Eco. Env. & Cons. 28 (1) : 2022; pp. (558-567)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i01.084

Recycling of the Greywater from Mosques in Oman

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(Received 12 October, 2021; Accepted 14 December, 2021)

ABSTRACT

Oman is located within Arid and Semi-Arid regions, where water resources are very scarce. The national average rainfall is just 80-100 mm per year. With high temperatures (30 ºC to above 40 ºC) the evaporation is also high. Therefore, it is absolutely necessary to conserve and recycle water in Oman. The study aims to identify ablution water (the ritual washing of the exposed parts of the body, the face, hands and feet before each prayer called ablution) and to prove that it as one of the least polluted sources of greywater, by examining the properties of greywater and comparing its results with the results of other greywater, taking into account the criteria for reusing treated water, as well as developing appropriate treatment techniques. The study dealt with the use of solar energy to operate the treatment unit, and developed an appropriate design for the treatment unit. The study recommends using the total volume of greywater generated for non-potable purposes including rinsing, car washing, gardening and irrigation purposes. In this way, the greywater from mosques is recycled in the most beneficial way and at a lower cost in order to provide fresh water for future generations.

Key words : *Greywater, Ablution greywater, Greywater recycling, Solar energy, Oman*

Introduction

When talking about the greywater from mosques, it is necessary to talk about ablution in the religion of Islam, where every adult Muslim is required to perform the five obligatory prayers every day. Each of these five daily prayers is preceded by the Islamic procedure of cleansing the exposed part of the body. It is a purification ritual called wudhu/wudu in Arabic or simply ablution in English. This Islamic ablution steps consist of washing hands up to wrists and the entire face and arms to the elbows, then wiping the head and ears and washing the feet to the ankles and rinsing the mouth and nose (Zaheer, 2010). Accordingly, every mosque has a place for ablution in its buildings. Ablution is a must, but at the same time, the Prophet Muhammad (may God bless him and grant him peace) advised Muslims not to waste any water even during this mandatory purification process. One ablution requires about 2.5 - 3.5 liters of water (Prathapar *et al.*, 2004). Hundreds of people perform ablution five times a day in the mosque, which produces a huge amount of greywater, averaging over 15 liters per person per day (Abu-Rizaiza, 2002).

Note that the water used for ablution is required that it does not change its smell, colour, or taste, and no detergents are used, so we find greywater resulting from ablution much better than other grey water resulting from sinks and washing machines, which contain a large number of detergents, as it contains greywater for the kitchen on food particles and oils/ fats that require different handling.

The Sultanate of Oman is located in the south-eastern corner of the Arabian Peninsula in arid and semi-arid regions, where water resources are very scarce and is a dry country with an average rainfall of only 10 cm per year (Ministry of Water Resources. 1995, 1998, 1999). With temperatures above 40 °C, the rate of evaporation is also high. The annual net natural recharge of groundwater is about 1260 million cubic meters. While the total water demand is about 1650 million cubic meters, 90% of it is used in agriculture. To fill the deficit, it is necessary to withdraw 390 million cubic meters of groundwater reserves, thus lowering the groundwater level, which leads to seawater intrusion and salinization of coastal areas (7), which includes more than 60% of agricultural production in Oman (Khatun *et al.*, 2011). Therefore, it is absolutely essential to recycle water in order to conserve freshwater for future generations. When properly managed, greywater can be a valuable resource for horticultural and agricultural growers, as well as home gardeners.

Greywater from sinks and washing machines contains a large number of detergents, which have many harmful effects on the soil. Gray water from the kitchen contains food particles and oils/fats that require different processing.

The paper compares different types of greywaters and allocates a section to the greywater resulting from ablution from mosques, which is the targeted water in the paper. The laboratory results indicate the quality and ease of recycling compared to other greywater generated from washrooms and household wastewater, where many factors can lead to variables Wide concentration of pollutants in greywater.

Table 1 shows common physical, chemical, and microbiological greywater quality ranges. The greywater ranges measured and presented in Table (1) are quite favorable to provide a broad idea of the concentration ranges of each parameter that can be expected in greywater.

Gray water quality can vary depending on the sources contributing to its formation and because of these variation sources, the paper addresses the direct procedure of treatment and recycling for greywater from ablution and separate section devoted to describing the construction of a simple greywater treatment plant.

Materials and Methods

This study aims to determine the characteristics of greywater generated in mosques compared to greywater from other sources, bathing, sink, kitchen, and other sources from residential buildings. Approaches were used between the results of the quantitative and qualitative analyses as part of this study. The study was independently relied on assessing the physical, chemical, and microbiological properties of greywater from bath/shower, sink, kitchen, and washing sources compared to the results of greywater resulting from mosque ablution. The collected samples were analysed for pH and EC using the respective meters, whereas the other parameters were determined through the standard laboratory methods (Standard Methods for the Examination of Water and Wastewater (APHA 2005). The Results were compared with published literature data. The treatment process and operating system have been modified to ensure that greywater recycled is complied with established standards for reuse requirements.

