); (Ledin et al., 2001a).

The quintessence is that a large number of chemical compounds and microorganisms can be present in the greywater. The content of chemicals of a specific greywater can be based on the "declaration of contents" present on the packages of chemical products as well as on industrial production statistics (Ledin et al., 2001a); (Eriksson et al., 2002).

1.2 Advantages of Activated Carbon

Activated carbon are specially treated material which undergoes the chemical process to increase the adsorption capabilities of the material. Various material are used for the activated carbon which includes coal(anthracite , bituminous, sub-bituminous and lignite), coconut shells, wood(both soft and hard). Some materials have also been evaluate like wall- nut shells, olive stones and palm kernels. In our project we have used the coconut shells as the activated carbon material as there is a abundance of coconut farming in konkan area. The activated carbon using coconut shell will be economical in preface as the filter media with the slow sand filter at house hold level also.

[Fig.1.1: Greywater Filter]

1.3 Motivation of Research

India holds 17.5% of the world's population yet it only contains 4% of the world's fresh water resources, which are declining in terms of both supply and quality. Although drinking water was once considered safe in India, today providing the nearly 1.2 billion inhabitants with access to safe drinking water is an increasingly difficult challenge. Groundwater sources are being rapidly depleted, surface water sources are largely contaminated and the infrastructure needed to deliver drinking water both in urban and rural areas is either non-existent or needs substantial upgrades to meet demand.

1.4 Scope & Objectives

- The main objective of this grey water filtration using slow sand filter with activated charcoal is to meet the need of water for household purposes (urinal and toilet flushing, irrigation of lawns, washing of vehicles and windows, fire protection.
- Grey water has relatively low nutrient and pathogenic content and therefore it can be easily treated to a high quality water using simple techniques such as sand/gravel filters or using activated charcoal, etc.
- With Grey water filtering and recycling, it is possible to reduce freshwater consumption as well as wastewater production.
- To compare the results of effluent (chemical and physical properties) from slow sand filtration and slow sand filtration aided with Activated Charcoal filter.

- The objective of this project is to prepare a cheap, efficient, affordable and sustainable grey water treatment system or slowsand filter for filtration of grey water for household.

2. LITERATURE REVIEW

2.1 Wastewater

"Wastewater" Definition

The term "wastewater" refers any water that has been used or polluted, and contains waste products. Wastewater is approximately 99% water; only 1% is a mixture of suspended and dissolved organic solids, detergent, and cleaning chemicals. "Sewage" is one kind of wastewater. It includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. Sewage treatment, or municipal wastewater treatment, is the process of removing contaminants from wastewater and household sewage. It includes physical, chemical, and biological processes to remove organic, inorganic and biological contaminants.The typical composition of municipal wastewater (after pretreatment) most often treated in CWs contains suspended solids, organic matter, and in some instances, nutrients (especially total nitrogen) and heavy metals, as shown in Table 2 **(Tchobanoglous& Burton, 1991**). Domestic sewage wastewater typically contains 200 mg of suspended solids, 200 mg biochemical oxygen demands, 35 mg nitrogen, and 7 mg phosphorus per liter**(Volodymyr, Sirajuddin, & Viktor, 2007).**

Table 2.1 : Contaminations Concentration in the Typical Untreated Domestic Wastewater

Parameter	Unit	Weak (Concentration)	Medium (Concentration)	Strong (Concentration)
TS	Mg/L	350	720	1200
TDS	Mg/L	250	500	850
TSS	Mg/L	100	220	350
BOD	Mg/L	110	220	400
COD	Mg/L	250	500	1000
TN	Mg/L	20	40	85
TP	Mg/L	4	8	15
Total Coliform	No/100mL	10^6-10^7	10^7 ~ 10^8	10^7 ~ 10^9

2.2 Wastewater Reuse and Reclamation

During the last century, the increasing demands for freshwater coupled with environmental concerns about the discharge of wastewater into ecosystems and the high cost and technology requirements of wastewater treatment have spurred processes in water reclamation and reuse. Early development stems from the land application for the disposal of wastewater, following the admonition of Sir Edwin Chadwick—"the rain to the river and the sewage to the soil" **(National Research Council of the National Academies, 1996, p. 17).** Such land disposal schemes were widely adopted by large cities in Europe and the United States in the 1900s.With the development of sewerage systems, domestic wastewater was firstly considered to be reused by farms. California was the pioneer in wastewater reuse and has the most comprehensive regulations pertaining to the public health aspects of reuse. By 1910, 35 California communities were using sewer water for irrigation (Recycled Water Task Force, 2003). In 1918, the California State Board of Public Health promulgated the initial Regulation Governing Use of Sewage for Irrigation Purpose, pertaining to irrigation of crops with sewage effluents. In 1929, the city of Pomona, California, initiated a project using reclaimed wastewater for the domestic irrigation of lawns and gardens **(Ongerth& Harmon, 1959)**. In 1965, the Santee, California recreational lakes, supplied with reused wastewater, were opened for swimming.Today, as more advanced technologies are applied for water reclamation, the quality of reclaimed water can exceed conventional drinking water quality based on most conventional parameters. Water reclamation or water purification processes could technically provide water of almost any quality desired **(Asano, 1998).**

2.3 Conventional Wastewater Treatment

The conventional wastewater treatment process consists of a series of physical, chemical and biological processes. Typically, treatment involves three stages, called primary, secondary and tertiary treatment.

