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Analysis, Reuse and Recycling of Grey Water

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Abstract

Proper management of water sources, reuses of water and recycling of water can overcome water scarcity of world today and in future. Recycling of water is one of the methods for water conservation. Water utilized by humans can be divided as black water which contain feces and grey water generated generally from household activities strictly excluding black water. Grey water is the waste water generated from bathrooms, sinks, washing machines, and other kitchen appliances. Grey water is generated by human beings during their household activities can be recycled by treatment for activities like gardening, flushing etc. This grey water if not managed properly creates problems like health hazards, river water pollution and land pollution. Thus it becomes extremely necessary to have a proper waste/grey water management system. Waste water management falls under the authority of Water Supply and Sewerage Board (WSSB). Grey water generated from residential area, commercial area, institutional area, and recreational area falls under waste water. There is an increase in grey water constantly due to increase in population and change in life style. In this paper we have tried to divide the management of wastewater into 2 subdivisions so that load on WSSB can be decreased and waste water can be managed in better way. We have considered Rajupura village near Vasad as our case study. This study will be helpful to WSSB for reducing load in water treatment plants and recycling of waste water. This will be model village for similar rural and urban areas for recycling grey water so as technology goes to grass root level.
Keyword- Grey water, Recycling, Reuse, Waste water

I. INTRODUCTION

Grey water is the wastewater that is being discharged from a house, excluding black water (toilet water). This includes water from showers, bathtubs, sinks, kitchen, dishwashers, laundry tubs, and washing machines. It generally contains traces of soap, shampoo and toothpaste, food scraps, cooking oils, detergents and hair in minor quantities. Grey water makes up the largest proportion of the total wastewater flow from household in terms of volume.

Typically, 50-80% of the household wastewater is grey water. If a composting toilet is also used, then 100% of the household wastewater is grey water.

Studies in different countries have estimated that the usable domestic grey water resource could amount up to 35% of the total domestic demand. Non-domestic establishments such as swimming pools, restaurants, hotels, schools, and other public buildings produce clean grey water. This grey water can be collected before it goes to the septic tank or the municipal wastewater system, and may be reused to irrigate plants after providing a simple treatment. With a little additional treatment, this water can also be used for toilet flushing and other applications. Of course, some safeguards are required. The risks to the human and plant health should be minimized. In certain cases, no treatment may be required.

II. METHODOLOGY

For study purpose, Rajupura village, 22.473 N, 73.085 E, in Anand, Gujarat, India has been chosen.

When a detailed analysis was done, the problems associated with the drainage system of the village were brought to surface. These are as follows:

Drainage system provided in old village lacks lateral line due to which, half of the population does not use the drainage system efficiently. For black water, they use individual house septic tanks and grey water is discharged directly in open i.e. on the roads. This discharged water later meets the river water, so it is evident that river water is polluted. Mosquito nuisance and microorganism inhabitancies increase due to this haphazard discharge, so health hazards may also take place which can be sometimes fatal.

Fig. 1: Site location
Source: Google earth

A. Grey Water Analysis

After collection of grey water various tests such as pH, turbidity, hardness, conductivity, total solids, suspended solids, dissolved solids, DO(dissolved oxygen) and BOD(biochemical oxygen demand) were conducted in environment engineering lab of civil department of our institute(SVIT Vasad).

1) *Quantity Of Grey Water Produced In Rajupura Village*

- Total use of fresh water as per Indian standards is 135 lpcd.
- Water supply to Rajupura village is as per Indian standards.
- Quantity of grey water produced in Rajupura village is approximately 60% of the fresh water supplied.
- Grey water produced in Rajupura village = 135*900(population)*0.60 = 72900 Lit.

