Review of gray water treatment and reuses for Irrigation

Bagher Yousefi [1], Hadi Moazed [1], Mohsen Pouladgar [1], Sahar Rahi[2]

[1] Irrigation and drainage Engineering, Shahid Chamran University, Ahvaz, Iran
[2] Agricultural Mechanization Engineering, Shahid Chamran University, Ahvaz, Iran
bagher.yousefi@gmail.com

Abstract: Regarding the population increase and incoming water crisis, the need to efficiency technologies and economizing water consumption is more and more seen necessary. One of these technologies is to use Gray water. Gray water is part of the home sewage which is produced by the bathroom, the toilet, the laundry and the kitchen and contains soil, oil and soap etc. depending on its quality, Gray Water can be used to irrigate green campuses by the process of treatment or without it. To achieve this goal, all kinds of physical, chemical and biological methods are used. In addition to study the advantages and restrictions of using Gray Water, this article presents matters which should be observed in irrigating green campuses using Gray Water.
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Introduction

At percent, 80 countries are situated in arid and semi-arid regions of the world with a population of forty percent of the whole world (global bank 2008).

The increasing competition between the agricultural part and the city inhabitants to use drinking-water sources which enjoy great quality in populated areas with arid and semi-arid climates, leads to pressure on these sources.

Regarding the water crisis in the world, using wastewater and non-ordinary kinds of water has increased more and more. The aim of this research is to introduce Gray Water and the methods of exploiting it in inhabited environments in order that drinking-water not be used in parts of the domestic consumption in which Gray Water can be used like green campuses. Regarding the climate in every region, the domestic green campuses consume about 4 to 10 liters of water per square meter and we can save this amount of clean water by using gray water in them (Sarshouri,. 2011).

Gray Water

Gray water is interpreted as the civic wastewater that involves water from bath, showers, washing machines, dishwashers and kitchen sinks but keeps out waters from toilets (Jefferson et al., 1999; Otterpohl et al., 1999; Eriksson et al., 2002). Some writers keep out kitchen waste water from other gray water streams (Al-Jayyousi, 2003; Wilderer, 2004). the sewage from the toilets is not used because of the possibility that it contains unhealthy micro-organisms. The wastewater from the water-softeners (in case it is used in the complex) is not also used because of great amounts of salt. The sewage from kitchen sinks and washing-machines and laundry must be infiltrated (Bennet, 1995).

Gray water accounts for 50-80% of the whole family and domestic wastewater (Eriksson et al., 2003). Because of low amounts of polluting pathogens and nitrogen, reworking and reusing of Gray water is enjoying increasing attention (Li et al., 2003).

In this article, treatment substitutes for gray water reworking are tested by revising the published works and a selection process of the suitable techniques for gray water treatments and reusing is presented in agriculture.

Treatment of gray water

Researchers have argued for using of many technics for gray water treatment. Advantages and limitations of using these technics have been considered. Sand filtrations along with disinfection is the most widely used technic for family gray water recycling in united kingdom (Jefferson et al., 2000). The gray water collected from this method has much organic load and muddiness, and this lessons the effect of chemical disinfection procedure. Membrane systems present an abiding obstacle to hanging particles larger than the size of membrane matter down to molecular dimensions for inverse osmosis. The most important reason which constrains the practicality of membrane system is the obstacles on the membrane surface by contaminating matters. Many researchers have argued for this (Nghiem et al., 2006). Here, membrane systems need a high amount of energy (Jefferson et al., 2000). To eliminate all the species, biological and physical treatments are necessary. The advantages of biological and physical treatments are mingled in the procedures such as membrane bioreactors. But, this system is better to be used for large-scale projects rather than schemes for single homes. Constructed wetland is another method which does not have much cost and recently has enjoyed

attention in working on gray water. Projects in central America (Dallas et al., 2004), middle east (gross et al., 2007) and the England (Frazer-Williams et al., 2008) say that if the hydraulic conserving time is represented, great amounts of uprooting can be done. So, in this work, a built wetland gray water recycling system is used to examine the effect of dwelling time in reservoir containers on the viability of the system (Liu et al., 2010).

Utilizing gray Water in Irrigation green campuses

Table 1 shows the qualitative characteristics of the used sewage water in different part of a home (Li et al., 2009). Regarding the low amount of contamination in the outgoing water, the hand basin, the shower, the laundry and the hand washing water can be used without treatment to wash toilets and it can also be used to irrigate the green campuses after only a little amount of treatment.

Table1. The characteristics of grey water by different categories.

