



Sustainable Greywater Management: Investigation, Feasibility Assessment, and Implementation

Marwan Alsulami and Nawf Alkhudire

Supervised by: Dr. Raouf Hassan

Abstract

The Kingdom of Saudi Arabia is one of the first countries with the most scarcity of fresh water sources. KSA has three sources of water: desalinated water (50%), groundwater (40%), and finally surface water collected from rainwater (10%). KSA's 2030 vision aims to maximize resources, move towards sustainability, and search for alternative and renewable sources of water. Based on statistics from 2022, the Kingdom's production of wastewater reached approximately 2 billion cubic meters annually, of which graywater constitutes around 70%. This study based on two parts: the first one is experimental study where the second part focused on design of greywater collection network. Desert sand, coarse sand, palm leaf, palm fiber and plastic waste are used as filter media with different thickness and combinations. Several samples of domestic's greywater are collected and analyzed in the laboratory to maintained its characteristics such as pH, conductivity, turbidity and solids content. The result shows that the best filter media is palm fiber with 20 mm thickness. The turbidity reduced by 88%The second part deals with design of collection greywater network for a residential compound located east of Riyadh. The network contains 19 branch lines ranging in diameter from 150 mm to 250 mm, all of which meet conditions of the minimum slope and minimum speed, two main lines with a total length of 5.5 km, and their diameters range from 200 to 400 mm.

The study provides a practical and inexpensive solution to address two problems at the same time, which are the shortage of pure water resources and also the increase in the amounts of solid waste.

Keywords: Sustainability; filtration; Greywater; palm residue; plastic waste; collection network.

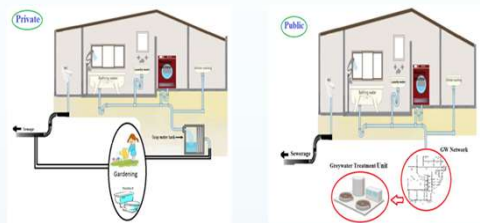
Problem Statement

The Kingdom of Saudi Arabia is considered one of the water-poorest countries in the world. Therefore, one of the priorities of the Kingdom's Vision 2030 was to provide alternative sources of water. Treating and reusing gray water is one of the best solutions, as it is considered a renewable and sustainable resource at the same time. One of the goals of Saudi Vision 2030 is also for Riyadh to become one of the top ten sustainable cities in the world.

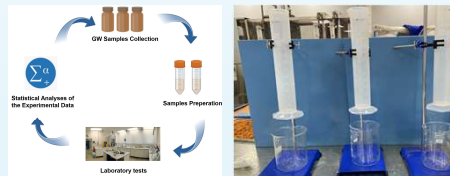


Methodology

Greywater Collection Network



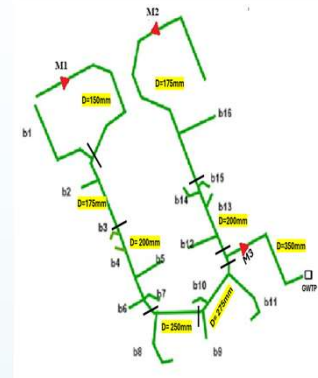
Experimental Study



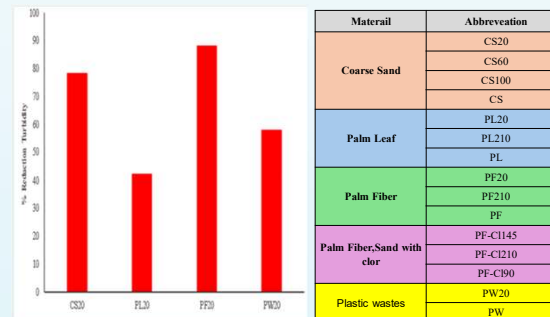
Results and Discussion

#	Line (m)	$Q_{min,D.W.G}$ (m³/sec)	Q_{des} (m³/sec)
1	593.56	0.001172804	0.014551091
2	477.8	0.000944076	0.011713241
4	125	0.000246985	0.003064368
5	25.1	4.95946E-05	0.000615325
6	18.4	3.63562E-05	0.000451075
7	15.4	3.04286E-05	0.00037753
8	42.6	8.41725E-05	0.001044337
9	23.2	4.58404E-05	0.000568747
10	24.4	4.82115E-05	0.000598165
11	76.8	0.000151748	0.001882748
12	34.6	6.83655E-05	0.000848217
13	24.5	4.84091E-05	0.000600616
14	77.6	0.000153328	0.00190236
15	42.3	8.35797E-05	0.001036982
16	19.2	3.79369E-05	0.000470687
17	28.7	5.67078E-05	0.000703579
18	19.5	3.85297E-05	0.000478041
19	54.9	0.000108476	0.001345871

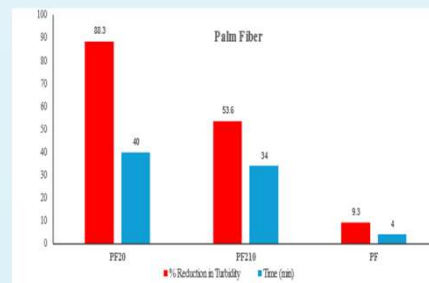
Flow rate of greywater network Lines.



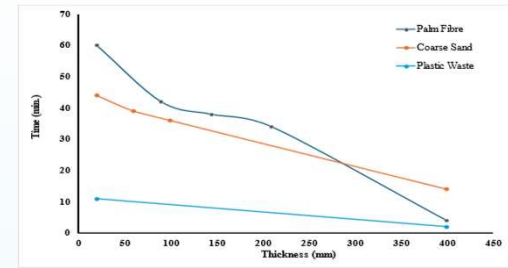
Diameter of Pipelines.



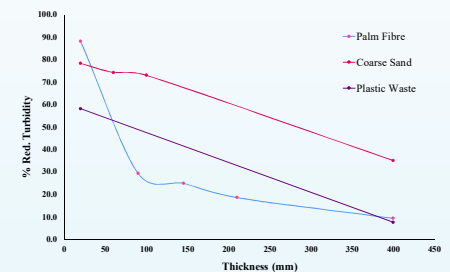
After all experiment we try we found and after the result compare it the best filter media is PF20 (Palm Fiber 20mm).



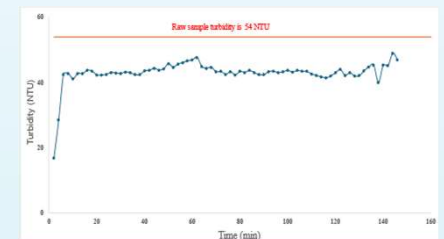
PF20 (Reduction in Turbidity with time)



Time Effect Thickness



%Reduction Turbidity Effect Thickness



Capacity of filter

Conclusion

- The chemical pretreatment of palm fiber removes the resulting color that clouds the sample, in addition to sterilization.
- The filter's effectiveness is acceptable for all media except palm leaf.
- In terms of ability to lower turbidity, a 20 cm thick palm fiber is the most effective. It reduced the turbidity by 88%.
- 150 mm is the diameter for all branch lines, where the diameters of main lines ranges from 200 to 350 mm.