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A Model Study of Greywater Treatment and Reuse

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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. Although India occupies only 3.29 million km^2 geographical area which forms 2.4% of the worlds land area, it supports over 15% of world's population with only 4% of the world's water resources. With increased population growth 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 minerals, 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 garden washing and flushing purposes.*

KEYWORDS: *Greywater, sources, treatment, recycle and reuse.*

I. INTRODUCTION

Greywater is specifically washwater. That is, bath, dish, and laundry water excluding toilet wastes and free of garbage-grinder residues.When properly managed, greywater can be a valuable resource which horticultural and agricultural growers as well as home gardeners can benefit from. It can also be valuable to landscape planners, builders, developers and contractors because of the design and landscaping advantages of on-site greywater treatment/management. It is, after all, the same phosphorous, potassium and nitrogen making greywater a source of pollution for lakes, rivers and ground water which are excellent nutrient sources for vegetation when this particular form of wastewater is made available for irrigation.

II. COMPOSITION OF GREYWATER

Greywater from Bathroom

Water used in hand washing and bathing generates around 50-60% of total greywater and is considered to be the least contaminated type of greywater. Common chemical contaminants include soap, shampoo, hair dye, toothpaste and cleaning products. It also has some faecal contamination (and the associated bacteria and viruses) through body washing.

Greywater from Cloth Washing

Water used in cloth washing generates around 25-35% of total greywater. Wastewater from the cloth washing varies in quality from wash water to rinse water to second rinse water. Greywater generated due to cloth washing can have faecal contamination with the associated pathogens and parasites such as bacteria.

Greywater from Kitchen

Kitchen greywater contributes about 10% of the total greywater volume. It is contaminated with food particles, oils, fats and other wastes. It readily promotes and supports the growth of micro-organisms. Kitchen greywater 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 greywater systems.

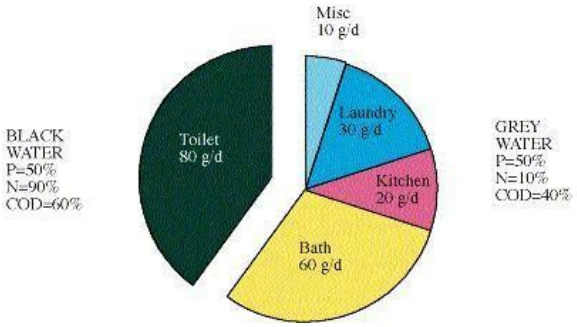
III. AVERAGE POLLUTANTS LOADING

Average Pollutants Loading
(grams per person per day - g/p.d)

Type	Greywater	Grey + Black combined
BOD5	34	71
SS	18	70
Tot. N	1.6	13.2
Tot P	3.1	4.6
Tot P*	0.5	1.9
* No Phosphorous detergent		

IV. HOW MUCH GREYWATER DO YOU PRODUCE?

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



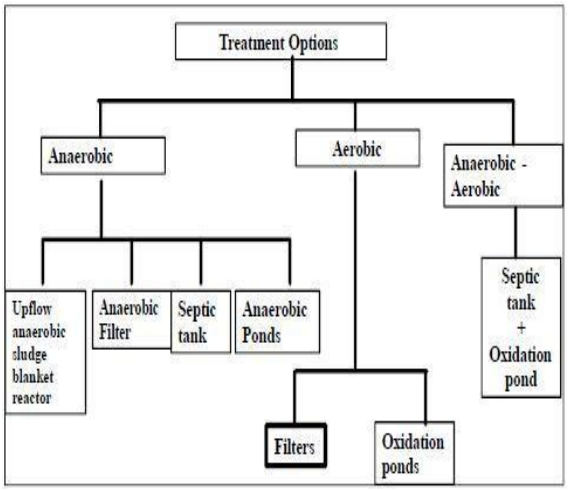
Combined Wastewater

Sources of waste water and its type

No.	Source of waste water	Types of waste water	Quantity/ day/person
1.	Toilets	Black water	3 liters
2.	Bathing	Greywater	20-30 liters
3.	Kitchen	Greywater	5-10 liters
4.	Washing cloth	Greywater	15-20 liters
5.	Animals	Greywater	10-15 liters

V. GREYWATER TREATMENT OPTIONS

Greywater reuse methods can range from low cost methods such as the manual bucketing of greywater from the outlet of bathroom, to primary treatment methods that coarsely screen oils, greases and solids from the greywater before irrigation via small trench systems, to more expensive secondary treatment systems that treat and disinfect the greywater to a high standard before using for irrigation. The choice of system will depend on a number of factors including whether a new system is being installed or a disused wastewater system is being converted because the household has been connected to sewer.

