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A Cohesive 3-R Approach for Domestic Water Treatment

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ABSTRACT

Water is critical for all life on the planet. Rapid industrialization and urbanization has caused India to face a water crisis since it has only 4 percent of the world's water resources. In order to resolve the crisis, India has to look for alternative water resources which may include rainwater harvesting, grey water and sewage reuse and desalination. Grey water is defined as waste water generated from the bathroom, laundry and kitchens. Nearly 70 percent of the water used in households results in grey water which can be treated using simple technology and reused. Reuse of grey water reduces the fresh water requirements and reduces the amount of sewage sent to treatment plants. An integrated approach is needed to manage the water and waste water treatment so that water supply is kept clean and waste water is recycled for beneficial use in agriculture and industry. Water and energy are important resources in the 21st century. Water is required to supply energy, and energy is required to supply water. The reclamation of wastewater can contribute significantly to the conservation of water and energy resources. Wastewater reclamation and reuse can relieve water scarcity. Reclaimed wastewater can be substituted for natural water. Wastewater is now extensively recognized as an important source of water in water-scarce countries. In recent years not only the threats of improper greywater management have been recognized; 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, car washing and others.

Keywords: Grey water, Irrigation, Reclamation, Electro-Oxidation, Electro-Coagulation.

INTRODUCTION

A.Greywater

Waste water generally is made of black water and grey water. Grey water also known as sullage is non-industrial waste water generated from domestic processes such as washing dishes, laundry and bathing (Figure:1). Grey water comprises 50-80% of residential waste water. Grey water is distinct from black water in the amount and composition of its chemical and biological contaminants (from faces or toxic chemicals).Grey water gets its name from its cloudy appearance and from its status as being neither fresh nor heavily polluted. Essentially, any water, other than toilet wastes, draining from a household is grey water. Although this used water may contain grease, food particles, hair and any number of other impurities, it may still be suitable for reuse.

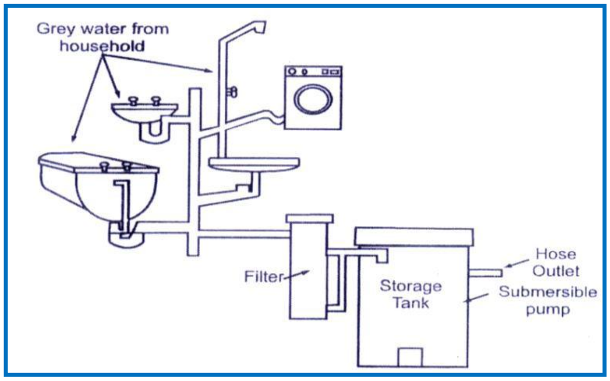

Fig 1. *Diagrammatic representation of household grey water generation*

B. Composition of grey water

The composition of grey water from its various sources is clearly illustrated in (Table. No:1)

Table 1. *Composition of grey water*

Compositions of Grey Water	Grey water from Bathtubs,Showers, and Hand basins	Grey water from Washing machines &Kitchen
BOD (mg/l)	85-200	250-550
COD(mg/l)	150-400	400-700
TSS(mg/l)	30-70	n/a
P(total)	0.5-4	3-8
N(total)	4-16	10-17
Total coliforms (MPN/ml)	10^1-10^5	10^1-10^5
E.coli(MPN/ml)	10^1-10^5	10^1-10^5

C. Reuse of greywater

Reusing grey water serves two purposes: it reduces the amount of fresh water needed to supply a household, and reduces the amount of waste water entering sewer or septic systems.

D. Other sources of greywater

Grey water is domestic waste water that is collected from dwelling units, commercial building and institutions of the community. It may include process waste water of industry (food, laundries etc.) as well as ground infiltration and miscellaneous waste liquids. It is primarily spent water from building water supply to which has been added to the waste effluent of bathrooms, kitchens and laundry

E. Necessity of greywater treatment

Domestic waste water is the spent water from the kitchen, bathrooms and laundry. Many of the minerals and organic matter in the water serve as food for saprophytic micro-organism and hence the waste water is unstable biodegradable reduction of relative dependence on potable water usage is becoming a necessary facet of good water management. Many new or modified treatment processes are being investigated and an attempt to solve the serious water supply and waste water disposal problems of the growing population and its industries are made. Even with the application of the water reducing scheme, a large amount of the water reducing scheme, a large amount of water is still required and eventually, reuse of water may have to be practice.

