WATER MANEGEMENT BY GREY WATER TREATMENT

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ABSTRACT: *Management and conservation of urban water has become a serious development issue in many developing countries. Population and water need rise rapidly, whereas, water availability is decreasing due to inefficient management and deterioration. If the problem is not given a serious look, then the future generations may have to face severe crisis of water. The aim of this study is towards the management of water by Greywater recycling for proposed area of Rajkot. In this present study design of various components of grey water treatment is suggest for proposed area. Design of various components for Grey Water treatment has been suggested for proposed area under study. Costs of all the components are also determined in this study. Total cost of Grey water treatment is Rs. 525000.*

Keywords—Water Management, Grey Water, Design of Components of grey water treatment

I: INTRODUCTION

Water management is the activity of planning, developing, distributing and managing the optimum use of water resources. In an ideal world, water management planning has regard to all the competing demands for water and seeks to allocate water on an equitable basis to satisfy all uses and demands. [1]
Historically water has always been a key factor in deciding where a town is established with most cities and towns usually located within close proximity to a reliable water source. Water has subsequently been used at an increasing rate in these cities and towns for both consumption and industry over time. Rising populations and rapidly changing climatic conditions are putting a strain on water resources across the globe as a consequence of continued and increasing demand for potable water. [2]

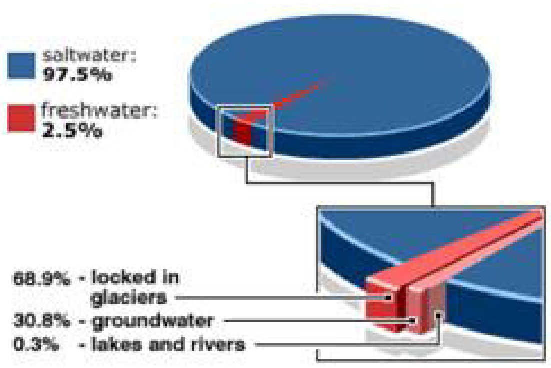

Fig.1Availability of fresh water
Source: A report prepared by Green Energy Foundation, 2010

Water should be viewed as a finite resource that needs to be recycled and reused in order to preserve it. Only 2.5% of the world's water is fresh, while 97.5% is ocean. And of that freshwater, only 0.3% is available from rivers, lakes and reservoirs. Most freshwater is locked up in polar ice, glaciers or soil moisture. Unfortunately, more and more of that precious freshwater is contaminated each year. [3]
In many part of the Globe, population growth and urbanization are increasingly becoming challenges to Governments. According to the information from the International Year of Freshwater (2003), by the year 2020, some 60% of the global population will live in urban areas. Currently, more than 80 countries, with 40% of the global population suffer from severe water shortages. In the developing countries of Asia urban water supplies have progressed little in the last 20 years. [4]

II: GERY WATER

According to the levels of cleanliness, the water we use can be classified into three types namely white water, black water and grey water. White water is fresh, completely clean and potable. Black water is used water which is heavily polluted by chemicals and/or biological contaminants. It is basically non-useable sewage water. Grey water is in between the two in terms of sanitation. This includes water from showers, bathtubs, sinks, kitchen, dishwashers, laundry tubs, and washing machines. It commonly contains soap, shampoo, tooth paste, food scraps, cooking oils, detergents and hair. Greywater makes up the largest proportion of the total wastewater flow from households in terms of volume. Typically, 50-80% of the household wastewater is greywater.

Greywater is less polluted wastewater which represents 60 to 70 % of the domestic water use. Over 50% of the water demand for domestic activities can be met by treated greywater than fully treated water; including applications such as toilet flushing, gardening and car washing etc. Greywater recycling & reuse is an effective and economical way of solving water scarcity. [5]

III: WHY GREYWATER RECYCLING?

The main purpose of greywater recycling is to substitute the precious drinking water in applications which do not require drinking water quality. Non-potable reuse applications include industrial, irrigation, toilet flushing and laundry washing dependent on the technologies utilised in the treatment process. With greywater recycling, it is possible to reduce the amounts of fresh water consumption as well as wastewater production, in addition to reducing the water bills. If greywater is regarded as an additional water source, an increased supply for irrigation water can be ensured which will in turn lead to an increase in agricultural productivity. Unlike rainwater harvesting, greywater recycling is not dependent on season or variability of rainfall and as such is a continuous and a reliable water resource. This results in smaller storage facilities than those needed for rainwater harvesting. Greywater has a relatively low nutrient and pathogenic content and therefore, it can be easily treated. Moreover, if space is not available, it can be installed in the cellar. [5]

Greywater systems have been in the market for several years but are yet to be fully accepted by the general public. The systems provide a good water conservation tool as they reduce the use of potable water. There may be widespread confusion within the general public as to what exactly greywater comprises of, given the lack of a uniform definition within the literature. Clarity is necessary for the promotion of grey water systems as ‘safe’ water conservation technologies.