2.3.1 ***Primary treatment*** is used to separate and remove the inorganic materials and suspended solids that would clog or damage the pipes. Primary treatment consists of screening, grit removal, and primary sedimentation. Screening and grit removal may also be called “preliminary treatment.” Large debris, such as plastics, rags, branches, and cans are removed by the screens, while smaller coarse solids, such as sand and gravel, are settled by a grit chamber system. Then wastewater is moved into a quiescent basin, with a temporarily retention; the heavy solids settle to the bottom while the lighter solids, grease and oil float to the surface. The settled and floating pollutants are removed by sedimentation and skimming, with the remaining liquid then discharged to undergo secondary treatment. Typically, about 50% of total suspended solids (TSS) and 30% to 40% of BOD are removed in the primary treatment stage **(Nelson, Bishay, Van Roodselaar, Ikonomou, & Law, 2007).**

2.3.2 ***Secondary treatment*** removes dissolved and suspended biological matter. Typically, up to 90% of the organic matter in the wastewater can be removed through secondary treatment by a biological treatment process **(U.S. EPA, 2004b).** The two most common conventional methods used to achieve secondary treatment are attached growth processes and suspended growth processes. In attached growth (or fixed-film) processes, the bacteria, algae and microorganisms grow on a surface and form a biomass. Attached growth process units include trickling filters, biotowers, and rotating biological contactors. In suspended growth processes, the microbial growth is suspended in an aerated water mixture. The most common of this type of process is called “activated sludge.” This process grows a biomass of aerobic bacteria and other microorganisms that will breakdown the organic waste.

2.3.3 ***Tertiary treatment*** is sometimes defined as advanced treatment; it produces a higher-quality effluent than do primary and secondary treatment in order to allow discharge into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, coral reefs, and others). The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality to the desired level. This advanced treatment can be accomplished by a variety of methods such as coagulation sedimentation, filtration, reverse osmosis, and extending secondary biological treatment to further stabilize oxygen-demanding substances or remove nutrients. As wastewater is purified to higher and higher degrees through such advanced treatment processes, the treated effluent can then be safely and appropriately reused.Before the treated wastewater is discharged, ***a disinfection process*** is sometimes required. Water systems add disinfectants to kill pathogenic microorganisms. The purpose of disinfection in the treatment of wastewater is to substantially reduce the number of microorganisms in the water to be discharged back into the environment, and it is almost always the final step in the treatment process regardless of the level or type of treatment used. Common methods of disinfection include chlorine, and ultraviolet light. The treated water can be discharged into a stream, river, lagoon, or wetlands, or it can be used for landscape irrigation. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.

1. KarnapaAjit (2016) Plain filtration was achieved in discharge standards by disinfectant .Removal of phosphates and surfactant can be achieved.
2. NargesshAmabadi, Hasan Bakhtiari, NafiseKochakian, MahamoodFarahani (2015) The quality of wastewater generated in different units ,including the administration and training units, the dormitories and the kitchen was determined.
3. Sandhya Pushkar Singh, Nusrat Ali, SabihAhmad,Dr.J.K. Singh, Manoj Kumar(2015) The reuse of grey water in certain countries will solve many problems related to water scarcity, and will lead to the saving of financial resources.
4. Vijaya V Shegokar (2015). The sample was analyzed for the physical and chemical parameters to check the quality of grey water and subsequently used the data for the selection of treatment process. (v) Amr M. Abdel-Kader(2013) Sand filtration unit prior to the disinfection for the RBC system is virtually recommended to comply with the reuse criteria.
5. J. S. Lambe, R. S. Choughule(2015) The optimization of resources can be achieved.

3. PROPOSED METHODLOGY

1. The first step consists of collecting the grey water sample from the sources.
2. Calculate the impurities in the sample.

3. The turbidity, TSS and the pH value Test for the sample before treating the water sample would be taken.
4. Pass the sample from the filter for treating the grey water.
5. Collect the resulting sample and testing its pH, turbidity and TSS value tests.
6. By comparing both the results, we can conclude the resulting form of the treated grey water.