Study area

This study was conducted in the Sultanate of Oman, the city of Salalah from June 2020 to March 2021. The Salalah is a city located on the southern side of the Sultanate of Oman, specifically on the coast of the Arabian Sea. It is surrounded by mountains from all directions except for the south. It is characterized by a mild climate and is the capital of the Administrative Dhofar Governorate. the samples collected from a number of mosques as well as different sources of greywater to make comparisons.

Analytical techniques

The pH, temperature, dissolved oxygen (DO) and electrical conductivity (EC) were measured using portable PASCO PASPORT probes, pH measured PASPORT pH sensor (PS- 2102) temperature measured by PASPORT Stainless Steel temperature sensor (PS- 2153) for Dissolved Oxygen PASPORT DO sensor (PS- 2108) and conductivity by using Pasco Scientific PASPORT Conductivity Sensor (PS-2116). The total organic carbon (TOC) and dissolved organic carbon (DOC), respectively, were determined using a TOC-5000A (Shimadzu, Milton Keynes, UK). The total suspended solids (TSS) concentration was measured following standard methods (APHA *et al.*, 2005). Chemical parameters (COD, BOD5, TP, TKN, NH4 –N and NO3 –-N) were determined using standard methods (APHA, 2005). Chemical oxygen demand (COD) was determined using the HACH Be Right ™ BOD Direst Plus and TOC Analyzer HACH.

Results and Disscussion

There are different sources of greywater inside homes [11]. We will compare this with the greywater or ablution water (see Table 1).

Greywater from the bathroom: Wastewater generated during hand washing and showering makes up about 50-60% of household greywater. It is less polluted than household greywater and contains chemical contaminants from soap/shampoo, toothpaste and possibly hair dye and other hygiene pollutants. It also contains some faecal contaminants for a long time such as bacteria/viruses accompanying through body washing. Figure (1-1) illustrated characteristics of average values greywater quality parameters from bathroom.

Laundry Gray Water: The water used for washing clothes represents 25-35% of household greywater. This greywater is rich in detergents and washing agents. It also contains some soil particles and faecal contaminants along with associated

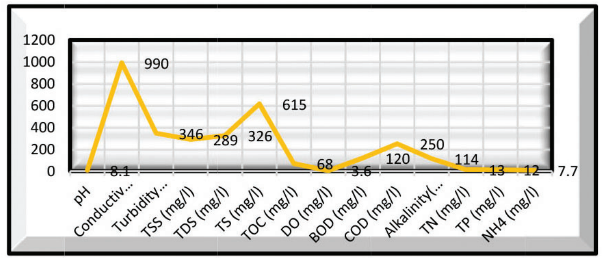


Fig. 1a. Characteristics of average values greywater quality parameters from bathroom pH, EC, TS(mg/l), TSS (mg/l), TDS (mg/l), TOC (mg/l), DO (mg/l), BOD (mg/l), COD (mg/l), Alkalinity (mg/l), TN (mg/l), TP (mg/l), NH_4(mg/l),

pathogens and parasites. Figure (1-2) illustrated of the average of greywater quality parameters from laundry.

Greywater from Kitchen: Greywater from the kitchen accounts for about 10% of the domestic greywater. It definitely contains food particles (both cooked and uncooked) along with oils, fats and other wastes. Kitchen greywater is conducive for the growth of numerous micro-organisms. The kitchen greywater also has detergents and other cleaning agents, which tend to be alkaline in nature. Figure (1-3) illustrated of the average of greywater quality parameters from kitchen.

Gray water used for ablution: Gray water used

Table 1.

Parameters	Bathroom	Kitchen	Laundry	Mosque
Temperature (°C)	31.5	31.2	32	31
pH	8.1	5.7	8.5	7.3
Conductivity (ìS/cm)	990	2180	2650	290
Turbidity (NUT)	346	160	320	14
TSS (mg/l)	289	136	260	23
TDS (mg/l)	326	910	2150	137
TS (mg/l)	615	1045	2410	160
TOC (mg/l)	68	82	170	N/A
DO (mg/l)	3.6	4.3	3.4	2.3
BOD (mg/l)	120	315	190	35
COD (mg/l)	250	315	260	65
Alkalinity (mg/l as CaCO3	114	111	135	85
TN (mg/l)	13	8	7	0.2
TP (mg/l)	12	25	23	8.2
NH4 (mg/l)	7.7	3.5	13	7.2
Faecal Coliforms (CFU/(log10.100 ml^{-1})	3.5	6	4	2.8
Total Coliforms (CFU/(log10.100 ml^{-1})	4	ND	3.75	ND

N: number of samples, ND: not detected

The comparison between the results obtained from physical and chemical characterization of greywater collected from various sources are presented Figures (1 – A)

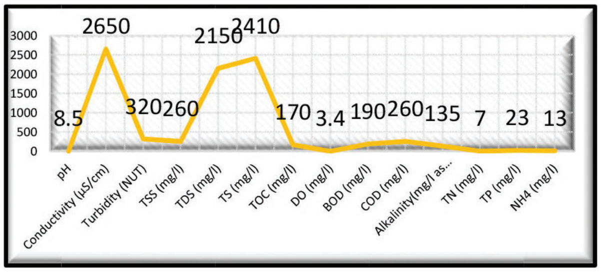


Fig. 1b. Characteristics of average values greywater quality parameters from laundry. pH, EC, TS(mg/l), TSS (mg/l), TDS (mg/l), TOC (mg/l), DO (mg/l), BOD (mg/l), COD (mg/l), Alkalinity (mg/l), TN (mg/l), TP (mg/l), NH_4(mg/l),