Therefore, several possible re-use of water schemes such as distillation and membrane techniques for complete reuse and biological oxidation, filtration and disinfection schemes for partial reuse have been considered.

Materials and Methods

A. Low cost management systems of greywater

The choice of a greywater management strategy is highly dependent on the end use of effluent produced. Greywater management strategies should therefore be adapted to a specific purpose such as generating an effluent suitable for agricultural reuse or whose quality allows its safe discharge. The very basic objective is to protect public health and environment.

B. Source Control

Implementation of an environmentally and economically sustainable greywater management strategy will be easier if control measures at the source (i.e. in the household) are practiced. Source control is by far the most effective way to reduce pollution loads and avoid operational problems in treatment systems, to lower management costs and guarantee long-term satisfactory performance of the treatment systems. The solids content of greywater discharged into a treatment or disposal system can be reduced considerably and simply in-house.

C. Direct reuse systems (no treatment)

It is possible to reuse greywater without any treatment provided that the water is not stored for long before use. Once bath water has cooled, it can be used directly to water the garden. Very simple devices are available to make this practical. Among these is the ‘WaterGreen’ by Drought buster UK Ltd, which is essentially a hose pipe with a small hand pump to create a siphon. This allows cooled bath water to be taken directly from the bath and sent through the hose to the garden (usually via an open window). Using greywater in this way may not suit everyone, but it does provide an inexpensive and easy way of saving water and avoids greywater storage issues.

D. Short retention systems

These systems take wastewater from the bath or shower and apply a very basic treatment such as skimming debris off the surface and allowing particles to settle to the bottom of the tank. The ‘Ecoplay’ unit aims to avoid odor and water quality issues by treating the greywater to a basic standard and makes sure it is not stored for too long. If it is not used within a certain time, the stored treated water is released and the system is topped up with mains water. These systems use the simplest level of treatment so are relatively cheap to buy and run. The risk of equipment failure is reduced so expensive repairs (of more complex systems) can be avoided. Another benefit of short retention systems is that they can be located in the same room as the source of greywater, reducing the need for expensive, dual-network plumbing.

E. Mesh Filter Bag

A basic grey water filtration system can be made at home by anyone .Greywater is first passed through a coarse mesh filter bag (Figure: 2), this removes any large particles such as lint and hair immediately. The grey water is then passed through a much finer filter to remove the small particles.

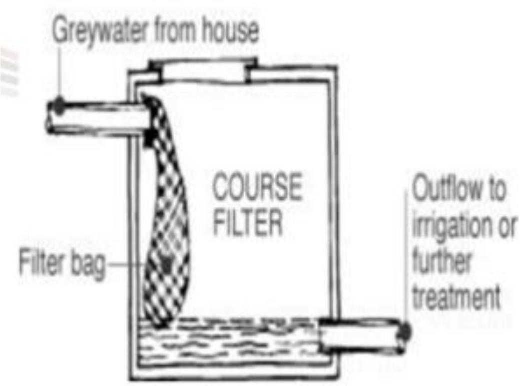

Fig 1. *Mesh Filter Bag*

F. Sand Filters

SSF has been used for years as a relatively simple and easy-to-operate process that allows raw water to pass through a sand medium (Figure. No: 3). A sand filter system is made up of a thin layer of gravel topped off with a much thicker layer of sand within a container (old plastic barrel or drum). Coarsely filtered water passes through the sand being finely filtered. A slow sand filter removes the smallest particles. A slow and constant flow of water through the filter leads to biological activity as the top layer of sand traps micro-organisms (e.g. bacteria). “Bio-film builds up on top of the sand.

