A Study on Grey Water Treatment Processes: A Review

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Abstract— India is facing a water crisis and by 2025 it is estimated that India's population will be suffering from severe water scarcity. Water scarcity leads to problems such as food shortage, decreased economic development, regional water conflicts and environmental degradation and drought problem occur. As the industries are growing day by day the load on effluent treatment and disposal is also increasing. Now the condition is getting worst so new treatment and new techniques are needed to be discovered. This paper presents a review of existing technologies for treatment of grey water. Bioremediation, sand filter and simple technologies have been shown to have limited effect on grey water. GAC (granular activated carbon) low cost adsorbent helps to remove the dye and color pigments. Activated carbon, bark & charcoal filter and Sand filtration technique is the oldest methods for treatment of grey water. Membranes are reported to provide good solid removal. The best methods were observed that combine different types of methods to ensure effective treatment for grey water. Physto-remediation filtration technique is helpful to save the soil nutrients. The treated grey water can be used for non-potable use such as irrigation or gardening toilet flushing, car washing and construction purposes.

Key words: Grey Water, Sand Filter, Bioremediation, Activated Carbon

I. INTRODUCTION

Grey water can be defined as any domestic waste water produced, excluding sewage. In other word we can say that residential grey water is a mixture of all water discharges from the household including bathroom sinks, bathtubs, kitchen sinks, and laundry wash-water sources. Kitchen waste water can contain food particles, grease, oils and fats and its use is not recommended (particularly without treatment). The main differences between grey water and sewage (or black water) is the organic loading, sewage has a much large organic loading compared to grey water. Some people also classified kitchen waste water as black water because it has quit a high organic loading relative to other sources of waste water such as bath water. Due to rapid industrialization and development, there is an increased opportunity for Grey water reuse in developing countries such as India [10]. The quality of grey water can be highly variable due to factors such as number of household occupants, their age, lifestyle, health, water source and products used (such as soaps, shampoos, detergents).

Grey water may contain:

1) Disease causing organisms (bacteria, viruses, protozoa) from nappies and other soiled clothing
2) Chemicals from soaps, shampoos, dyes, mouthwash, toothpaste, detergents, bleaches, disinfectants and other products (such as boron, phosphorus, sodium, ammonia and other nitrogen based compounds).
3) Dirt, lint, food, hair, body cells and fats.

The potential risks to public health and the environmental impact of grey water that can be caused through improperly designed, installed, and maintained systems. Grey water may contain significant levels of disease causing organisms particularly where household members are suffering from a gastrointestinal illness.

II. COMPOSITION OF GREY WATER

A. *Grey Water from Bathroom:*

Water used in hand washing and bathing generates around 50-60% of total grey water and is considered to be the least contaminated type of grey water. Common chemical Contaminants include soap, shampoo, hair dye, toothpaste and cleaning products [8]. The concentration of BOD is 76-200mg/l, turbidity is 60-240NTU, TSS is 48-120 and pH is 6.4-8.1 etc.

B. *Grey Water from Cloth Washing:*

Water used in cloth washing generates around 25-35% of total grey water. Wastewater from the cloth washing varies in quality from wash water to rinse water to second rinse water. Grey water generated due to cloth washing can have fecal contamination with the associated Pathogens and parasites such as bacteria [8]. The concentration of BOD is 48-290mg/l, turbidity is 50-210NTU, TSS is 88-250 and pH is 9.3-10 etc.

C. *Grey Water from Kitchen:*

Kitchen grey water contributes about 10% of the total grey water volume. It is contaminated with food Particles, oils, fats and other wastes. It readily promotes and supports the growth of micro-organisms. Kitchen grey water also contains chemical pollutants such as detergents and cleaning agents which are alkaline in nature and contain various chemicals. Therefore kitchen wastewater may not be well suited for reuse in all types of grey water system. [8]

III. HOW MUCH GREY WATER DO YOU PRODUCE?

According to state and local authorities we each use about 140 litres of water per day for cleaning and washing – grey water. The table below lists the expected volume in litres from each grey water source.

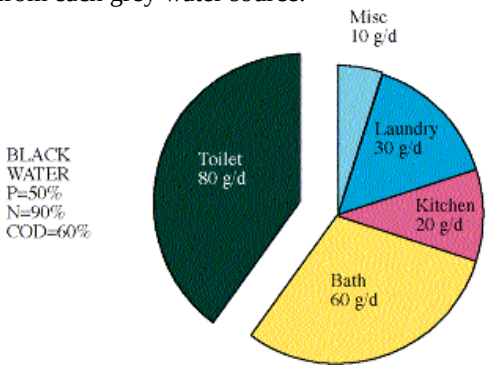

Fig. 1: Domestic demand of water in India is about 135litres/day/person. In developed countries it is about 500litres/day/person. [9]