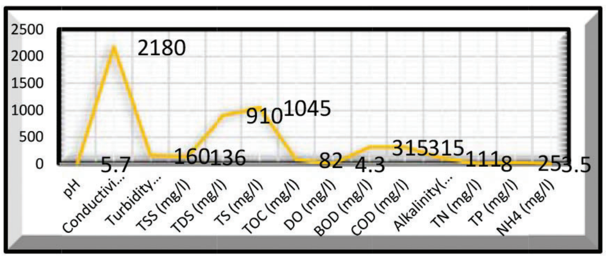


Fig. 1c. Characteristics of average values greywater quality parameters from kitchen pH, EC, TS(mg/l), TSS (mg/l), TDS (mg/l), TOC (mg/l), DO (mg/l), BOD (mg/l), COD (mg/l), Alkalinity (mg/l), TN (mg/l), TP (mg/l), NH_4(mg/l),

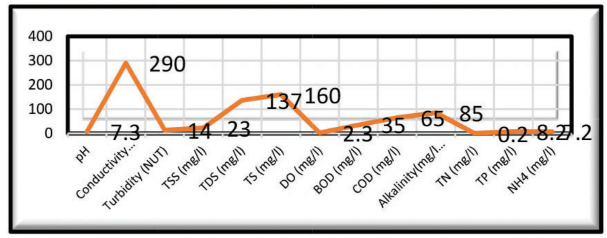
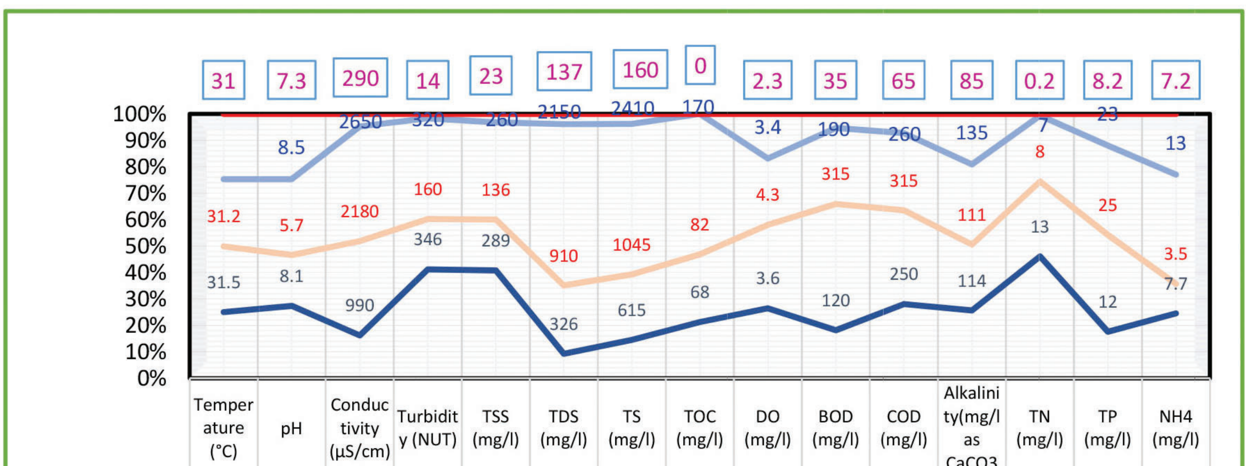


Fig. 1d. Characteristics of average values greywater quality parameters from Mosques pH, EC, TS(mg/l), TSS (mg/l), TDS (mg/l), TOC (mg/l), DO (mg/l), BOD (mg/l), COD (mg/l), Alkalinity (mg/l), TN (mg/l), TP (mg/l), NH_4(mg/l),

for ablution constitutes 80% of the water consumed in mosques. The remaining 20% is black water consumed in bathrooms. The ablution mainly includes washing the hands up to the wrists and the entire face and the arms up to the elbows, then wiping the head and ears, washing the feet to the ankles, and rinsing the mouth and nose. Mosques have separate basins for washing hands with soap in order to keep the greywater resulting from ablution free of detergents, which is the water under study for comparison. Other greywater quality. Figure (1-4) shows the average greywater quality standards in mosques.

The greywater of mosques confirmed its quality according to the results obtained from the results of



	Temperature (°C)	pH	Conductivity (µS/cm)	Turbidity (NUT)	TSS (mg/l)	TDS (mg/l)	TS (mg/l)	TOC (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Alkalinity(mg/l as CaCO3	TN (mg/l)	TP (mg/l)	NH4 (mg/l)
Mosque	31	7.3	290	14	23	137	160	0	2.3	35	65	85	0.2	8.2	7.2
Laundry	32	8.5	2650	320	260	2150	2410	170	3.4	190	260	135	7	23	13
Kitchen	31.2	5.7	2180	160	136	910	1045	82	4.3	315	315	111	8	25	3.5
Bathroom	31.5	8.1	990	346	289	326	615	68	3.6	120	250	114	13	12	7.7