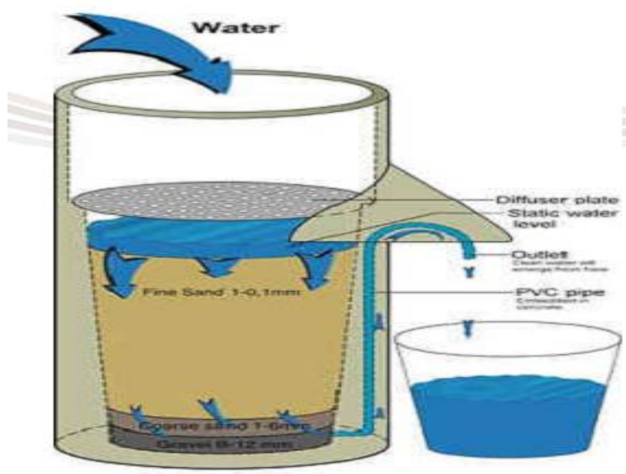

Fig 2. *Slow Sand Filter*

G. Granular activated carbon (GAC)

Activated Carbons (ACs) currently used in water treatment are made of a variety of materials (e.g. nutshells, wood, coal and petroleum). Moreover, they differ in terms of characteristics (e.g. number of micro and macro-pores, surface area, functional groups etc.) GAC is commonly used as a filtration or post filtration method to adsorb organic/taste/odour compounds, synthetic organic chemicals and PhACs with results that depend on the carbon quality, pollutant type and concentration, when used for post filtration, GAC receives high-quality water to adsorb organic compounds that were not filtered out in previous stages. If applied as filters, GACs often replace or are combined with RSFs, thus reducing the need for further filtration. GAC filters can operate at higher loading rates than SSF. Therefore, they are popular in treatment plants where space is a limiting factor. Furthermore; GAC can be added to the anaerobic digestion process to improve methane production. It can also enhance the sludge digestion process by increasing the removal of SS (including volatile SS).

H. Electro-coagulation (EC)

Electro-coagulation is based on the electrochemical dissolution of “sacrificial” electrodes (typically steel or aluminum) and formation of solid porous particles (hydroxides) which (ad) absorb suspended matter and dissolved inorganic ions .Electro coagulation (EC) is already being applied for industrial and municipal waste water treatment can be potentially used for greywater treatment .EC has proven to be competitive and effective in the treatment of water and waste water to remove metals, anions, dyes, organic matter(BOD,COD), suspended solids, colloids and even arsenic. Grey water is diverted from the greywater collection pipe into an overhead collection tank where the grey water is mixed. Initial screening is a must to remove relatively large suspended solids from greywater. The samples are collected in 20 L plastic containers and are allowed to settle for 2 hrs and this settled greywater is used in all the EC experiments.

EC is performed in an electrolytic cell of 1 L capacity made from 5 mm thick Plexiglas with the dimension of 75mm*75mm*175mm employing aluminum electrodes having an effective area of 65 cm2. The electrode is installed vertically at the middle of the reactor with an electrode gap of 3 cm .The current and voltage is controlled by a digitally regulated DC power supply. Nearly 80% COD removal is obtained with an electrolysis time if 20 min for approximately current densities 2 mA/cm2 and 5 mA/c.

I. Electro-oxidation (EO)

Electrochemistry is attracting attention globally because it has been used in industry to remove a wide range of pollutants and microorganisms. Electro oxidation (EO) works by applying a current between two electrodes in a solution to cause oxidation at the positively charged electrode or (anode).The resultant radical oxidant species destroys microorganisms and degrade organic pollutants. Electro-oxidation may occur either by direct oxidation by hydroxyl radicals produced on anode's surface or by an indirect process where oxidants like chlorine, hypochlorous acid and hypochlorite or hydrogen peroxide/ozoneare formed at electrodes.

EO is done with boron- doped diamond, well known for producing high levels of strong oxidants, as a novel anode material to enable efficient treatment of waste water. EO can also be performed by incorporating activated carbon as abed material which acts in two ways: Firstly through adsorption of pollutants; and secondly by acquiring charge and acting as a third electrode, It also degrades pollutants via oxidation reactions on its surface.

Conclusions

The above discussion concludes that grey water treatment and reuse must be taken as a promising step for conservation of sustainable water in present context of water scarcity in India in near future. The technology should be adopted based on grey water characteristics and the purpose for which treated water is to be used. The reuse of treated water can reduce our fresh water requirement for non-potable purpose such as toilet flushing, garden irrigation, floor and lawn washing etc. Treated grey water is a substitute of fresh water to be used for non-potable purpose. The action may be taken by the Government to motivate the public for implementation of grey water treatment plant in large buildings, complexes, public centre’s, and also for single house hold especially in water shortage areas.

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