Grey water reuse has been a long practice in country and areas with limited water resources, with application predominantly for water gardens and lawn in the USA and for landscaping, fountains and toilet flushing in Japan.

IV: ESTIMATION OF GREY WATER PER PERSON

Grey water makes up approximately 50 to 80 percent of all wastewater coming from homes and other residences. As per WHO, water required for bathing, washing clothes, washing utensils and other is about 90 lpcd.

GREY WATER COLLECTION FROM ONE COLONY IN RAJKOT CITY

The colony named. “Savan Sapphire” lies in Rajkot having 3 towers of four floors and having four flat in each floor. So, total numbers of flats are 48.

Total nos. of flats = 48

No. of persons in each flat = 4

Total no. of persons = 200

Grey water from each person = 90 lpcd

Total grey water generated = 90 x 200 x 0.9 = 16200 lpcd = 17 KLD

VI: GREY WATER TREATMENT

There are multiple variations of greywater system design, but most treatment systems consist of six major components:

(1) Screening
(2) Equalization tank
(3) Sedimentation Tank
(4) Aeration Tank
(5) Filtration of water
(6) Disinfection of water

DESIGN OF BAR SCREEN

The function of the bar screen is to prevent entry of solid particles/ articles above a certain size; such as plastic cups, paper dishes, polythene bags etc into the Grey water treatment plant. (If these items are allowed to enter the Grey water treatment plant, they clog and damage the pumps, and cause stoppage of the plant.)

Table: 1 Assumption in Design of Bar Screen

Sr. No.	Parameter	Units
1	Size of bar	10mm x 50 mm
2	Spacing between bars	10 mm
3	Angle of inclination	45
4	Velocity through the screen	0.6 m/s
5	Approach velocity	0.3 m/s
6	Depth of flow of incoming screen	0.07 m

Table: 2 Design of Bar Screen

Parameter	Value/Calculation	Remarks
Average Daily flow	17 KLD	Quantity of grey water
Peak hourly flow	= 3 x Avg. hourly flow = 3 x 1.97 x 10^{-4} m3/sec = 5.902 x 10^{-4} m3/sec	The peak is assumed to be three times the average
Design flow velocity	0.30 m/sec	
Cross section area of the screen channel	5.902 x 10^{-4} / 0.3 = 1.97 x 10^{-3} m2	Volume/Hr = Cross-sectional area x flow velocity
Adjust for the flow area blocked by the bar.	= 1.97 x 10^{-3} m2 x 1.5 = 2.95 x 10^{-3} m2	Cross-sectional area is increased by 50% to compensate for the obstruction posed by the bars of the grill.

Numbers of opening	2.995×10^{-3}/(0.07 x 10/1000) = 5	
Numbers of bars	4	
Width of the screen	= (5 x 10/1000)+ (4 x 10/1000) = 0.09 m	
Length of the screen	=0.52 m	L= (d+ 0.03) cot θ + 1.73(W + ds)
Velocity of flow in screen	0.03 m/sec	= Q/W x d
Head loss	0.0045 m	

DESIGN OF OIL AND GREASE TRAP

The grease and grit trap is placed at the discharge point of the canteen/ kitchen area itself to arrest solid and fatty matter at source. The wastewater output from this unit is taken to the equalization tank.

Table: 3 Design of Oil and Grease Trap

Parameter	Value/Calculation	Remarks
Total quantity	17 KLD =17 m3/day	Quantity of grey water
Hourly average sewage inflow	= 17/24 m3/Hr = 0.708 m3/Hr	
Tank volume	= 0.708 x 30/60 m3 = 0.354 m3	Tank is designed to hold resident time of 30 min. of average flow.
Water depth in tank	0.6 m	
Tank area	= 0 .354/0.6 m2 = 0.59 m2	

DESIGN OF EQUALIZATION TANK

Flow equalization simply is the damping of flow rate variation to achieve a constant or nearly constant flow rate and can be applied in number of different situation; depending on the characteristics of collection system. The sewage from the bar screen chamber and oil, grease and grit trap comes to the equalization tank. The equalization tank is the first collection tank in Grey water treatment. Its main function is to act as buffer: To collect the incoming raw sewage that comes at widely fluctuating rates, and pass it on to the rest of the STP at a steady (average) flow rate. The equalization tank must be of sufficient capacity to hold the peak time inflow volumes.

