Reuse of Greywater by Various Treatment Methods

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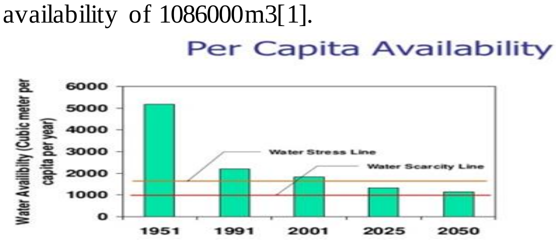
***Abstract*-The used water is now termed as wastewater. It may be either domestic waste water or industrial waste water. The waste water should be treated properly before disposing anywhere to avoid pollution. The waste water is treated using physical, chemical and biological methods, keeping in mind the acceptability and economical viability of the method adopted, any waste can be converted into potable water. In the present research a case of existing treatment plan has been reported. Visited the treatment plant personally, the schematic diagram of the has been reported. The analysed data related to the quality and quantity of waste water before and after treatment as been reported here. The analysis indicate profitability over fresh water usage apart from saving precious fresh water**

***Index Terms*- Grey water, grit chamber, sedimentation tank, equalization tank, clarifier tank, sludge slump, physio-chemical, irrigation.**

INTRODUCTION

Grey water is the wastewater generated from bathroom, laundry and kitchen. Due to rapid industrialization and development, there is an increase opportunity for grey water reuse in developing countries such as India. Consequent to rapid growth in population and increasing water demand, stress on water resources in India is increasing and per capita water availability is reducing day by day[1].

In India per capita surface water availability in the years 1991 and 2001 were 2300m3(6.3m3/day) and 1980m3(5.7m3/day) respectively and these are projected to reduce to 1401 and 1191m3 by the years 2025 and 2050 respectively(kumar etc al,2005). Total water requirement of the country in 2050 is estimated to be 1450000m3which is higher than the current availability of 1086000m3[1].



Greywater, also known as sullage, is non-industrial waste water generated from domestic processes such as dish washing,laundry and bathing. Greywater comprises 50-80% of residential wastewater. Greywater gets its name from its cloudy appearance and from its status as being neither fresh (white water from ground water or portable water), nor heavily polluted(blackwater).

Demand for water exceeds the available water resources. About 71% of the water demand is utilized by irrigation. The water demand in the country increases due to increasing of population, industrial development/expansion and irrigation. One of the methods to minimize the water scarcity in the country is utilization of wastewater for irrigation by installing sewage treatment plants to treat the influent from municipalities and industries.

Nicholas Kathijotes carried out the wastewater reuse for irrigation study to the reuse of treated effluents resulting from treatment of domestic effluents. Taking into account that statistics give about 50% of the total water resources are used for agricultural purposes and mainly irrigation, with this figure reaching even 70% in drier regions, then a tremendous conservation of hydrological resources can occur.

Mr. A. K.Sengupta, National Professional Officer (SDE), WHO India Country Office

Niman Bhavan, New Delhi (2006), carried out a study on Wastewater Management and Reuse for Agriculture and Aquaculture in India and Use of Waste Water in Irrigated Agriculture reduces the burden on Fresh water withdrawal and one of the best option in the recent years.

Suleaman Mohammed carried out a study on reuse of wastewater for agriculture and the purpose and the scope of this thesis work were to assess the application of reuse of wastewater for irrigation purposes and possible use after additional treatment as source for drinking water in Middle East countries, particularly in Jordan.

N.Latha, N.Deepa, B K Anand , K V Raju,H L Shashidhara Ecological Economics Unit, Institute for social and economic change , Bangalore. Wastewater Reuse in Mega cities. Emerging Trends in Bangalore carried out a study for the reuse of Wastewater as Bangalore, one of the fast growing, most happening city, called as Garden-city of south Asia is feeling the heat presently due to the lack of adequate water.

EMILY VIAU, Arizona state university m.c.maria socorro romero h.,universidad autonoma de baja California Jordon peccia, Arizona state university undergone a project on the reuse of treated wastewater for irrigation is a potential approach for alleviating water supply problems in the arid US.-Mexico border region.

MATERIALS AND METHODS

Study area: The study area geographically lies between 12° 45´48" N and 77° 25´36"E. Jain residential school, situated in Ramanagara district was originally constructed by the British in the year 1942 in view of providing the local residents with clean water for irrigation, domestic use, fisheries etc.. The following is the Google location map showing the sample collection points.

MATERIALS

Greywater from bathrooms: Water used in handwashing 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.

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 from kitchen: Kitchen greywater contributes about 10% of total greywater volume. It is contaminated with food particles,oils,fats and other wastes. kitchen greywater also contains chemical pollutants such as detergents and cleaning agents, which are alkaline in nature and contain various chemicals.

