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A literature review on physio-chemical parameters of domestic grey water of residential building

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ABSTRACT

One of the most persistent complications of today is water inadequacy. International Water Management Institute has been estimated that one in three persons will face water inadequacy by the year 2025 in India and as per the United Nations report 2016 around 2.7 billion people by the same time in worldwide. Although India occupies only 3.29 million km^2 geographical areas which form 2.4% of the world's land area, it supports over 15% of world's population with only 4% of the world's water resources. With augmented population progression and development, there is a need to critically look at alternative approaches to ensure water availability. These alternative resources include rainwater and bulk of water used in household will emerge as grey water and contain some organic waste materials dissolved and suspended in it. When this is allowed to flow out this will join the sewage and bacteriologically contaminated, resulting in a sewage stream. It is possible to intercept this grey water, at the household level, treat it so that it can be recycled for using of other purposes.

Keywords— *Physio-Chemical Parameters, Grey Water, Water Scarcity*

1. INTRODUCTION

Grey water is basically a wastewater, generated in buildings from various sources of grey water include sinks, showers, baths, washing machines or dishwashers streams except for the wastewater from toilets. When appropriately managed, greywater can be a valuable resource which can be used for multipurpose. It is considered to be the largest potential source of water reuse option at point source, accounting for around 50% to 80% of the total water use in India. [1] & [3]

1.1 Grey Water Produced

As prescribed by the Central Public Health and Environmental Engineering Organization (CPHEEO), the standard norm for domestic water usage in India is 135 liters per capita per day (lpcd). With rapid expansion of cities and domestic water supply, quantity of gray/wastewater is increasing in the same proportion. As per CPHEEO estimates about 70% to 80% of total water supplied for domestic use gets generated as wastewater. The wastewater generation per capita by the class-I cities and class-II towns is about 72% of urban population in India.

Table 1: Water Requirements and Grey Water Generation as per CPHEEO Estimates [5]

S. No.	Description	Quantity of Water (Per Personal Per Day)	Grey Water Generation (Liters Per Person Per Day)
1.	Bathing	12 - 18	12 - 18
2.	Washing of Clothes	8 – 12	8 – 12
3.	Flushing of Water Closet	5 – 10	-
4.	Washing the Floor/House	2 – 5	-
5.	Washing of Utensils	3 – 5	3 – 5
6.	Cooking	3 – 5	-
7.	Drinking	5 - 8	-

1.2 Need of Study

The objective of this paper is to study the various Physio-chemical parameters of domestic grey water and its scope of reuse of same waste water for other purposes established on the bases of literature review

2. METHODOLOGY

The secondary data will be obtained from the literature review of various published research paper and articles by recognized institutes. The study work includes the efforts for study the physico-chemical parameters of residential grey water and reuse of same waste water for other purposes.

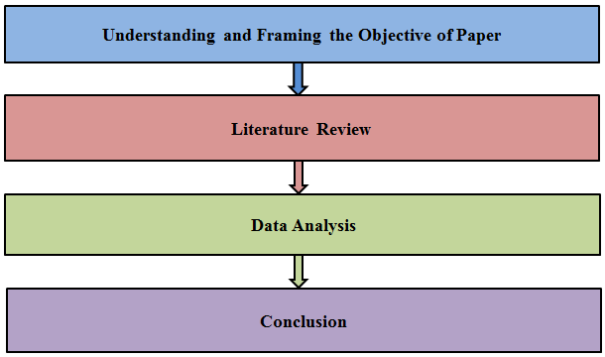

Fig. 1: Overall Methodology Process

3. LITERATURE REVIEW

I) J. S. Lambe et al.

With increased population growth and development of India and world, there is a need to critically look at other approaches of water resources to ensure water availability. These alternative resources include rainwater and bulk of water used in household will emerge as grey water. It is possible to intercept this grey water, at the household level, treat it so that it can be recycled for garden washing and flushing purposes.

II) Patil. P.N et al.

In this research paper author recommend that the availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Author brief about different physico-chemical parameters such as color, temperature, acidity, hardness, pH, sulphate, chloride, DO, BOD, COD, alkalinity used for testing of water quality. Heavy metals such as Pb, Cr, Fe, Hg etc. are of special concern because they produce water or chronic poisoning in aquatic animals. Some water analysis reports with physic-chemical parameters have been given for the exploring parameter study. Author also provided guidelines of different physic-chemical parameters also have been given for comparing the value of real water sample.

III) Golda A. Edwin et al.

Author analyzed the quality of different grey water sources is characterized with respect to the physical, chemical, biological, nutrient, ground element and heavy metal properties. The pollutant loads indicate that the diversion techniques are not suitable for household application and, therefore, treatment is necessary prior to storage and reuse. Author observed that the total volume of grey water generated exceeds the reuse requirement for suggested reuse such as for flushing and gardening/irrigation. In spite of generating less volume, the kitchen source is found to be the major contributor for most of the pollutant load and, therefore, not recommended to be considered for treatment. It is concluded that treatment of grey water from bathroom source alone is sufficient to meet the onsite reuse requirements and thereby significantly reduce the potable water consumption by 28.5%.