Table: 4. Design of Equalization Tank

Parameter	Value/Calculation	Remarks
Total quantity	17 KLD =17 m3/day	Quantity of grey water
Hourly average sewage inflow	= 17/24 m3/Hr = 0.708 m3/Hr	
Equalization tank volume	= 0.708 x16 m3 = 11.33 m3	
Free board	0.3 to 0.5 m	
Water depth in tank	2.0 to 2.5 m	
Tank area	= 11.33/2 m2 =5.67 m2 L = 2.5m B = 2.5 m	
Diffuser requirement	Select size and number to suit the dimensions of the tank	Typically, a pair of diffusers must fit within the width of the tank. If the tank is not wide enough, the pair may be placed at an angle. Several such pairs of diffusers are placed along the length of the tank.
Air quantity required	0.8 x 11.33 = 9.06 m3/Hr	Air provided at rate of 0.8 m3/m3 hr

PRIMARY SEDIMENTATION TANK

Clarification, through the process of sedimentation is the separation of suspended particles by gravitational settling. This operation can be used for grit and solids removal in the primary settling basin, removal of oil and grease, removal of chemically treated solids when the chemical coagulation process is used or solids concentration in sludge thickeners.

Efficiently designed and operated primary sedimentation tank should remove from 50 to 70 percent of the suspended solid and from 25 to 40 percent of the BOD.

Table: 5 Assumptions in the Design of Sedimentation Tank

Sr. No.	Parameters	Values
1	Over flow rate	1 m3/m2.hr
2	Flow rate	17 KLD
3	Detention time	2.5 hr

Table: 6 Design of Sedimentation Tank

Parameter	Value/Calculation	Remarks
Flow rate	17 KLD	

	=17 m3/day = 17/24 = 0.708 M3/Hr	
Water depth in tank	2.5 m	
Tank area	= 0.708/1 m2 = 0.708 m2 L = 1m B = 1 m	

DESIGN OF AERATION TANK

The Aeration tank (together with the settling tank/ clarifier that follows) is at the heart of the treatment system. The bulk of the treatment is provided here, employing microbes/bacteria for the process. The main function of the Aeration tank is to maintain a high population level of microbes. This mixture is called MLSS (Mixed Liquor Suspended Solids).

Table: 7 Design of Aeration Tank

Parameter	Value/Calculation	Remarks
Grey water quality	17 KLD	Quantity of Grey water
BOD in grey water	300 mg/L =0.000300 kg/L	
BOD Load/Day	= (17 x 1000) x 0.000300 = 5.1 kg/day	This means the aeration tank has to supply 30 kg of Oxygen every day. (This is the “Food” in the F/M ratio.)
F/M ratio	0.12	
M (biomass)	= 5.1 / 0.12 = 42.5 kg	
Design MSLL level	3500 mg/L (= 3.5 kg/ m3)	The acceptable MLSS range is 3500-4500. But we chose the lowest MLSS in the range in the range, because it gives us the most conservative size for the aeration tank (see the row below).
Aeration Tank Volume	= 42.5 / 3.5 = 12.14 m3	= Biomass / MLSS Selecting lowest MLSS yields the highest-possible size for the aeration tank. This size will be able to handle higher values of MLSS.
Aeration Retention Time	= 12.14/ 17 x 24 Hrs = 17.14 Hrs	
Depth of Aeration Tank	3.0 m	
Area of Aeration Tank	= 12.14/3 = 4.04 m2	Area = Volume / Depth
width of Aeration Tank	3.5 m	This width is ideal to accommodate set of 1m long Diffusers
Length of Aeration Tank	= 4.04/3.5 = 1.16 m	Length = Area/width
BOD Load/hour	=5.1/22 = 0.23 Kg/day	= (BOD load per day) / (no. of aeration hours). Assuming 22 hrs of aeration.
Air requirement for BOD	= 0.23x60 = 13.9 m3/Hr	
Air requirement for mixing	= 13.9x1.1 = 15.3 m3/Hr.	This requirement is @1.0-1.2 m3/m3 of tank Volume
Air requirement for mixing	= 2 x 4.04 = 8.08 m3/Hr	This requirement is @ 2 m3/hr / m2 floor area
Air to be supplied	15.3 m3/hr	The highest quantity of the three iterations above.
Select size of diffuser	90 OD x 1000 Length OD-outer dia.	
No of diffuser	= 15.3 /8 = 2 Nos. (nearest whole number)	
Placement of diffusers	2 diffusers (1 pairs)	Rows are distributed evenly along the length of the tank.