S.NO.	Sources	% of grey water

1	Bathing	55
2	Laundry	20
3	Washing of house	10
4	Washing of utensils	10
5	Cooking	5
Total		100

Table 1: Grey water generated from domestic use [4]

s.no	parameter	unit	range
1	pH	---------	6.4-8.1
2	suspended solids	mg/l	40-340
3	turbidity	NTU	15-270
4	BOD_5	mg/l	45-330
5	nitrate	mg/l	0.1-1.0
6	ammonia	mg/l	1.0-26
7	total kjeldhal nitrogen	mg/l	2-23
8	total phosphorus	mg/l	0.1-0.8
9	sulphate	mg/l	0.3-12.9
10	conductivity	ms/cm	325-1140
11	hardness	mg/l	15-50
12	sodium	mg/l	60-250

Table 2: Characteristics of Grey water [9]

S.No.	Parameters	Guidelines For Treated Grey Water Quality
1	odor	Non offensive
2	color	< 15 (in hazen units)
3	pH	6-9
4	turbidity	<2 NTU
5	Total residual chlorine	0.5 mg/l to 2 mg/l
6	BOD_5	<5 mg/l
7	Total coli form	<10CFU/100ml
8	E.coli	Non detectable / 100ml
9	Total legionella count	Not applicable

Table 3: Guidelines for treated grey water quality- for recycling of grey water for toilet flushing, general washing, irrigation (3)

IV. Treatment Technologies for Grey Water

Investigations into the treatment and recycling of grey water have been reported since the 1970s. The first technologies studied were mainly physical treatment options such as coarse filtration or membranes, often coupled with disinfection. Later in the 1980s and 1990s, biological based technologies such as rotating biological contactors, biological aerated filters and aerated bioreactors were investigated. In the late 1990s, reports also emerged on the use of advanced technologies such as membrane bio-reactors and cheaper extensive technologies such as reed beds and ponds. Several studies reported that people will favor low cost and low maintenance technologies for economic reasons. In low cost activated carbon, bark and charcoal filter, sand filtration, rice husk ash, fly ashes are generally used. Out of these activated carbon is most effective treatment for grey water.

V. Review and Research Paper

The review of literature presented in this paper collect the information of treatment, reuse and recycle the residential grey water.

A. Krishna Kumar O, K Adithya, Abhilash R and Arvind T

This research paper discussed grey water treatment by the process of BIO-REMEDIATION. Grey water taken from bathroom and sink (basin) are treated using effective micro-Organisms solution and the filtered by the use of sand filter. The major technique involves bio-remediation which includes the use of EM solution for Deodorization and treatment of harmful micro-organism present in dirt water and use of sand filter for filtering purpose. This technique is very simple and economical, thus saving money, water and eco-friendly to the environment. [6]

B. Tiyasha, Shakibala Suraj kr Bhagat

This paper discussed the sand filtration technique is the oldest techniques which are natural filters used for huge wastewater purification. Simultaneously another method of removal of toxic substances from soil and water was developed which is known as physto-remediation. Phytoremediation technique has a large gap of application and research is only in its infancy. The purpose of the paper is to bring these two techniques together and make a design which can be used in small scale like house hold as well as for a whole colony to preserve, treat and reuse wastewater. [11]

C. Rajarshi Kar, Oindrila Gupta

In this research paper, study on the analysis of removal of dye and color pigments (such as ethanaminium) from grey water on synthetic activated carbon. The present work generally focus on the recycle of grey water that is produced from the bathroom, laundry, shower, basin, kitchen (dish washing), which can be recycled on site for uses such as Irrigation, constructed wetland, toilet flushing etc. [10]

D. Kamal Rana, Mitali Shah, Amita Upadhay

A review of those processes has been done to identify the best suitable method at household and community level. Septic tank, constructed wet land and intermittent sand filter are used for treating the grey water. These three steps are best suited decentralized or small scale treatment system discussed in this study. The present studies reviews and suggests the concept of using grey water in various purposes and solves the water scarce problem and reduce the sewage generation. [5]

E. Lucia Hernandez leal, Hardy temmink, Grietje Zeeman and Cees.J.N Buisman.

This research paper presents the study based on the comparison between three systems for Biological grey water treatment at similar hydraulic retention time (approximately 12-13 hr). These three systems are, first is the aerobic treatment in a sequencing batch reactor and second one is the anaerobic treatment in an up flow anaerobic blanket reactor and third is combined anaerobic- aerobic treatment.[7]

F. Mohammed Hasan Al-Mughalles, Rakmi Abdul Rahman, Fatihah Binti Suja' Mastura Mahmud And Sharifah Mastura Syed Abdullah