The results obtained from physical and chemical characterization of greywater collected from various sources are presented as box and chart in Figure (1 – A)

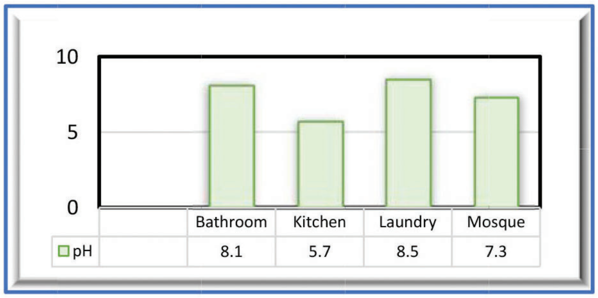


Fig. 2. Represents the conductivity results, the comparison of average measured conductivities of the different sources of greywater samples show the ablution greywater was least conductivity were the laundry show the high conductivity value.

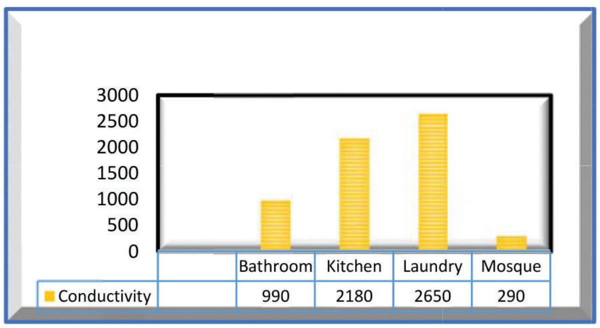


Fig. 3. Represents the turbidity results, the comparison of average measured turgidities of the different sources of greywater samples show the greywater from mosques (ablution) was least turbidity were the greywater from bathing sources show the high turbidity value.

analyses conducted for five samples of each type of greywater. Table 1 Explanation of the results obtained, and a number of figures have been attached for further clarification. According to the above, it will be easy to put the greywater from mosques at the forefront of the least polluted water. See the data shown in Table 1.

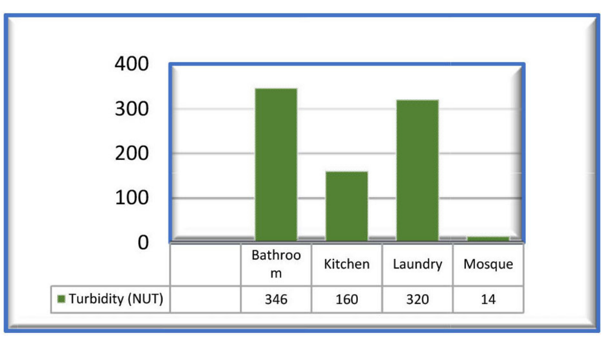


Fig. 3

Physico – Chemical Characterization

The study assessed the physical and chemical properties of greywater samples generated from the Kitchen, laundry, and bathing sources and mosques. Five sets of samples for each greywater sources were collected from 25 different places over a period of 4 weeks in sterilized 2 liters bottles labelled and sealed and then placed in cooler box

The average of results obtained from the measured total suspended solid and total dissolved solid for different sources of grey water (bathing sources, Kitchen, laundry and mosques) represented in Fig. 4.

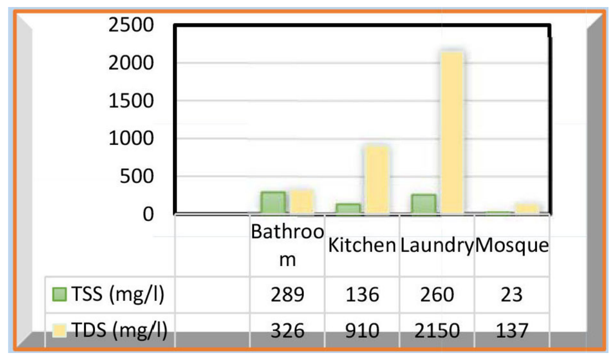


Figure 4

The chemical oxygen demand (COD) is measurement of the amount of oxygen required to oxidize the organic matters present in water samples while BOD is biochemical oxygen demand. The measured COD always high than BOD in greywater samples because of higher of organic matter Figures (5) represent the comparison of average results of the measured COD in the greywater samples tested.

The biological oxygen demand (BOD) measures the number of organic compounds in the grey water which oxidized biologically the measured BOD for greywater from kitchen sources exhibited the highest average results 315 mg/l. the measured BOD for

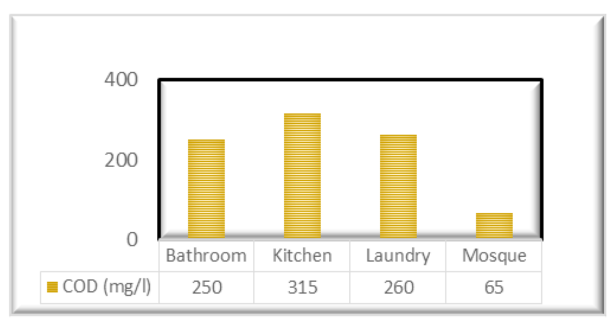


Figure 5.

the greywater from the mosques was lower with average value of 35 mg/l. see Fig. 6.