IV) Sonune NA et al.

This research paper focused on the study of physico-chemical parameters of wastewater in Vishnupuri, Nanded. All parameter were analyzed as per the standard methods given in American Public Health Association (APHA, 1989). Water quality parameters such as pH, Total Dissolved Solid (TDS), Total Suspended Solid (TSS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonical Nitrogen, Nitrate and Phosphate were analyzed. Author has found that BOD, COD, Ammonical Nitrogen and Nitrate value were above permissible limit whereas TSS, TDS, pH, Phosphate were within the permissible limit.

V) R. T. Pachkor et al.

In this paper author studied the grey water of Shrirampur gram panchayat, Nasik. Author has taken 564 random samples from Kitchen and bathroom considering sources of supply as tap water and borewell water in spring, winter and summer seasons. The overall performance of the laboratory scale integrated plant for treatment of kitchen and bathroom grey water is considered. The percentage removal efficiency of pollutant was found better for the sample collected in winter season than spring and summer seasons. The performance was showed in terms of reduction competency of water pollutants such as COD (84%), BOD (92%), Coliform (98%), TSS (87%), TDS (76%), Turbidity (64%) and Total hardness (70%). This treatment technology can be considered as a viable alternative to conventional treatment plant in rural region.

VI) Michael Oteng-Peprah et al.

This paper presents a literature review of the quality of greywater generated in different, especially developing, countries, constituents found in greywater, some treatment systems and natural materials for treatment, some reuse strategies and public perception regarding greywater reuse. The review shows that generation rates are mostly influenced by lifestyle, types of fixtures used and climatic conditions. Contaminants found in greywater are largely associated with the type of detergent used and influenced by other household practices. Many of the treatment systems reviewed by author were unable to provide total treatment as each system has its unique strength in removing a group of targeted pollutants. The review revealed that some naturally occurring materials such as Moringa oleifera, sawdust, can be used to remove targeted pollutants in greywater. The study further showed that user perceptions towards greywater treatment and reuse were only favorable towards non-potable purposes, mostly due to perceived contamination or lack of trust in the level of treatment offered by the treatment system.

VII) Dhanu Radha Samayamanthula et al.

In this research paper author collected the grey water from three different sources such as kitchen sink, shower and washing machine in Fahaheel, Salmiya and Farwaniya areas of Kuwait. To meet the future challenges of water scarcity, an attempt has

been made in this study to utilize treated greywater obtained by gravity governed filtration technique and disinfection for domestic usage. The study addresses the possibilities of groundwater recharge with the treated greywater. The method focuses on a gravity-governed flow through a column containing activated carbon, sand and gravel. The study concluded that for a volume of 1167 cm^3 filtration media used, the designed column was 34% effective for first 1100 mL of greywater.

VIII) Kavita Gour et al.
The paper presents a design of Grey water treatment system for treatment of grey water for residential area. The Treatment system combines biological treatment with physicochemical treatment. The Treatment system produced effluent of excellent quality, meeting the BIS quality regulation. Grey water treatment system was very efficient in removal of Suspended solids, Turbidity, Total hardness, Sulphate, Nitrate, Total phosphorous, Sodium, BOD, Total colliform, Faecalcolliform & E-coli. Further, the paper discusses the implications on the applicability of grey water reuse for toilet flushing purpose. Recycling of grey water reduces the amount of fresh water needed to supply and reduces the amount of waste water entering sewer or septic tank.

4. DATA ANALYSIS AND DISCUSSION

In this section, on the bases of literature review the physio-chemical parameters of grey water and its reuse for other purposes have been conferred.

4.1 Physio-chemical Parameters of Grey Water

Sr. No.	Tittle	Year of Publication	Location	Erudition from Research Paper		
				Physio-chemical Parameters of Grey Water	Unit	Range
1.	Greywater - Treatment and Reuse	2010	India	BOD_5	mg/lit	34
				Suspended Solid	mg/lit	18
				Nitrate	mg/lit	1.6
				Phosphate	mg/lit	3.1
2.	Characterization of domestic gray water from point source to determine the potential for urban residential reuse by Golda A. Edwin Et. al	2014	Puducherry, India	pH		9.1
				COD	mg/lit	1545.8
				BOD_5	mg/lit	186.5
				Electrical Conductivity	µS/cm	641.6
				Hardness	mg/lit	721
				Total Dissolved Solids	mg/lit	586
				Dissolved Oxygen	mg/lit	N.D
				Total Suspended Solids	mg/lit	141.2
				Nitrate	mg/lit	0.3
				Nitrite	mg/lit	0.2
3.	Study of physico-chemical characteristics of domestic Wastewater in Vishnupuri, Nanded, India by Sonune NA Et. al	2015	Vishnupuri, Nanded, India	pH		7 – 8
				BOD_5	mg/lit	56 – 96
				COD	mg/lit	180 – 300
				Ammonical Nitrogen	mg/lit	129 – 146
				Nitrate	mg/lit	74 – 181
				Phosphate	mg/lit	0.4 – 2.1
				Total Dissolved Solids	mg/lit	1228 – 1440
				Total Suspended Solids	mg/lit	43 – 65.43
4.	A Literature Review on Integrated Approach for Grey Water Treatment by R. T. Pachkor1 Et. al	2017	India	pH		6.6-8.7
				BOD_5	mg/lit	90-290
				COD	mg/lit	280-800
				Oil & Grease	mg/lit	37-78
				Turbidity	NTU	22-200
				Conductivity	µS /cm	325-1140
				Total Dissolved Solid	mg/lit	126-175
				Temperature	^0C	18-38
				Total phosphorous	mg/lit	0.6-27.3
5.	Greywater Characteristics, Treatment Systems, Reuse Strategies and User Perception—a Review by Michael Oteng-Peprah Et. al	2018	India	pH	-	7.3-8.1
				BOD_5	mg/lit	100–188
				COD	mg/lit	250–375
				Oil & Grease	mg/lit	7
				Turbidity	NTU	-
				Total Dissolved Solid	mg/lit	573
				Calcium	mg/lit	0.13
				Magnesium	mg/lit	0.11
6.	Physicochemical Characterization of Grey Water and Treatment	2019	Nagpur, India	pH	-	7.2
				BOD	mg/lit	400
				Turbidity	NTU	340
				Suspended Solid	mg/lit	532
				Total Harness	mg/lit	160
				Nitrate	mg/lit	0.25
				Sulphate	mg/lit	28