PRESSURE FILTER

The pressure sand filter (PSF) is used as a tertiary treatment unit to trap the trace amounts of solids which escape the clarifier, and can typically handle up to 50 mg/l of solids in an economical manner.
This unit is essentially a pressure vessel that is filled with graded media (sand and gravel). The water filtered with PSF is passed on to the next stage in the STP chain: the Activated Carbon Filter.

Table: 8 Design of Pressure Filter

Parameter	Value/Calculation	Remarks
Design throughput flow	17 m3/day	Quantity of grey water.
Design filtration hour	20 Hrs (per day)	Allow 4 hours for rest, backwash, etc.
Filtration Rate	= 17 / 20 = 0.85 m3/Hr	The filter must be able to handle the clarified water at this rate.
Loading rate on filter	12 m3/m2 / Hr	
Filter cross section area required(min)	= 0.85 / 12 = 0.071 m2	= (Filtration rate) / (Loading rate)
Diameter of filter(min)	= (0.071 x 4/ π)1/2 = 0.3 m	Area of a circle= π/4 x Dia2
Height of filter	1.5 – 1.8 m	Selected by convention
Depth of sand layer	0.6 – 0.75 m	Selected by convention

ACTIVATED CARBON FILTER

An activated carbon filter, like the Pressure Sand Filter, is a tertiary treatment unit. It receives the water that is already filtered by the Pressure Sand Filter and improves multiple quality parameters of the water: BOD, COD, clarity (turbidity), colour and odour.

4.9 Design of Activated Carbon Filter

Parameter	Value/Calculation	Remarks
Design throughput flow	17 m3/day	
Design filtration hour	20 Hrs (per day)	
Filtration Rate	= 17 / 20 = 0.85 m3/Hr	The filter must be able to handle the clarified water at this rate.
Loading rate on filter	10 m3/m2 / Hr	
Filter cross section area required(min)	= 0.85 / 10 = 0.085 m2	= (Filtration rate) / (Loading rate)
Diameter of filter(min)	= (0.085 x 4/ π)1/2 = 0.33 m	Area of a circle= π/4 x Dia2
Height of filter	1.5 – 1.8 m	
Depth of sand layer	0.6 – 0.75 m	

SODIUM HYPO DOSING SYSTEM

The filter should be able to treat all the water that is decanted from the Secondary Clarifier tank.

4.10 Design of Sodium HYPO Dosing System

Parameter	Value/Calculation	Remarks
Design throughput flow	17 m3/day	on daily basis
Design max. chlorine dose	5 PPM = 5 mg/L = 0.005 kg/m3	
Chlorine dose per day	= 17 x 0.005 = 0.085 kg	
Hypo dose per day	= 0.085 / 0.1 = 0.85 kg/day	Hypo is available at 10 % strength.
Select hypo tank capacity	50 L	
Dose pump rating	0-4 L/Hr	

COST OF ALL COMPONENTS IN GREY WATER TREATMENT

Sr. No.	Unit	Size	Cost
1	Bar screen	0.6m x 0.09m x 0.07m	1000
2	Oil & Grease trap	1m x 1m x 0.6m	4800
3	Equalization Tank	2.5m x 2.5m x 3m	150000
4	Aeration Tank	1.5m x 3.5m x 2.5m	105000
5	Sedimentation Tank	1m x 1m x 2.5m	20000
6	Pressure Sand Filter	Dia. 0.3 m, ht. 1.5m	1500
7	Activated Carbon Filter	Dia. 0.3 m, ht. 1.5m	1500
8	Storage Tank	3m x 2.5m x 2.5m	150000
9	Other mechanical		40000

	units		
	Total cost		525000

VI: CONCLUSION

Greywater makes up the largest proportion of the total wastewater flow from households in terms of volume. Typically, 50-80% of the household wastewater is greywater. Design of various components for Grey Water treatment has been suggested for proposed area under study. Costs of all the components are also determined in this study. Total cost of Grey water treatment is Rs. 525000. The population growth of the Rajkot city is very fast. In summer people suffer from water scarcity. They purchase water from private water suppliers. By Grey water recycling we can save large amount of water. If people of Rajkot focus on this study, they can get more water for domestic and Industrial purpose. Water problems of Rajkot are solved by some extent.

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