2011 International Conference on Environment Science and Engineering
IPCBEE vol.8 (2011) © (2011) IACSIT Press, Singapore

Simple system for handling and reuse of gray water resulted from ablution in Mosques of Riyadh City, Saudi Arabia

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Abstract—**Greywater is the term given to all used water discharged from a house includes shower, bath, hand basin, kitchen sink, dishwasher, washing machine and laundry tub water except for toilet water. To cope with the current and future water scarcity in Saudi Arabia, we need to look for alternative water sources and work towards achieving high level of sustainability. One such alternative is the reuse of domestic greywater for irrigation around homes. The greywater reuse practice is becoming increasingly common in many households around the country, but there are no in-depth studies that provide a clear understanding of how the greywater reuse impacts on soil, plant and human health in the long-term. Furthermore, the re-use of greywater for garden irrigation or in flushing system should be encouraged in urban and rural households as it utilizes a valuable on-site resource, conserves precious drinking water and reduces the load on wastewater disposal systems. This paper covers a simple system for treatment of greywater generated from hand and mouth wash (ablution) basin in mosques in Saudi Arabia. The proposed system contained sand and activated carbonic filters along with simple sterilization (Ultra Violet unit) for removing the pathogenic microbes and other impurities may found in the Greywater. The suggested system was tested in a big mosque (Othman bin Affan Mosque) – Riyadh, Saudi Arabia. The obtained results indicated that the concentration of (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^-, CO_3^{2-}, Cl^- and SO_4^{2-} in gray water were relatively not changed than tab water. However, by using the tested system the concentrations of the studied ions became more or less the same as in tap water, especially at the final stage of water purification (after passing the water through the U.V. unites) but it is very efficient in treating the microbial content after the treatment. It's needless to say that such purified water could be successfully re-used for flushing toilets or irrigating all kinds of crops (as grass and palms) which are sensitive and /or resistant to salinity.**

Key Words-Grey water, ablution water, Irrigation water quality

I. INTRODUCTION

Saudi Arabia is experiencing water restrictions due to current drought conditions and the critically low levels of surface water storage. It is recognized that in times such as these many Mosques like to conserve water by reusing their grey water. We all need to treat and recycle waste water resulted from ablution to prevent pollution, and to conserve and re-use our limited resources. As the estimated production of desalination plants exceeded 3.5 million m^3/day. This represents 60%of total urban water in the year of 2010. Such a high amount of water consumption produces a huge amount of swage water which needs to be treated. Lowering the amount of urban water demand has become a necessity in Saudi Arabia for the ministry of water. This could achieved by a combination of different measures such as increasing the efficiency of water supply systems (mainly reducing the pipe losses), installation of water conserved appliances (showers) and reusing some of that water (greywater). Experience of several countries indicates that grey water can be a cost effective alternative source of coming from baths , showers, washing machines and bath ram sinks, comprising 60 -70% of the total water demand . Grey water has been used to conserve water and to promote sustainable development without compromising public health and environment. Prathapar *et al.,*[1] concluded in their study at Oman that building industry can be persuaded to install grey water treatment system in new apartment complexes and public buildings. There have been several studies conducted in many counters and overseas to understand community views on general water issues and effluent reuse, but there is only limited research to date specifically focusing on greywater reuse issues [2], [3] and [4].

Abu-Rizaiza, [5] identified greywater reuse for irrigate and toilettes flushing to conserve water. In a study at Los Angeles on the utilization of grey water effluents for irrigate, 12-65% of water saving were observed. An Australian experience shows that reuse of greywater of toilet flushing and garden irrigation saved up to 50% [6]. While the saving in Mallorca Island, Spain reached to 23% [7].

Since ablution does not cause the quality of water to deteriorate beyond judicious reuse, it may be suited for the flushing of toilets or the irrigation of public gardens [8] and [1]. This research suggests the development of a plumbing system designed to collect, filter and disinfect ablution water to be used subsequently for the above purposes. Therefore, the objectives of this study are to assess the greywater recycling systems and to investigate the effect of the treatment on microbial and chemical quality of the recycled water.