QUALITATIVE COMPOSITION OF GREYWATER

WATER SOURCE	Bacteria	Chlorine	Foam	Foodparticals	Hair	High pH	Nitrate	Odor	Oil & Grease	Organics matter	Oxygen	Phosphate	Salinity	Soaps	Sodium	Suspended solids	Turbidity
Cloth washing			*			*	*		*		*	*	*	*	*	*	*
Washing Of utensils	*		*	*		*		*	*	*	*			*	*	*	*
Bathing	*				*			*	*		*			*		*	*
Kitchen	*			*				*	*	*	*			*		*	*

POTENTIAL OF GREYWATER REUSE: Reuse of greywater serves two purposes,

•Reduces freshwater requirement,

•Reduces sewage generation and load on sewage treatment plants.

•The amount and quality of greywater will in part determine how it can be resued. Irrigation and toilet flushing are two common uses,but nearly any non-contact use is a possibility.

Possible uses of treated greywater are presented in the table below

Use of treated Greywater	Purpose
Individual household	Toilet flushing
School	Floor cleaning
Government office	Irrigation
Hospital	Gardening
Airport	Car washing
Railway station	Construction
Apartment/colony	Toilet flushing
Theatre	Toilet flushing

METHODOLOGY

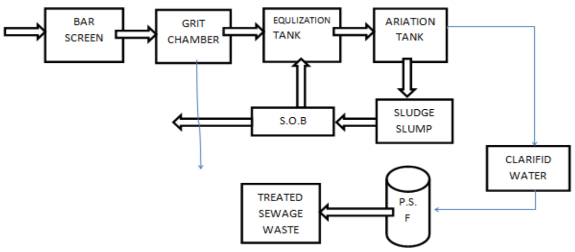
Levels of Greywater Treatment

Wastewater treatment options may be classified into groups of processes according to the function they perform and their complexity:

Priliminary treatment, it is done with simple processes that deal with debris and solid materials. The purpose of priliminary treatment is to remove those easily separable components. This is usually performed by screening and grit removal. Their removal is important in order to increase the effectiveness of the later treatment processes and prevent damages to the pipes,pumps and fittings[2].

Primary treatment is done by mainly the removal of solid by settlement. Simple settlement of the solid material in sewage can reduce the polluting load by significant amounts. It can reduce BOD by up to 40%[2].

Secondary treatment In secondary treatement the organic material that remains in the waste water is reduced biologically. It actually involves harnessing and accelerating natural process of waste disposal whereby bacteria converts into organic stable forms[2].



The grey water treatment plants have been constructed by providing treatment techniques such as screening, equalization, settling, filtration and sludge drying beds. The treated grey water from the treatment plant is used for irrigation of indoor plants ex: for gardening purposes.

COMPONENTS OF EXISTING GREYWATER TREATMENT SYSTEM AT JAIN RESIDENTIAL SCHOOL

1.GRIT CHAMBER

A chamber in which the velocity of waste flow is reduced to a point where the denser sand and other grit will settle out, but the organic solids will remain in suspension. The settled material is buried or used for fill.

2.BAR SCREENS

A grating of steel bars spaced about 2-4 cm on centre is placed at angle to the flow of sewage through an open channel. The screen removes coarse and floating solids from the sewage. The screen must be cleaned regularly and the removed solids must be burned, ground and digested, or buried[3].

3.EQUALIZATION TANK

The equalization tanks are provided to balance fluctuating flows or concentrations, to assist self neutralization, or to even out the effect a periodic discharge from a batch process.

4.SEDIMENTATIONTANK

Figure 5 : Rectangular sedimentation Tank

These are usually large tanks in which solids settle out of water by gravity where the settleable solids are pumped away. It operates by means of velocity of flow is reduced to about 0.005 m/s so that the suspended material will settle out. The usual detention time is 4-8 hours. Longer periods usually result in depletion of dissolved oxygen and subsequent anaerobic conditions.

5. SLUDGE DIGESTER

The sludge which settles in the sedimentation basin is pumped to the sludge digester where the temperature of 30-35 ◦c is maintained.

6. DRYING BEDS

Digested sludge is placed on drying beds of sand where the liquid may evaporate or drain into the soil. The dried sludge is a porous humus like cake which can be used as fertilizer base

7. FILTER

The type of filter required for a grey water system depends largely upon the amount of grey water to be filtered, the type of contaminants present and end use. Filtration is one of the most important operations in the grey water purification process. In filtration, water is passed through a filter medium in order to remove the particulate matter not previously removed by sedimentation.

8. STORAGE TANK

The purified water from the filters are pumped to the storage tanks and from there the treated grey water can be supplied for irrigation of indoor plants (for gardening purposes) as the grey water is most suitable for this purpose

STUDY AREA

The study area selected is located at Jain Global Campus, Jakkasandra village, Kankapura Taluk, Ramanagara District. The purposed area study area of Global Campus consists of an area of 38 acre and it consists green belt area of 60% of overall area. Hence, here this study is carried to purpose sewage treatment plant to treat the sewage generated in college campus and to use the treated water efficiently for gardening purpose within the campus.