In this research paper, grey water treatment by using the GAC (granular activated carbon) and sand filter. the system involving a GAC biofilm up-flow expanded bed (UEB) reactor and a slowdown-flow packed sand filter was

established for treating mosque grey water (ablution water). The faecal coliforms (F.C.), chemical oxygen demand (COD), total suspended solids (TSS), nitrate (NO_3), were investigated under continuous flow operation using a hydraulic retention time (HRT) ranging from 1-6 hr over the period from 5/9/2010 to 6/2/2011. The system was arranged so that the GAC reactor is the first stage of treatment, and the sand filter is the second stage. Influent and effluent samples from the system were analyzed weekly. The system demonstrated satisfactory removal of faecal coliforms with removal efficiencies of 63–80 %, and the efficiencies of COD and TSS removal were 70 % and 72 %, respectively. [8]

G. Fangyue Li, Joachim Behrendt, Knut Wichmann and Ralf Otterpohl

This paper evaluated the performance and suitability of a resources and nutrients oriented decentralized grey water treatment system which uses a submerged spiral wound module. This grey water treatment system is aimed at treating and recovering the resources present in the wastewater. The study revealed that the UF membrane filtration system was able to maintain a permeate flux between 6 and 10 L/m2/h. TOC can be reduced from the influent value of 161 to 28.6 mg/L in the permeate, meaning an average elimination rate of 83.4%. In addition, soluble nutrients such as ammonia and phosphorus can pass through the UF membrane and remain in the permeate. The total nitrogen and total phosphorus in the permeate were 16.7 and 6.7 mg/L respectively. The permeate was low in turbidity (below 1 NTU) and free of suspended solids and E. coli and had an excellent physical appearance. [1]

H. Francis W. Kariuki, Kiplagat Kotut and Victor G. Ngángá

This study investigated the low cost technology for the treatment of grey water. . The system comprises of discrete units of barrels that allows for filtration, flocculation, sedimentation and disinfection. GWT system produced water with both pH and electrical conductivity suitable for irrigation according to WHO guidelines. The study concludes that the GWT system can be a sustainable and promising low cost low technology treatment system that can be run and maintained by unskilled operators. [2]

VI. Discussion

Review of study on grey water treatment processes shows that technologies are effective on organic, solid and microbial fractions. Bioremediation, sand filter and simple technologies have been shown to have limited effect on grey water. The use of bioremediation technique we found that the treated water is clean and free from harmful microbes and organic matter and can be utilized for flushing. But there is one limitation of bio-remediation is, in this treatment using EM requires minimum presence of chlorine present in the grey water since large amount of detergent or chlorine presence can destroy the effective micro-organism easily.

GAC low cost adsorbent helps to remove the dye and color pigments. Activated carbon, charcoal and Sand filtration technique is the oldest methods for treatment of grey water. membranes are reported to provide good solid removal . The best methods were observed that combine different types of methods to ensure effective treatment for grey water. phyto-remediation filtration technique are helpful to save the soil nutrients. Physto-filtration technique is also beneficial to the treatment of grey water. This filtration technique is an eco- friendly to the environment. But there are some disadvantages like a) The contaminants are left in place, so the site need stabilization for some time b) Elevated, toxic effects may prevent plants from growing. c) If soil additives are used, they may need to be periodically reapplied to maintain the effectiveness of the immobilization etc.

Aerobic system is preferred to the treatment of grey water but anaerobic system is not feasible for the treatment of grey water. Because the result found that 90% COD removed in aerobic condition and 51% COD removed in anaerobic treatment because high concentration of anionic surfactants influent (43.5mg/l) so the low removal of COD in anaerobic reactor. 89% COD removed in third system. Methane produced 32% for the anaerobic system and 25% for aerobic- anaerobic system. Grey water treatment by GAC and sand filter are effective but this system showed low removal efficiencies of nitrate which was 0–13 %. And no ammonia removal was recorded.

VII. Conclusion

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 which in turn helps to support the economy. Also grey water treatment and reuse are the best way to minimize the potential adverse impacts on plant and human health. Several studies have recommended to reuse the treated grey water which are beneficial to domestics purpose i.e. irrigation, toilet flushing, car washing, constructed wetland etc. Bioremediation technique is suitable for treatment of grey water but aerobic system is feasible as compared to anaerobic system for the treatment of grey water. Physio remediation technique is also beneficial for the treatment of grey water. Different types of adsorbents such as activated carbon, charcoal, coconut shell fly ash and rice husk ash are also used in most of the studies such material help to remove the color, heavy metals, and impurities of grey water. based on the above study I conclude that the treatment of Grey water is not sufficient by these technique & methods alone therefore to treat grey water effectively and efficiently we have to use two or more methods combined and also Further studies have also to be carried out to find out the best treatment method to treat grey water effectively and efficiently.

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