II. Materials and Methods

A greywater reuse system was designed for the purification of water consumed in ablution. The system cosseted of: (A) four PVC sand filters (15 cm internal diameter and 1.5 m long each), (B) one activated charcoal filter (20 cm internal diameter and 1.0 m long), (C) ultra violet unite, and (D) tanks for collecting grey water and final purified water, (E) valves and regulators. as shown in (Figs.1-2).

We used gravel infiltration galleys and filter the grey water through the septic system so the pipe doesn't clog. A greywater reuse system receive the effluent from one big Mosque (Othman bin Affan Mosque), as the out put of water passed through the system was analsized all year round. Due care was in the system to protect public health, protect the environment, meet community aspirations and be less cost-effective. Current on-site treatment systems have generally adopted the technology of the conventional sand filters, activated Charcoal filters and U.V filter for large treatment systems (Table,1). Different stages of water treatment were analyzed to identify its physical chemical and chemical characteristics such as the amount of suspended matter; turbidity, EC_w ; pH and their content of (Ca^{2+}, Mg^{2+},Na^+, K^+, HCO_3^-, CO_3^{2-}, Cl^-, and SO_4^{2-}), the number of colon bacteria (E. coli.), COD, TOC and Turbidity were determined according to the methods described by [9] and[10].

Table 1. Technical characteristics of the UV device

Number of lamps	1
Type of lamps	Low pressure
Emission of lamps (W real UV)	6.4
Reactor diameter (mm)	110
Reactor length (mm)	650
Net volume of contact chamber (l)	6
Hydraulic pressure (bar)	100
UV output (w)	25

III. Results and Discussions

Data presented in Table (2) show that the concentrations of (Ca^{2+}, Mg^{2+}, Na^+, K^+, NH_4^+, HCO_3^-, CO_3^{2-}, Cl^- and SO_4^{2-} in the grey water were relatively similar or higher than tap water. However, by using the system the concentrations of the studied ions became more or less the same as in tap water, especially at the final stage of water purification (after passing the water through the U.V. unites). It's needless to say that such purified water could be successfully re-used for flushing the toilets or in garden irrigation. As the chemical composition of such water was more closed to those of tap water (Table, 2 and 3) with safe microbial content.

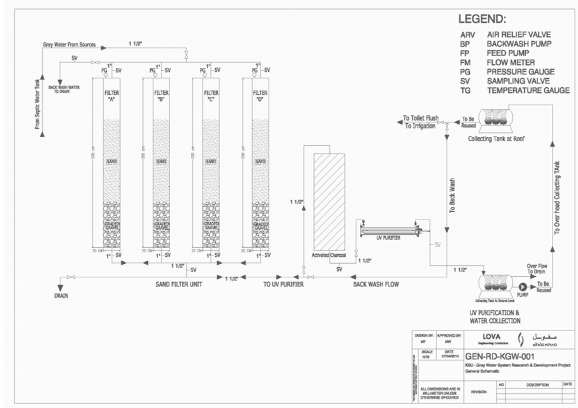

Figure. (1) Schematic diagram for the system that used for treating Gray water.

Figure.(2) Sand and activated charcoal filters.

Table (2) Chemical properties of the grey water before and after purification

Treatments	Soluble Cations (meq.l-1)*				Soluble anions (meq.l-1)		
	Ca^{2+}	Mg^{2+}	Na^+	K^+	HCO_3^-	Cl^-	SO_4^{2-}
First Period							
Tap Water	4	2.3	2.69	0.108	1.95	4	2.3
Greywater	4.75	2.7	3.85	0.183	3	4.5	2.4
Sand Filter	4.6	2.1	2.69	1.35	1.95	4.1	2.4
Charcoal filter	2.95	5.3	2.69	1.4	3	4.75	2.7
Ultra violet	4	2.3	2.69	0.115	1.8	3.9	2.4
Fifth Period							
Tap Water	4	2.35	2.69	0.115	2.1	5	2.54
Greywater	5	2.45	3.58	0.128	3.25	5.25	2.54
Sand Filter	4.75	2.55	2.92	0.141	3	4.45	3.66
Charcoal filter	4.75	2	2.69	0.531	2.75	4.68	2.8
Ultra violet	4.15	2.35	2.69	0.503	1.85	4.5	2.5

Respecting the COD and TOC and Turbidity, data in Table (4), clearly appear that the studied parameters were so much higher in the grey water (water consumed in ablution) compared to the tap water. However such parameters were greatly decreased by using the simple system.