Fig. 2: Present condition and problem

B. *Methods of Recycling of Grey Water*

1) *Mechanical Method*

- Screening
- Sedimentation tank
- Filtration

2) *Aerobic System*

- Wetland system(bio filters)
- Mixed media filter beds
- Capping of sand filters
- Gravity filters
- Pressure filters
- Upflow filters
- Automatic gravity filters
- Continuous cleaning filters
- Inline clarification
- Precoat filtration

The terms "multilayer," "in-depth," and "mixed media" apply to a type of filter bed, which is graded by size and density. Coarse, less dense particles are at the top of the filter bed, and fine, denser particles are at the bottom. Down-flow filtration allows deep, uniform penetration by particulate matter and permits high filtration rates and long service runs. Because small particles at the bottom are also more dense (less space between particles), they remain at the bottom. Even after high-rate backwashing, the layers remain in their proper location in the mixed media filter bed.

For this case, in filtration brickbats and sand is used. Thickness of brickbats is 8 cm in every stage and sand layer thickness is varied as 5 cm, 6 cm, 8cm and 10 cm.

C. *Collection System*

For collection of grey water, there is no need to design a collection system because the R.L. towards the river is decreasing. R.L of the different area of the village is as shown in the fig.

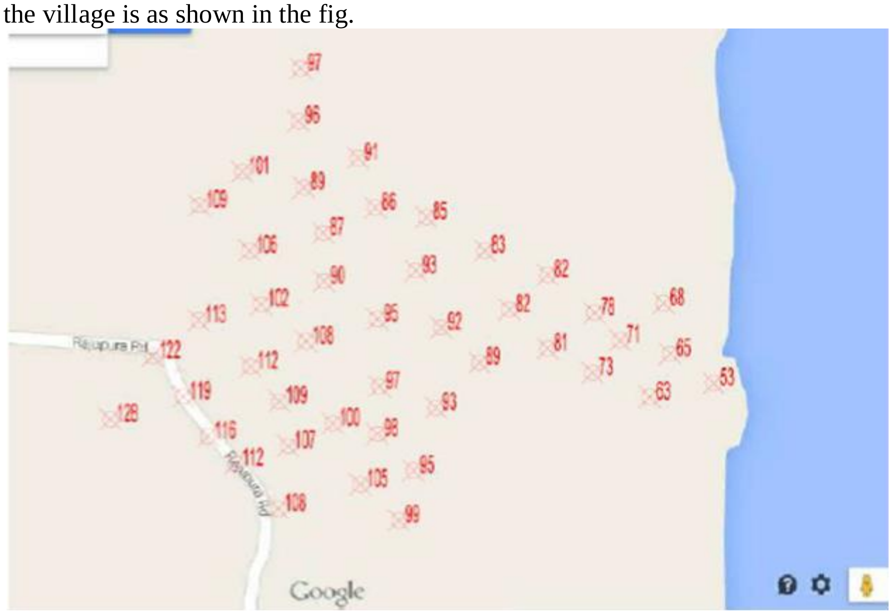

Fig. 3:R.L. Of the Village
Source: Google earth

Year	*Population*	*Increase*	*% increase*
2000	*650*	*-*	*-*
2005	*725*	*75*	*11.5*
2010	*830*	*105*	*14.5*
2015	*900*	*70*	*8.5*

Table 1: Population forecasting by geometrical increase method:

Increase in population (by arithmetic mean) (%) = (11.5+14.5+8.5)/3 = 11.5

Forecasting of population for 2025
$P=P0 (1 + (r/100))^n$
$=900(1+ (11.5/100))^2$
=1120
Forecasting of population for 2030
$P=P0 (1 + (r/100))^n$
$=900(1+ (11.5/100))^3$
=1247 persons=1250
Considering population of 1250 in 2030,
Grey water generated in 2030
= (grey water generated per person per day in lit.)*(population in 2030)
= (0.6*135)*1250
= 101250
Assuming approximate to be 1,00,000 liters per day.

D. Detention Period

It is the theoretical time for which waste-water remains inside the tank. It is calculated by dividing the volume of tank with the discharge. It is normally kept as 1 to 1.5 hours for waste-water. Velocity of flow in case of rectangular primary sedimentation tank can be taken between 15 to 30 cm/min.

