Low-Cost Methods to Treat Greywater: A Case Study from Oman

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Oman is an arid country where the pressure on freshwater reserves is as severe as that of any other arid or semi-arid country in the world. Increasing water availability by treating and reusing wastewater, particularly for irrigation, is a government policy in Oman. Identification of alternative sources of water and development of appropriate technology to harness them in order to reduce pressure on freshwater reserves and production capacity in Oman is a priority.

Experience from overseas, and in particular from arid and semi-arid countries, indicates that greywater can be a cost-effective alternative source of water. Greywater is washing water; water coming from baths, showers, washing machines, and bathroom sinks. Some sanitary experts define greywater as water that is lower quality than potable water (drinking water), but of higher quality than blackwater. Studies have shown that 80% of water used in Omani households is greywater.

Greywater can be used to further sustainable development and resource conservation without compromising public health and environmental quality. Under most conditions, it would be possible to reuse greywater with minimum treatment. Water for domestic use is produced at a very high cost. Domestic wastewater (combined greywater and blackwater) is also treated at high cost and then used for limited irrigation. If greywater is separated from blackwater, likely benefits will include water savings, reduction in wastewater treatment costs, and reduction in groundwater pollution, and will have positive environmental and economic benefits.

A research project was completed at Sultan Qaboos University in Oman with the objectives to quantify greywater production in urban Omani households and mosques, characterize important water quality parameters, and design simple treatment systems. Results show a high degree of variability of greywater production and its quality from individual households and mosques. Experimental data show that a simple treatment system combining aeration, sand filtration, and chlorination will be able to meet the existing Omani reuse standards.

Commercially available greywater systems are too expensive for individual households and small mosques. Therefore, a low-cost low-maintenance treatment system was designed (Figure 1), constructed, and operated at a mosque (Al Hail, See photo above).

The ablution water was sent through a sand trap (A), to allow settlement of soil particles. Since the sand trap was shallow, periodic cleaning of this trap was easy. Subsequently, the ablution water was conveyed by gravity to the ablution water storage tank (B), and the water dropped from near soil surface to the water level, aerating on its way. The ablution water storage tank has a storage capacity of 3.82 m3 per day if necessary, but it was noted that maximum ablution water produced in a day was only 1.94 m3. Therefore, the storage tank will be adequate to store more water, in the event that the number of worshippers increased in the future. A submersible pump (C) of 0.4 horsepower was installed in the ablution water storage tank, which was controlled by a float. The pump operated whenever approximately 0.68 m3 was added to the storage tank. Thus, untreated water was not held in the storage tank for prolonged periods. Water lifted by the pump was sent through an irrigation filter (D). This prevented floating matter proceeding further. Subsequently, water entered a filter unit (E), which consisted of an activated carbon tray (10 cm deep), 0.2 mm washed beach sand (70 cm deep), gravel 1/8 mm (10 cm deep), gravel ¼ mm (10 cm deep), and stones (10 cm deep) (Figure 2).

Following filtration, the water passed through a chlorination chute (F), packed with chlorine tablets. These tablets contain 90% chlorine as Trichloroisocyanyric acid with solubility of 1.2g/100g of water at 30o C (its commercial name is NEO-CHLORO). Filtered water mixed with chlorine was then dropped into the treated water storage tank, being aerated on its passage. The treated water storage tank could store up to 3.825 m3 per day if necessary.

A commercial system was installed at Sultan Qaboos University mosque which is much larger and produces a lot more greywater. This system also performed well and produced water satisfying the existing Omani standards for reuse. A commercial system was also installed in a household in Al Hail and its performance was also excellent.

The financial analysis showed that the internal rate of return (IRR) for the locally manufactured (Al Hail mosque system) and the commercial systems (SQU mosque) for the mosques were 14.9% and 19.06%, respectively. This shows that such systems will be cost effective. IRR for the commercial system at a private house indicated that such systems will not be cost effective. Costs of the systems and the amount of greywater treated were the main factors affecting the outcome of the financial analysis.

It is worth mentioning here that such systems are not restricted for treatment of greywater only. It is possible to use this system for improving the quality of low-quality surface water. A similar system was installed in the Al Jabal Al Akhdar area of Oman (see photo below). The government completed the building of 24 retention dams for storing surface water in this mountainous area. Most of these reservoirs are eutrophic because of the fecal matter of goats and donkeys that gets washed into the reservoir via surface run-off. These waters are also contaminated with unacceptable levels of coliform bacteria and some also had pathogenic *Escherichia coli*.

The treatment unit significantly improved the quality of water with regards to COD, TSS, and a few other water quality parameters. Coliform and *E. coli* were completely eliminated. Treated water met the Omani standards for reuse for irrigation. A survey among the adult male population of the village overwhelmingly showed their eagerness to adopt this system and use the treated reservoir water for uses other than agriculture. Such change in water use patterns will definitely have an impact on groundwater extraction, as household requirements for groundwater are likely to decrease.