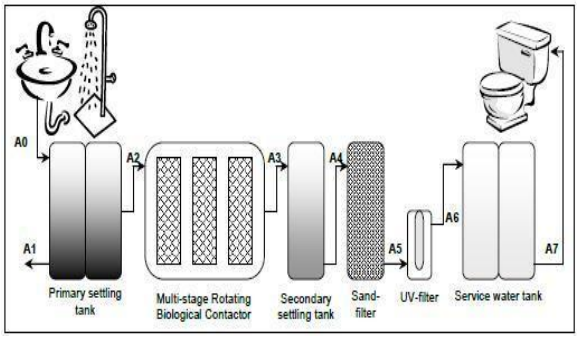


VI. COMPONENTS OF GREYWATER TREATMENT SYSTEMS

A number of technologies have been applied for greywater treatment worldwide varying in both complexity and performance. The following in general greywater systems considered :-

a)Primary treatment - pre-treatment to secondary treatment:-

1. Screening 2.Equalization b)Secondary treatment:-1.Gravel filtration 2.Sand filtration 3.Chlorination

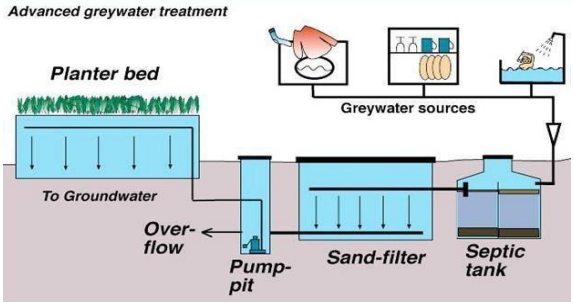


Greywater Treatment Scheme

Raw greywater

Primary treatment (Screening, Equalization tank)-Secondary treatment-I (Gravel filter, Sand filter) Secondary treatment-II

Broken brick,Charcoal, Chorination)-Treated greywater

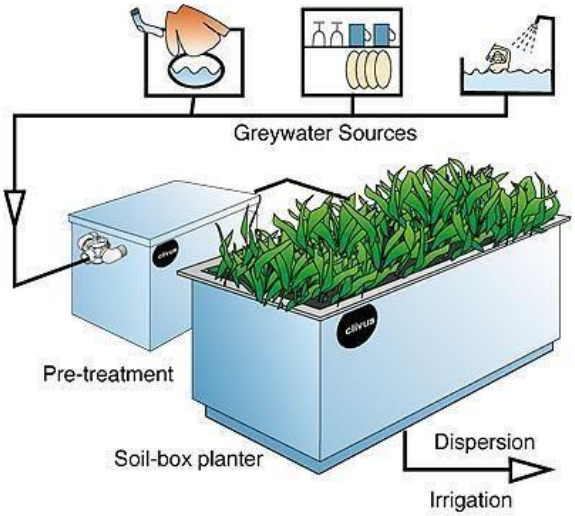


Treatment Units and Functions

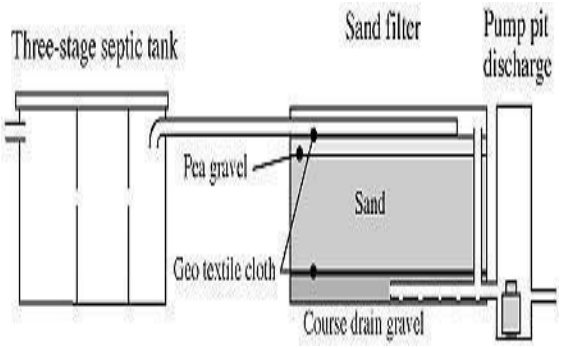
Unit of treatment system	Removal
1. Screen	Floating matter,

	suspended matter
2. Junction chamber	Odour, some of settleable solids
3. Equalization Tank (Holding)	Settleable solids
4. Horizontal Roughing Filter	Turbidity, suspended solids, some amount of BOD
5. Slow Sand Filter	Colour, bacteria, suspended solids and some amount of BOD
6. Disinfection	Bacteria, odour

Aerobic Pre-treatment -- suitable for showers, hand-washing and laundry* water treatment.



Anaerobic to aerobic treatment

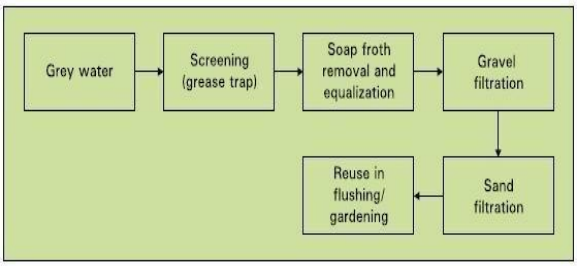


VII. HOUSEHOLD LEVEL GREYWATER TREATMENT AND REUSE SYSTEM

In water scarce areas, with specific treatment the greywater can be cleaned and reused not only for gardening but for other use also.