4.2 Reuse of grey water after treatment

The advancements for treatment of grey water incorporate physical, compound and organic frameworks. Grey water reuse should progressively turn out to be a piece of an arrangement of incorporated activities towards the normal utilization of water, the quality of effluent will be completely depending upon the system of treatment or their combination for better output.

4.2.1 Physical Treatment

(a) Sand and Gravel Filter: The wastewater moves through a channel medium – sand or rock in low-tech grey water channels. The fundamental treatment process involves the maintenance of particles by channel material and cleaning process because of natural action in the bio-film on the sand and rock.

(b) Cabinet Compacted Sand Filter: The Drawer Compacted Sand Filter (DCSF) is an adjusted plan for a sand channel in which the sand layer is separated into a few layers, every one of which is 10cm high and set in a versatile cabinet isolated by a 10cm space. A lab-scale DCSF was outlined and worked for 330 days nourished by engineered grey water. Results demonstrated that DCSF could evacuate >90% of natural issue and aggregate suspend solids for all measurements. No noteworthy distinction was seen as far as general channel proficiency between heaps of all parameters. It diminishes the issue, for example, obstructing, causing of awful odour.

(c) Filter Using Marble Chips: The grain estimate conveyance for marble chips ranges from 4.75 to 20 mm. The most extreme evacuation got for turbidity, COD and aggregate solids were 75.6%, 59.4% and 43.16% separately at 8-hour maintenance time. In sand channel the expulsion effectiveness of turbidity has been recorded up to 81.89%.

(d) Filter Using Jute Coir: In this media the expulsion of COD proficiency is 59.03% out of 8-hour maintenance time. The permeable structure in this media serves to develope the thick matt of particles and furthermore lessens the COD.

4.2.2 Chemical Treatment

(a) Normal Coagulants: Normal coagulant assumes an imperative part in the expulsion of turbidity and contaminants. Normal coagulants, for example, concentrates of miniaturized scale living beings or plant starting point (illustrations: Narmali seeds, Moringa seeds, Okra seeds, Cassava seeds, Dutchuslabla, Broad beans, Flava beans, Water melon).

(b) Artificial Coagulants: Manufactured coagulants incorporate Aluminum sulfate, Aluminum chloride and Sodium aluminate, Ferric sulfate, Ferrous sulfate, de and Ferric chloride sulphate.

(c) Electro-Coagulation: Electro-coagulation is the strategy with stainless steel cathode as anode in the arrangement of bipolar association. In the examination of treated waste water it demonstrates that greatest evacuation of BOD, COD, Suspended Solids were 92.71%, 88.76% and 93.1% respectively.

(d) Alum Treatment: The water is dealt with by alum filtration through a glass segment with medium measured quartz sand and cotton fleece plunged at the base. The alum is included with crude water responds with bicarbonate alkalinities the floc draws in fine molecule and suspended molecule.

5. CONCLUSION

The literature review showed that the quality of grey water with respect to COD, BOD, TS and pathogens requires adequate treatment prior to household reuse. With regard to the trace and heavy metal contents, no further treatment is required. The bath/wash basin sources contribute to around 55 % of total grey water, but are found low in nutrient load and BOD. However, it is high in turbidity, suspended solids, COD and EC. The laundry GW is found to be high in hardness, SS and COD. Of all greywater sources, the kitchen sink contributes to less volume but very high in turbidity, SS, BOD, COD and overall pollutant load.

In various researchers paper low cost treatment of grey water has been elaborated and its applicability has been deliberated for flushing, gardening, agriculture etc. Reusing grey water will help definitively to solve the problem of water demand in the world. The treatment system can be easily adopted by the developing countries. This treated grey water can be reuse for toilet flushing and many more purposes.

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