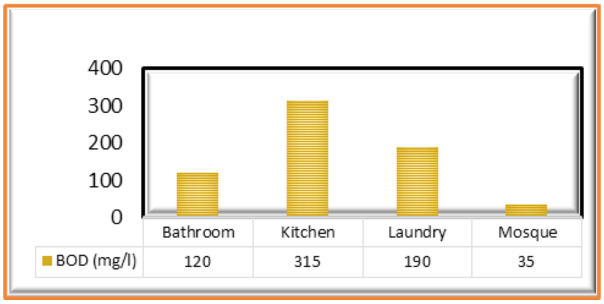


Figure 6

Different types of greywaters require different type of treatment before making them available for reuse (MWR, 1998, 1999). Among all the types, the ablution greywater is the easiest to recycle. The overall quality of greywater in Oman is much superior than in other countries (Mohamed *et al.*, 2018; Othman *et al.*, 2016). After the treatment the greywater definitely needs to meet the public health considerations including:

a. Physical water quality factors (turbidity, colour, etc.).
b. Chemical water quality factors (constituents including solids, metals, nitrogen, phosphorus, etc.).
c. Biological water quality factors (possible presence of pathogens including bacteria, helminths, virus, etc.).
d. Emerging water quality factors (possible presence of pesticides, pharmaceuticals, hormonal products, personal care products, etc.).

Potential of Greywater Reuse

Greywater is a major fraction (about 80%) of the water used in the Mosques and households. By the end of 2017, there were over sixteen thousand registered Mosques in Oman (Prathapar *et al.*, 2006). It is to be noted, that Oman has a population of about five million. In each Mosque, on an average hundreds of persons make use of the ablution facilities five times a day. This generates a substantial amount of greywater in each Mosque every day. If this greywater is recycled onsite or offsite, it can save the precious fresh water in significant quantities. It is to be noted that a high fraction of the freshwater obtained in Oman is through the desalination of seawater. The greywater from the ablution facilities in the Mosques is of very high quality and easy to process. It is of much better and recyclable quality than the domestic sources of greywater.

The summary of the water consumption pattern in a typical Mosque is presented in Figure-1. From the data in Figure 7, it is evident that there is a great potential in recycling the greywater from the Mosques (Olhman *et al.*, 2016). The greywater from the ablution facilities has very low level of contamination and consequently has a much higher potential of reuse. The greywater from the ablution facilities can be treated on site with ease (Khatan *et al.*, 2011). Most Mosques can accommodate a simple greywater treatment facility, which can provide water for non-potable purposes [30-31].

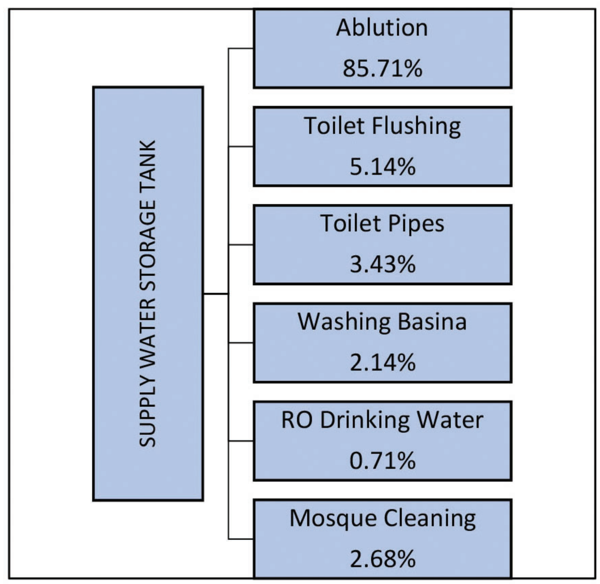


Fig. 7. Water Input-Output in a Mosque

Recycling the Ablution Greywater

In Table 1, we noted the relevant characteristics of the ablution greywater. Based on these characteristics, the following sequence of steps is recommended for an effective treatment of the ablution greywater (MWR, 1995; 1998) .

1) Screening: The ablution greywater is sure to contain some floating solid particles such as hair, grass clipping, cloth fibres, pieces of miswak (also known as siwak is teeth cleaning twig from selected plants, particularly the Salvadora persica tree), etc. These need to screened out. A drip-irrigation filter serves the purpose well.
2) Sand Removal: Ablution involves washing of

the feet. So, the ablution greywater is sure to contain some sand/soil particles. The removal of these sand/soil particles can be accomplished using a sand trap.

3) Monitoring of pH: From Table 1, we note that the pH is within the permissible limits. So, pH balancing is not required but close monitoring is essential.

4) Ablution Greywater Storage w/Aeration: The greywater has to be stored for some time. During this time the suspended solids settle but at the expense of increased microbial activity along with an increase in the amount of anaerobic release of soluble COD (Chemical Oxygen Demand) and there is also an increase in the reaeration from the atmosphere. Consequently, a long-term storage makes the greywater septic. It is recommended that the greywater is stored for less than 24 hours. So, it is necessary and sufficient to design greywater storage capacity for 24 hours.

Aeration: From Table 1, we note that the Chemical Oxygen Demand (COD) and the Dissolved Oxygen (DO) are within the prescribed limits. These parameters are expected to improve during the previous stage of filtering using the 'sand filter'. So, the falling of water through the pipes is expected to provide adequate aeration.