Technological process

Greywater treatment process at the household level mainly involves screening (grease and silt removal), soap froth removal, equalization and filtration. Flow diagram of household based greywater treatment system is shown below:



Greywater treatment for reuse in household

1. Advantages:-

- Reduces fresh water requirement
- Prevents greywater stagnation
- Prevents vector breeding
- Use in flushing toilets to make toilets functional
- Use of greywater in gardening
- Minimal risk to users of greywater as it incorporates principles of water safety.

2. Applicability household.

3. Action :-Individual households may construct and operate this system.

4. Description :-A three-stage greywater filtration system at household level having following components may be constructed.

Inlet pipe: 63mm (2 inch) PVC pipe **Inlet chamber:** 30cm x 30cm x 10cm (Brick masonry Cement plaster) (A sponge piece is kept in the chamber to absorb the debris coming with the water, so that these can be checked to flow further)

Treatment chamber-1:
Size: 30cm x 60cm x 30cm.
filled with gravels, (40 to 60mm size), Brick masonry in 1:4 cement mortar & cement plaster 1:4 with neat cement finish
Treatment chamber-2: Water flows from chamber-1to chamber-2 Size-40cm x 60cm x 30cm filled with fine sand
Filter water Size: 40cm x 60cm x 50cm **storage tank:** Brick masonry in 1:4 cement mortar & cement plaster 1:4 with neat cement finish.

Base of all the chambers: Constructed with

1:2:4 RCC work with 12mm grit size and then cement finis with 5% slope (1 in 20)

Out let: Through 63mm (2 inch) PVC pipe.

The operation and maintenance is not a skilled job in the system, as it requires washing of the sponge kept in the inlet chamber on regular basis and the washing and changing/refilling of gravel & fine sand time to time in the treatment chamber 1 and 2. Members of the beneficiary family are doing this and the system is functioning satisfactorily.

O&M

- Periodical cleaning of grease trap, filters and sponge
- Gravels and sand from the filtration unit need to be washed periodically
- Sedimentation tanks require de-sludging every month.

Costing and economic viability

- Appromite material cost – Rs 600/-
- Labour charges-Rs 250/-
- Approximate total cost-Rs 850/-.

Construction of greywater treatment system

VIII. DETAILS OF GREYWATER TREATMENT SYSTEM

Parameter	500 to 2000 l/day	2000 l/day
Treatment	Sedimentation Horizontal filter Slow sand filter Disinfection	Sedimentation Horizontal filter Slow sand filter Disinfection OR Sedimentation Wetland
Uses	Toilet flushing Irrigation Floor washing Constructio n	Toilet flushing Irrigation Floor washing Construction
Const.on Cost	USD 250-600 based on flow*	USD 500 1000 based on flow*
Main. Cost per year	USD 12-25*	USD 25-50*
Water saving per year	200,000 to 400,000 litre	per year More than 400,000 litre
Monitoring/ Main.	High	High
Health risk	Low	Low

IX. CASE STUDIES

Economics of Greywater Recycle & Reuse

Consider a Complex with 100 Residential Units. Each unit has say 4 persons. Average consumption of Freshwater is @ 100 ltrs/day/person.

Hence Total Freshwater required shall be 100 x 4 x 100 = 40000 litres/day.

The cost of Municipal water is say 30 Rs/1000 litres (It is increasing day by day. At Chennai it is already 60 Rs/1000 litres)

Daily Water Bill = 40000 x 30/1000 = Rs. 1200/day. Which is Rs. 4,38,000/year.

At 60 Rs/1000 litres this will be Rs. 8,76,000/year. There will be charges for Disposal (Disposal Cess) on Sewage soon.

The reduction in Disposal Volume will save this on ongoing basis.

Savings in Sewage Treatment Plant Cost (Capital as well as Operating Cost).

If Greywater Recycling system is installed, Smaller Sewage Treatment plant shall suffice.

X. CONCLUSION

The benefits of greywater recycling include: Reduced use of freshwater, Less strain on septic tanks or treatment plants, More effective purification,Feasibility for sites unsuitable for a septic tank,Reduced use of energy and chemicals, Groundwater recharge,Plant growth, Reclamation of nutrients, Increased awareness of, and sensitivity, to natural cycles .Saving water per day . Saving of 750 to 1000 liter water per day in residential schools (ashrams)

/hostels of 50 children. Saving of drinking water by reuse of grey water. Grey water reuse for toilet flushing and gardening.

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