	Bathroom	Laundry	Kitchen	Mixed
pH (−)	6.4–8.1	7.1–10	5.9–7.4	6.3–8.1,
TSS (mg/l)	7–505	68 – 465	134–1300	25–183
Turbidity (NTU)	44–375	50 – 444	298.0	29–375
COD (mg/l)	100–633	231 – 2950	26–2050	100–700
BOD (mg/l)	50–300	48 – 472	536–1460	47–466
TN (mg/l)	3.6–19.4	1.1 – 40.3	11.4–74	1.7–34.3
TP (mg/l)	0.11– >48.8	ND – >171	2.9– >74	0.11–22.8
Total coliforms (CFU/100 ml)	$10–2.4\times10^{7}$	$200.5–7\times10^{5}$	$>2.4\times10^{8}$	$56–8.03\times10^{7}$
Faecal coliforms (CFU/ 100 ml)	$0–3.4\times10^{5}$	$50–1.4\times10^{3}$	–	$0.1–1.5\times10^{8}$

If drip irrigation is used or if the green campus is above the level of reservoir tank, we need a pump to transfer the gray water to the green campus. The features of the pump are defined by factors such as necessary pressure elevation, distance of the reservoir to the green campus and the elevation on which the gray water must reach. For the level grounds, a centrifuge pump with the horsepower of 0.5 is needed. For a four-peopled family, the above mentioned pump works for 4 to 5 minutes during the irrigation season. One of the most important challenges in designing the gray water system is to prepare the irrigation system and assigning the area of the region and volume of the water which is needed to be irrigated. In figure 1, a profile of gray water system is shown (Bennett D, 1995).

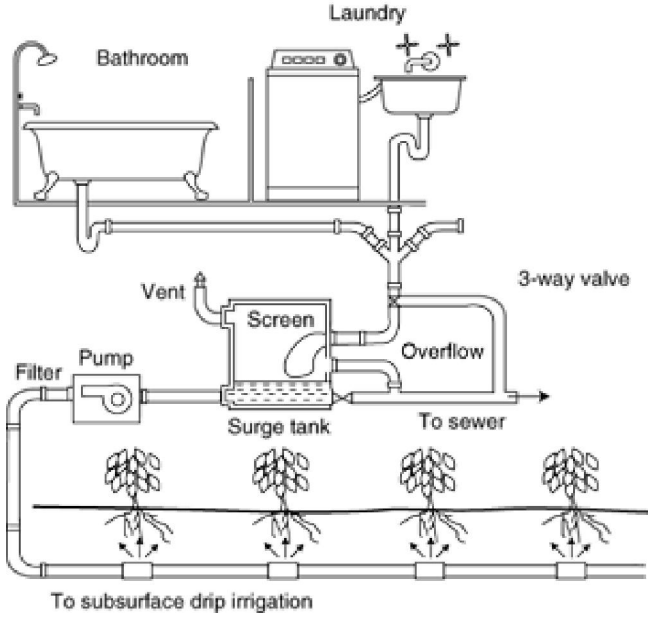

Figure 1. Schematic of a residential gray water system

Some items to be considered in irrigation of green campus by using gray water (Sarshour et al., 2011):
-If there are a lot of salt in the green campus, it is better to use liquid washing material instead of powder, because they have less sodium.
-Because the washing materials are alkaline, the plants which need an acid environment (those in need of shade) must not use gray water.
-To use gray water, it must be stored in a tank in order not to be mistaken for drinking water. The tank must have a cover and this water must not be stored longer than 24 hours. Because if gray water remains without treatment for some days, it will absorb a lot of microbes and will become putrid.
-Gary water must not be poured directly on the leaves of the plants but only for the roots.
-It must not be used to clean the vegetables because of its unhealthy features.
-Don't pure the gray water directly around the trunk of the plants. This may corrupt the crest of the plant.
-Don't use it to irrigate the flowers of a vases, the restricted area of their roots makes them more and more vulnerable.

At the end table 2 shows, advantages and the disadvantages of using the gray water to irrigate the agriculture crops (Borojeni et al., 2010).

Table 2. The most important advantages and disadvantages of using gray water to irrigate the agriculture crops

Advantages	Disadvantages
• Reduction of irrigation costs in areas near the cities. • Reduction of demand to use drinking water in agriculture part. • Less agriculture need to Chemical fertilizer. • Less wastewater going in to reservoirs. • Faster absorption of mineral nitrogen in gray water rather than organic nitrogen in wastewater. • Possibility of using this kind of water in drip irrigation systems because of having less solid matters. • Less smelly than wastewater	• Biological accumulation of some noxious components in the plants • Less Plant performance because of acidity or lack of balance in food components • Destruction of soil structure because of sodium and Surfactants • The possibility of contamination in ground waters • Lack of infrastructures and the needed regulations to use the gray water in the agricultural part.

Conclusion

The demand for drinking water in the world is increasing day to day and it means that consumption and irrigation needs are increasing and that reconsidering the importance of non-ordinary waters and wastewater is inevitable. This needs the treatment of water using renewable energies. Using gray water is one of the methods which can be helpful in dealing with environmental challenges, because by recycling gray water in most of the deserts regions and the regions that lack drinking water, the gray water can be used in irrigation and so saving large amount of drinking water. Of course, some points must be considered in irrigation using gray water. Regarding what was discussed in this article, it can be said that gray waters must be recycled to decrease water consumption, decrease individual costs, enjoying a cleaner environment and more water sources.

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