Table (3) Chemical properties of the greywater before and after purification.

Treatments	EC dSm^{-1}	pH	T. Hardnes	RSC
First Period				
Tap Water	0.836	8.10	317.5	-4.25
Greywater	0.923	7.97	372.5	-4.20
Sand Filter	1.05	7.30	365.0	-4.30
Charcoal filter	1.100	7.46	337.5	-4.00
Ultra violet	0.980	7.92	325.0	-4.65
Fifth Period				
Tap Water	0.836	8.10	317.5	-4.25
Greywater	0.923	7.97	372.5	-4.20
Sand Filter	1.05	7.30	365.0	-4.30
Charcoal filter	1.100	7.46	337.5	-4.00
Ultra violet	0.980	7.92	325.0	-4.65

Table (4) TOC, Turbidity and COD of the grey water before and after purification

Treatments	COD mg O_2 /L	Turbidity NTU	TOC mg C/L
First Period			
Tap Water	260	0.09	97.5
Greywater	500	0.95	187.5
Sand Filter	480	0.47	180.0
Charcoal filter	400	0.46	150.0
Ultra violet	340	0.12	127.5
Fifth Period			
Tap Water	280	0.08	105.0
Greywater	520	0.99	195.0
Sand Filter	480	0.50	180.0
Charcoal filter	320	0.46	120.0
Ultra violet	340	0.12	127.5

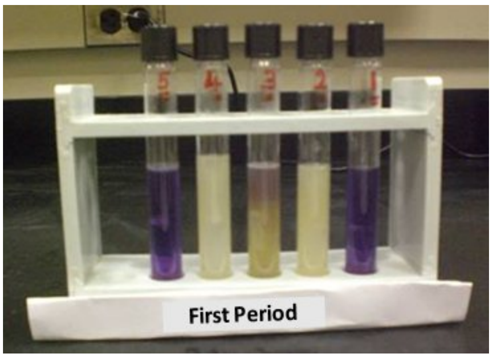

Fig. (3) Colon bacteria (E. coli) in the grey water before and after purification at the 1st period. .

(Tube No I contained Tap water; Tube 2 contained grey water , tube 3 water after passing through sand filte r , Tube 4 water after passing through Charcoal filter sand Tube 5 water after passing through the U.V unit).

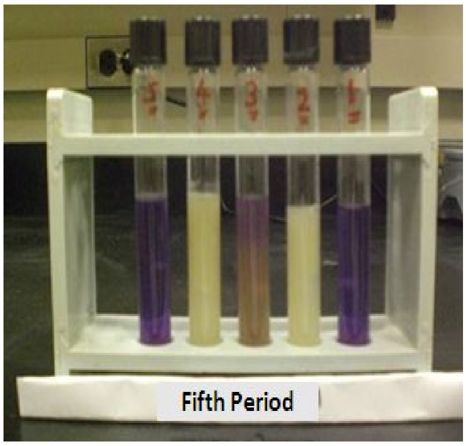

Fig (4) Colon bacteria (E. Coli) in the grey water before and after purification at the 5th period..

(Tube No I contained Tap water; Tube 2 contained grey water , tube 3 water after passing through sand filter , Tube 4 water after passing through Charcoal filter sand Tube 5 water after passing through the U.V unit).

IV. Conclusion

This paper is an introduction to greywater re-use. Tertiary quality effluent can be achieved through the use of constructed sand filters, activated charcoal, and UV unit. Using this simple system can safe about 30-40 % of fresh water to be used in toilets and irrigate the landscape area. Its introduction needs to be seen in terms of its contribution to sustainable development and resource conservation without compromising public health or environmental quality.

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