5) Filtration: From Table 1, we note that the TSS (Total Suspended Solids) are within the prescribed limits. Filtering is recommended in order to overcome the accidental increase in TSS within the greywater treatment system. It is recommended to use the 'sand filters' along with the 'carbon filters' to remove the toxins and odour. It is expected that the sand filter enhances the water quality parameters including the Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Pumps with adequate power need to be installed in order to transfer the greywater for treatment, at least once in 24 hours. In a hybrid system, we can also make use of wind and solar energy.

6) Chlorination: The ablution greywater has more than the acceptable levels of the Coliform. So, it is extremely necessary to include adequate chlorination in the treatment of the ablution greywater.

7) Storage of the Treated Ablution Greywater: A water tank with a two-days capacity is recommended to store the treated ablution greywater. This ensures a dependable supply. The water in this way gets further aerated along the way. The capacity of the treated water storage tank is about 4,000 litres

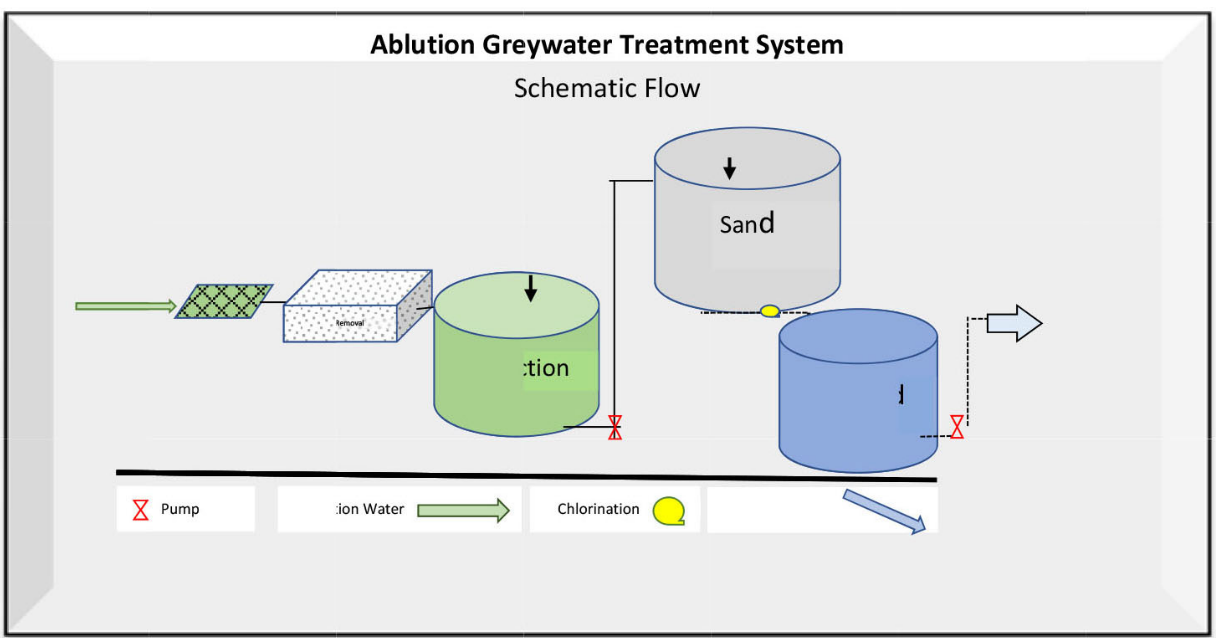


Fig. 8. Ablution Greywater Treatment

Construction of the Ablution Greywater Treatment Plant

At present, the commercially available greywater treatment plants are expensive for using both domestic and Mosque purposes. It is best to use a simple design and construct the required ablution greywater treatment plant it locally. The schematics are available in Fig. 8. There can be some variations in the steps (Prathapar *et al.,* 2005; Rabab *et al.,* 2018). The eight steps outlined in the previous section need to be executed as follows.

Process Description

First the ablution water is made to pass through a 'Screen Chamber' and 'Sand Trap' in order to remove floatable particles such as hair, grass clipping, cloth fibres, and allow the sand/soil and other heavy solid particles to settle down. Sand trap requires regular cleaning, particularly if it is shallow. Next the sand-free ablution water is transported to the 'Ablution Collecting Tank' under the action of gravity over a height of about one metre. This ensures that the water get aerated as required. The capacity of the storage collecting tank is about 4,000 litres. It is to be noted that we are targeting to treat 3000 litres of ablution water per day. The water tank was accompanied by a 'Pump' of adequate capacity. The switching on/off of the pump was controlled by a float at a median height. This ensured that the pump was used to the minimum and at the same time the ablution greywater was not stored for more than 24 hours.