E. Design of Sedimentation Tank

V=1, 00,000 lit/day
V=100.0 m^3/day
Designing for 1 lakh lit. Per day
Assuming SOR (surface overflow rate) of 25 m^3/m^2 per day
Assume detention period = 2.0 hours
Capacity of tank = (100*2.0)/24 = 8.33 m^3
Assume surface overflow rate,
Surface area = (water + water-flow) / SOR
= 100/25 = 4 m^2
Effective depth = 8.33/4 = 2.08 m
Assume, (L/B) =2 L=2B
(L*B) = 4
(2B*B) = 4
B2 = 2
B = 1.41m L=2*B = 2*1.41 = 2.82m
L= 2.82+1.5 = 4.32 = 4.5m (approx.)
D=2.20 m B=1.5m
Taking, 0.5m for sludge & 0.5m for free board
Total depth D = 2.2+0.5+0.5 = 3.2m
Hence dimension of tank = 1.5*4.5*3.2 = 21.6 m^3

F. Design of Filter

Rate of filtration as per model = 3.33 litters/hr.
Surface area of model = π / 4 * 0.252
Rate of filtration per sq. m. = 66.6 liters/hr./sq.m
Per capita grey water = 80 liters/ head / day (100000/1250)
Where,
100000 = future grey water generation
1250 = future population of year 2030
Average daily demand = 100000 liters / day
Rate of filtration per day = 66.6 * 24
= 1598.4 liter's / sq m / day
Total surface area = 100000 / 1598.4
= 62.56 sq. m
Single unit to be used
$B^2 = 62.56$
B = 7.90
Hence provide 1 filter unit of size 8m * 8 m
And height = 0.1 (sand layer) + 0.08 (brickbats) + 0.2 (free board) = 0.38 m

Hence, we provide filter basin of 8 * 8 * 0.4 m.

III. RESULTS AND DISCUSSION

PARAMETER	UNFILTERED	FILTERED
pH	8.4	8.08
Turbidity (NTU)	81	15
BOD (mg/lit)	274	104
TS (mg/lit)	1080	104
COD (mg/lit)	560	240

Table 2: Overall test results of grey water samples

A shared Grey water recycling system, using either treatment option, should be considered in building design. As population grows, and rainfall patterns alter with climate change, the national and international costs of water are expected to rise. Moreover, increasing pressure on the aging and deteriorating water and waste water infrastructure will influence water procurement costs. Under such conditions, solutions that reduce water demand – such as higher usage of Grey water – becomes more viable financially. Given that the utility service infrastructure created to support buildings typically has a design life of 20-40 years, adoption of systems that might be marginally more expensive now but deliver considerable benefits in the future should be seriously considered.

IV. CONCLUSION

- It was found from survey work conducted during project that no treatment for waste water is present in Rajupura village.
- Untreated Waste water is directly disposed in either septic tanks or river Mahi situated in the vicinity of the village.
- During preliminary experimentation it was found that grey water of Rajupura village has higher BOD value around 274 mg/litre and higher total solids 1080 mg/litre, which should be 30 mg/liter and 100 mg/liter respectively as per Indian standards for inland surface water standards.
- Form the preliminary project survey it has been concluded that grey water generated from any place can be treated properly for reuse.
- For decreasing the amount of BOD and TS (total solids) a model was prepared and analysis of samples is done for different thickness of filtration material (sand) and found optimum thickness of sand layer for filtration. After filtration amount of BOD has decreased to 35 mg/litre and TS has decreased to 104 mg/litre.
- Grey water treatment cost is lesser than waste water treatment. Any waste water contains 50-80% grey water. So we concluded that cost of waste water treatment can be reduced by proposing grey water treatment system. From grey water sample results of Rajupura village we concluded that many benefits can be obtained by proposing grey water treatment system. The benefits are as follows-

* Reducing health problems
* Reducing river pollution
* Treated grey water can be reused for irrigation

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