The college includes,

1. Day scholar (including students, teaching and non-teaching staff) = 1800 members
Water consumption = 90 lit/day
Therefore,
1800 * 90 lit/day = 1,62,000 lit/day ------------(1)

2. Hostel students = 600 (including students and staffs)
Water consumption = 225 lit/day
Therefore,
600 * 225 lit/day = 1,35,000 lit/day ------------(2)

Total water consumption = eq.(1)+eq.(2)
= 1,62,000+1,35,000
= 2,97,000 lit/day

Now it is assumed that 80% diversity of total water consumption
= 0.8*2,97,000
= 2,37,600 lit/day
say 240 KLD

DESIGN OF TREATMENT UNITS

The following design details shows the required dimensions of each individual units of treatment plant that has to be constructed for treatment and reuse of sewage generated by the Jain Engineering college campus.

1. Equalization tank
Q = 240 KLD
Detention tank = 0.4 hr
Pumping hour = 16 hr
Flow rate = 240/16 = 15 KL/hr
Volume of equalization tank = 4*15 =60 KL
Tank Size required = 4.5 m * 4.5 m * 3 m * 1 no.

2. Extended Activated Aeration System (EAAS) Plant

a) Aeration tank
Assuming mess cone = 4000 mg/L or 4 Kg/m^3
F/M = 0.125
BOD cover = 450mg/L
Total BOD load = 240 * 450 = 108 Kg/day
Volume of aeration tank = 108 / (4 * 0.125) = 216m^3
Tank size required = 5.5m * 11.5m * 3.5m * 1 no.

b) Diffused Aeration System
O2 required = 2 times of BOD @ 20 hr working of blowers
= 2 * 216
= 432 Kg/day
= 4,32,000 gm/day

c) Air Flow Required
Assuming 18 gm of O2 transfer/m depth
60% of blower consideration

Air flow = 4,32,000 / (24*18*0.6*4) = 416 m^3/hr

Air blower equipment capacity = 500m^3 /hr @ 2 no. (1+1)

length of diffuser membrane at air discharge @ 10 m^3/m length

= 416 / 15.6 = 27 Running meters

3. Clarifier Tank

Considering sludge recycling to aeration tank from sludge tank @ 100%

= 240 * 2

= 480 KLD

Assuming SLR @ 25m^3/m^2/hr

Area of tank = 280 / 25 = 19.2 ≈ 20m^2

Hence provide 4.5 m * 4.5 m * 3.0 m * 1 no.

4. Clarified Water Tank

To provide continuous filter separation, hence provide the tank of 4 m * 4 m * 3 m * 1 no.

5. Pressure and Filters

Discharge, Q = 240 m^3/day

No of hours working =16 hr

Flow = 15 m^3/hr

SLR= 15 m^3/m^2/hr

Filter required = 0.8 m Φ * 2 no.

6. Activated Carbon Filter

Discharge,Q = 240 m^3/ day

No. of hours working = 16 hr

Flow = 15 m^3/ hr

SLR= 15 m^3/m^2/hr

Filter required = 1.1 m Φ * 1 no.

7. Chlorinator

Chlorine,Cl_2 discharge <= 1mg/L electronic dosing Pump of 2 LPH= with sodium hydrochloride solution which consists of 5-10% strength

8. Head water holding tank

To provide for continuous separation hence provide a sump of 100 m^3 capacity.

Results and discussions:

The sewage generated will have various physio-chemical parameters which causes various effects on environment as well as human health if it is directly used without any treatment.

Below table shows the raw sewage water quality.

Parameter	Unit	Raw sewage
pH	-	5.5-9.5
Suspended solids	mg/l	90-400
BOD	mg/l	150-400
Nitrite	mg/l	1-10
Ammonia	mg/l	10-35
Sulphate	mg/l	12-40
Boron	mg/l	5-10
Chloride	mg/l	800-1000
TDS	mg/l	2500-5000
COD	mg/l	Nil

After providing the conventional treatment for the sewage generated the water quality should be with the limits prescribed in the below table

Parameter	Unit	Raw sewage
pH	-	6.5-8.5
Suspended solids	mg/l	100-200
BOD	mg/l	100
Nitrite	mg/l	>20
Ammonia	mg/l	10
Sulphate	mg/l	>12
Boron	mg/l	2
Chloride	mg/l	800-1000
TDS	mg/l	600
COD	mg/l	Nil

CONCLUSION

The treatment processes that has been established to treat the wastewater can reduce the physio-chemical parameters in to a desirable limit, hence the efficient use of the treated water can be done. As per the project which is undertaken, 66% of total treated grey water is obtained which is used for irrigation, flushing and gardening etc.

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