The water from the tank was lifted using the pump through the drip-irrigation filter. This ensured that the separation of the floating particles on the water. Now, the water is free from both the suspended and floating solids. This water is processed in the 'Sand and Carbon Filter Unit'. The unit consists of layers of activated carbon, washed beach sand, mesh, gravel, mesh, gravel, mesh and finally the stones. The thicknesses of these layers are customized based on the quality of the greywater. After the complete filtration process, the water is made to pass through the 'Chlorination Chute' packed with commercially available chlorine tablets. The chlorine tablets for water purification purposes generally contain 90% chlorine in the form of Trichloro iso cyanyric acid ($C_3Cl_3N_3O_3$). It is to be noted that such tablets are widely used in the swimming pools as the chemical compound is a very effective disinfectant, algicide and bactericide. The filtered and chlorinated water is transported to the 'Treated Water Storage Tank' under the action of gravity. The water in this way gets further aerated along the way. The capacity of the treated water storage tank is about 4,000 litres.

The water pumps in the treatment of the greywater can be driven by wind energy or solar energy or a combination of both. There is no rigidly fixed time to do the treatment of the greywater. So, the constraints of the solar energy (day time) and the wind-driven systems are not a hinderance.

The treated ablution greywater needs to be tested in a laboratory periodically as an extra precautionary measure. This is to ensure that the water after treatment is of adequate quality and fit to use for the various purposes.

Use of Solar Energy

Oman has one of the highest solar densities in the world. Solar energy has even the potential to provide sufficient electricity to meet all of Oman's national electricity demand. So far, solar energy is only used on private roofs to heat up water and in the oil production industry (Khatun *et al.,* 2011). The water pumps in the treatment of the greywater can be driven by wind energy or solar energy or a combination of both. There is no rigidly fixed time to do the treatment of the greywater. So, the constraints of the solar energy (day time) and the wind-driven systems are not a hinderance.

The treated ablution greywater needs to be tested in a laboratory periodically as an extra precautionary measure. This is to ensure that the water after treatment is of adequate quality and fit to use for the various purposes.

The solar radiation data and the wind data for Oman points to the great potential in using solar energy and wind energy respectively. The complete treatment plant of the ablution greywater can be run on either solar or wind energy or better by a hybrid combination of both (Prathapar *et al.,* 2005). The use of photovoltaic (PV) cells would serve the purpose (Prathapar *et al.,* 2005). In fact, the additional power generated can be used by the Mosques. A similar idea has been demonstrated for the schools in Egypt (Prathapar *et al.,* 2005).

Oman like the other desert countries of the region has scarce water resources. Recycling the ablution greywater can contribute to the water scarcity solutions, though on a small-scale. The ablution greywater is of a high quality and its processing is feasible. The greywater treated onsite can be used for flushing the toilets and for the car washing in the locality. Importantly, it can be used for gardening the lawns of the Mosques and the trees surrounding in the adjoining localities.

The remaining treated ablution greywater can be used to recharge the aquifers. Significantly, it will make the public conscious of the water scarcity and the way of recycling. This consciousness is sure to reflect in numerous ways in other spheres concerning the conservation of the environment. Prophet Muhammad (Peace be Upon Him) had said, '*Do not waste water even if you were at a running stream*.

Conculsion

This paper sheds light on the Islamic practice of ablution and then briefly reviews the characteristics of the different types of domestic greywater, comparing it with greywater for ablution, examining its potential uses, and then discussing the basic scheme for recycling ablution greywater. Since the quantities of greywater in a medium-sized mosque are not very high, treatment plants available commercially at present are not a viable option. It would be better to use the locally developed greywater treatment plants for ablution. Although the procedure for treating greywater for ablution has been clarified, it can technically be extended to any greywater with appropriate modifications. Building complexes and educational institutions will be another place to plant greywater recycling. The idea of recycling greywater for ablution and other greywater species can be pursued around the world to reduce fresh water consumption and reduce treatment costs by using the simple design of treatment unit installations as well as utilizing solar energy to operate the treatment unit.

References

Abu-Rizaiza, O. S. 2002. Ablution water: prospects for reuse in flushing of toilets at mosques, schools, and offices in Saudi Arabia. *Engineering Sciences*. 14(2)

Ali Al-Dousari, Waleed Al-Nassar, Ali Al-Hemoud, Abeer Alsaleh, Ashraf Ramadan, Noor Al-Dousari and Modi Ahmed, 2019. Solar and wind energy: Challenges and solutions in desert regions. *Energy.* 176 : 184-194 https://doi.org/10.1016/j.energy.2019.03.180.

Azeanita Suratkon, Chee Ming Chan and Tengku Syamimi Tuan Ab Rahman, 2014. Smart WUDHU': Recycling Ablution Water for Sustainable Living in Malaysia. *Journal of Sustainable Development*. **7** (6): 150-157 http://dx.doi.org/10.5539/jsd.v7n6p150.

Greywater Treatment and Reuse, *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)* ISSN: 2278-1684, PP: 20-26 www.iosrjournals.org

Greywater Use in the Middle East: Technical, Social, Economic and Policy Issues, Stephen McIlwaine and Mark Redwood (Editors.), International Development Research Centre (IDRC), (2011); https://www.idrc.ca/en/book/greywater-use-middle-east-technical-social-economic-and-policy-issues.

Huelgas, A., Nakajima, M., Nagata, H. and Funamizu, N. 2009. Comparison between treatment of kitchensink wastewater and a mixture of kitchensink and washingmachine wastewaters, *Environmental Technology*. 30 (1) : 111-117 (2009); https://doi.org/10.1080/09593330802445549.