Materials used:

1. Coarse aggregate
2. fine aggregate
3. sand
4. soil
5. coconut shells

- Coarse Aggregate: Coarse aggregate is often used as filtration medium to terminate the solids comes with wastewater and reduces the turbidity of water (Gnanaraj et al., 2019). In this project the two sizes of aggregate like, 6-8 mm and 12-16mm which is washed several times to remove all the dirt's from the surface of aggregates.
- Fine Aggregate: Fine aggregates were works as physical strainer and biological renovator to help the pathogens to die. It also helps to decrease the COD of wastewater. The size of 0.5-1.0mm sand was sieved and washed 2 to 3 times to remove small particles and dried of (Gnanaraj et al., 2019).
- Activated Carbon: Activated carbon has been used to clean water as a water filtration media. Activated carbon's primary function is to absorb colour and odour. Due to its great adsorption capability, granular activated carbon was extensively utilised to remove pollutants from water.

Conduct Test:

1. pH : The digital pH meter was used to calculate the pH value for waste water sample and after it was used to calculate the pH value of treated water.
2. Turbidity : The turbidity test was used to test the turbidity value in the waste water sample and after wards it was used to check the value of turbidity of the treated water.
3. Colorimeter (TSS) : The colorimeter was used to determine the total suspended solids {TSS} in the waste water sample. And after it was used for the treated water.

Preparation of Activated Charcoal by using coconut shell: Activated charcoal, (also called activated carbon) is a form of carbon having small pores that helps in increasing the surface area available for adsorption. All the activated carbon with more micropores show high specific surface area as well as total pore volume which depends upon the activation time prolonging; the highest ones were around 3100 m2 /g and 1.5 mL/g, respectively (Lin and Zhao, 2016). Coconut is a member of the palm tree family known for its versatility of uses. The shell of coconut contains cellulose, lignin, charcoal, tar, tannin etc. Coconut shell is first collected and then cut into small pieces, followed by washing with simple tap water for removal of dust adhering to it. It was followed by drying in sunlight and grinding into a powdered form called coconut husk. This powdered form is then heated in the oven at 110oC temperature. Dried materials were kept in the muffle furnace at 150°C for removal of other volatile impurities. This leads to the formation of fixed carbon (charcoal). For the first batch, whole fixed carbon is treated at 300oC in a muffle furnace for formation of ash for proximate analysis. The sample was carbonized using a 25% concentrate solution of $CaCl_2$ (Gawande and Kaware, 2017). The soaked sample was transferred into a tray and washed repeatedly with distilled water to remove traces of chemical. The washed sample was transferred into an oven at 110 ℃, cooled and led to formation of chemically activated charcoal and stored for use.

[Fig.3.1: Activated Carbon using Coconut Shell]

Treatment of Greywater:

Greywater can be called as washwaterie, water from bath, dish, laundry except toilet waste and free of garbage residue. A household grey water flow is around 65% of total waste water flow (Ghaidiak and Yadav, 2013). If properly used grey water can become a valuable resource for horticultural and agricultural practices. Water in bathing and hand washing produce 50-60% whereas, cloth washing produces 25-35% and kitchen washing produces 10% of total grey water (Lambe and Chougule, 20). As greywater flow and composition varies daily, weekly and monthly depending upon the various factors (Dalahmeh, 2013). To understand the area of application, physicochemical tests like BOD, COD (as per ASTM D1252), turbidity etc were performed to study the change in quality before and after treatment of grey water (Figure: 2 (From left to right) Greywater, Charcoal added water, Clear water) with activated charcoal. Since, grey water contains metals such as Pb, Ni, Vu, Cd, Hg and Cr in appreciable concentration (Eriksson et al., 2010). Generally, except Mg and Ca, metals like K, Fe, Zn, Cu, Na, Cd and Cr are higher in grey water compared to tap water, whereas, Pb level is similar in all sources of water (Kariuki et al., 2012). Generally, the range of K ions and sulphate ions found in grey water lies between 1-20 mg/L and 2-40 mg/L (Hubicki and Kołodyńska, 2012). These contaminants in grey water indicate the gradual increase in the level of complexity in composition of grey water (Peprahet al., 2018). Along with this, some ions like copper, manganese, cadmium etc also provide colour to it. It is observed that the normal concentration of Cr, Cu and Mn found in grey water lies in the range of 0.2 to 5 mg/L (Inspection Report of STPs in Agra, 2015; The Environment (Protection) Rules, 1986).

4. CONCLUSION

After the whole process i.e. after collecting the treated water from the grey water filter and testing its results from the various test taken it is concluded that the results taken before filtering and after filtering has differences and actually have more approximate value for the potablewater. The water collected can be used further for many outdoor purposes and also can be very much beneficial to the other surrounding and the environment. It is also economical and easy to use the process and eco-friendly in nature.

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Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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