Rainwater Harvesting and Greywater Treatment System

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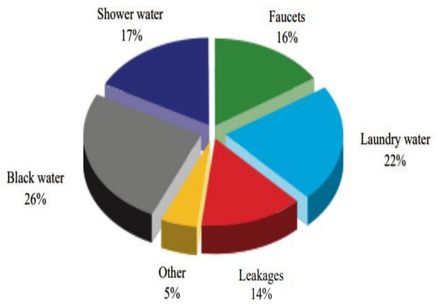
KFUPM Design Expo

Intro to Technical Problem

Saudi Arabia has limited water resources due to rapid population growth and high-water consumption. On average, a person in Saudi Arabia uses 270 liters of water per day, with 55% to 75% being greywater. Riyadh receives an average annual rainfall of only 98 millimeters. Existing solutions are expensive and lack integration, creating a need for a new, sustainable solution.



Water consumption distribution ratio per person (According to MEWA)

Problem Statement

In addressing Saudi Arabia's water shortage and environmental concerns, a holistic approach focuses on reusing greywater, capturing rainwater, and utilizing low-cost treatments to add water sources and reduce dependence on other options.

Constraints

- The Saudi Green Construction Code and Mewa.
- The filtration process will need space within the home area.
- Methodology of separating the gray water and black water inside the home.
- Storage area to store the water before the filtration.

Target Specifications

Metrics	Specification
Area needed to construct a system	< 8 m^2
Cost of devices and equipment needed	< 4000 $
Maintenance for the system every...	> 4 Months
The life cycle of the product	> 10 Years
Filtration rate	> 5 L/hr
Storage time of greywater	< 24 h
PH level	6 < PH < 8.4
Turbidity	< 5 NTU

Testing / Validation

Metrics	Actual Value		State
	Greywater	Rainwater	
PH	7.5	8.1	Met
Area needed to construct a system (m^2)	2.16		Met
Turbidity (NTU)	3.71	1.68	Met
Cost of devices and equipment needed ($)	2218		Met
Filtration rate (5L/h)	1 min (5 L)	15 min (5L)	Met

Important Equations

Greywater Equations:

$$Instantaneous\ flow\ rate = \frac{Assumed\ flow(m^3)}{Assumed\ time(day)}\ (m^3/day)$$

$$\text{Instantanous Filtration rate} = \frac{\text{Instantanous Flow } (m^3/h)}{\text{Surface area } (m^2)}$$

Rainwater Harvesting Equations

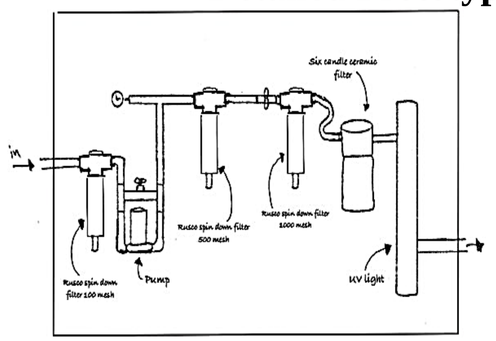
Energy equation to get the H(pump) in terms of heads:

$$\frac{P1}{\gamma} + Z1 + \frac{V1\text{^}2}{2g} + H(pump) = \frac{P2}{\gamma} + Z2 + \frac{V2\text{^}2}{2g} + H(losses)$$

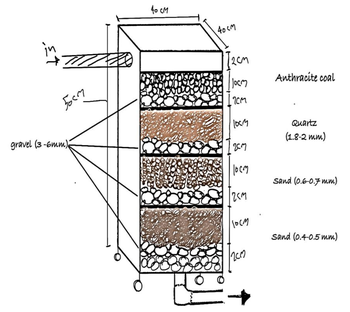
Power needed for the pump.

$$Pump(power) = \gamma * \mathrm{Q} * \mathrm{H(pump)}$$

Detailed Prototypes Design

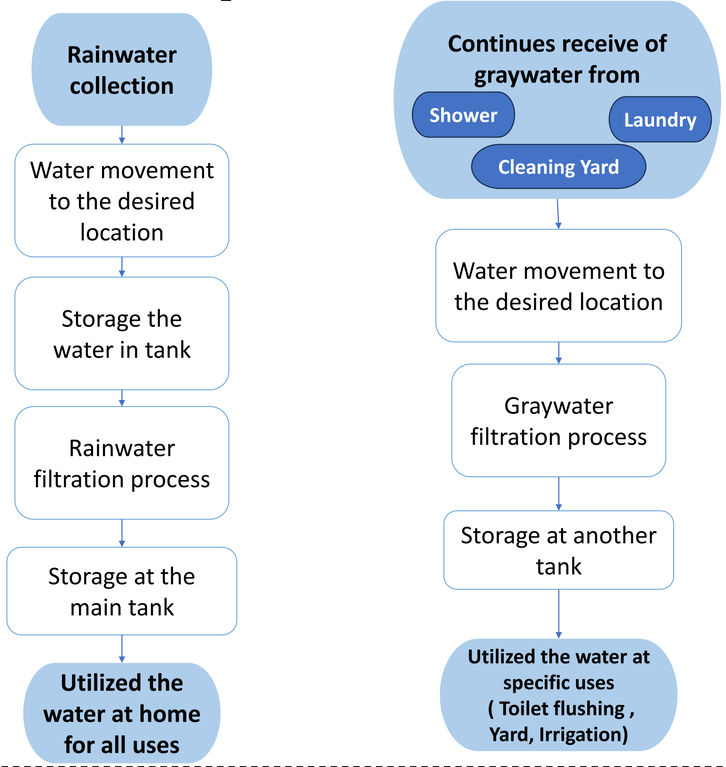


Rainwater Filter Design



Greywater Filter Design

Concept Process Flow Chart



Conclusion

Our project aimed to create new water sources by maximizing greywater reuse and efficiently capturing rainwater. By reducing freshwater consumption by 57%, this will help to reduce the reliance on other options.