Khatun, A. and Amin, M.R. 2011. Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, Greywater reuse: a sustainable solution for water crisis in Dhaka, Bangladesh

Khatun, A., Murshid, S.M. and Badruzzaman, A.B.M. 2011. Greywater Quality Assessment and Treatment from Different Sources in Dhaka, Bangladesh. Accepted for the *3rd International Conference on Chemical Engineering, ICChE-2011, BUET, Dhaka, Bangladesh.*

Ministry of Water Resources. 1995. Water Resources of the Sultanate of Oman: An Introductory Guide. Ministry of Water Resources: Sultanate of Oman.

Ministry of Water Resources. 1998. Dams in the Sultanate of Oman. Ministry of Water Resources: Sultanate of Oman.

Ministry of Water Resources. 1999. Water Situation Report in the Sultanate During the Period 1980–1999. Ministry of Water Resources: Sultanate of Oman.

Mohamed, R. M., AlGheethi, A. A., Noramira, J., Chan, C. M. Amir Hashim, M. K. and Sabariah, M. 2018. Effect of detergents from laundry greywater on soil properties: a preliminary study, *Applied Water Science*. 8, Article Number 16 (2018); https://doi.org/10.1007/s13201-018-0664-3.

Othman, M. Y., Hamid, S. A., Tabook, M. A. S., Sopian, K., Roslanb, M. H. and Ibarahim, Z. 2016. Performance analysis of PV/T Combi with water and air heating system: An experimental study. *Renewable Energy*. 86: 716-722 https://doi.org/10.1016/j.renene.2015.08.061.

Prathapar, S. A., Ahmed, M., Al Adawi, S. and Al Sidiari, S. 2006. Design, construction and evaluation of an ablution water treatment unit in Oman: a case study. *International Journal of Environmental Studies*. **63** (3) : 283-292 https://doi.org/10.1080/00207230600773257.

Prathapar, S. A., Ahmed, M., Al Adawi, S. and Al Sidiari,

S. 2004. Variation in quality and quantity of greywater produced at two mosques in Oman. In: *Proceedings of the International Wastewater Conference, Salalah, Oman.*

Prathapar, S. A., Jamrah, A., Ahmed, M., Al Adawi, S., Al Sidairi, S. and Al Harassib, A. 2005. Overcoming constraints in treated greywater reuse in Oman, *Desalination*. 186 (1-3) : 177-186. https://doi.org/10.1016/j.desal.2005.01.018.

Rabab, I. EL-Nwsany, Ibrahim Maarouf and Waled Abd el-Aal, Water management as a vital factor for a sustainable school. *Alexandria Engineering Journal*. 58 (1): 303-313. https://doi.org/10.1016/j.aej.2018.12.012.

Sameen Ahmed Khan, 2015. UNESCO Sultan Qaboos Prize for Environmental Preservation. *Current Science*. 110 (1) : 15 (10 January 2016); http://www.currentscience.ac.in/Volumes/110/01/0015.pdf.

Sameen Ahmed Khan, 2017 UNESCO Sultan Qaboos Prize for Environmental Preservation, *Current Science*. 114 (2) : 252 (25 January 2018); http://www.currentscience.ac.in/cs/Volumes/114/02/0252.pdf and http://dx.doi.org/10.18520/cs/v114/i02/252-252.

Sameen Ahmed Khan, 2019 UNESCO Sultan Qaboos Prize for Environmental Preservation awarded to Ashoka Trust, Bengaluru, India, *Current Science*. 118 (12): 1868 (25 June 2020). https://www.currentscience.ac.in/Volumes/118/12/1867.pdf.

Sameen Ahmed Khan, Legacy of the UNESCO Sultan Qaboos Prize for Environmental Preservation, Chapter-4 in *A Closer Look at Climate Change*, Editor: Reggie Paredes (Nova Science Publishers, New York, 2018, http://www.novapublishers.com/), pp. 65-94 (October 2018). https://isbn.nu//978-1-53614-600-4.

Sameen Ahmed Khan, 2018. Singapore Index for climate change, *Nature*. 556 (7700), 174 (12 April 2018); http://dx.doi.org/10.1038/d41586-018-04168-3.

Sameen Ahmed Khan, UNESCO Sultan Qaboos Prize for Environmental Preservation, Chapter-5: in *A tribute to the Lasting Legacy of His Majesty the Sultan*, *Success Stories of the CEOs*, *48th Glorious Renaissance Day*, *Editor*: Hassan Kamoonpuri, pp. 30-33 (23 July 2018). (Oman Establishment for Press, Publication and Advertising). http://www.omanobserver.om/.

Statistical Year Book, 2018. Issue **46**, National Centre for Statistics and Information, Oman (August 2018); https://www.ncsi.gov.om/.

Syed Iqbal Zaheer, 2010. *An Educational Encyclopedia of Islam*, Iqra Publishers, Bangalore, India (2010); http://islamicencyclopedia.org/.

Yash Boyjoo, Vishnu K. Pareek and Ming Ang, 2013. A review of greywater characteristics and treatment processes, *Water Science & Technology*. 67 (7) : 1403-1424; https://doi.org/10.2166/wst.2013.675.