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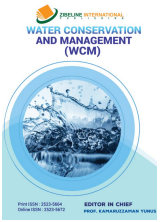

EFFECT OF RETENTION TIME ON PRIMARY MEDIA FOR GREYWATER TREATMENT

Anudeep Nema [a*], Kunwar D. Yadav[b] Robin A. Christian[c]

[a,b,c] Department of Civil Engineering, SV National Institute of Technology, Surat, Gujarat, India *Corresponding author. Tel: +0261-2201522, Email: anudeepneman@gmail.com

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ABSTRACT

Reuse of greywater is the one of the alternative to fulfil the water demand. This study was carried out the efficiency of filter media for greywater treatment. The main aim of present study to develop the primary filter by using locally available media (i.e. jute coir rope, rise husk, pine wood pieces and marble stone). Greywater was collected from the Girls Hostel at SVNIT on regular basis. Filter performance was examined by maintaining the physico-chemical such as turbidity, COD and total solids. Filters were run for different retention time (i.e. 2h, 4h, 6h., 8h., and 16h.) in which at 8h RT, gives maximum removal efficiency. Filters used as primary filter so greywater applied directly and obtained results shows that all media remove impurities significantly Rice husk media shows maximum turbidity removal (66-81%) for different retention time. Than turbidity removal showed by jute coir rope (63-79%) followed by marble chips (53-73%) and pine wood (52-73%). COD removal in treatment by marble chips bed (34-59%) slightly greater than coir jute rope (41-52%), pine wood (31-51%) and rice husk (22-55%). Total Solids maximum removed by pine wood (21-48%) for all retention time examined. Effect of retention time also was monitored for all filters among the all media filters 8h retention time showed maximum removal efficiency in terms of impurities analysed.

1.INTRODUCTION

Globally, water use increased six-fold during the twentieth century and by the year 2025 about 1.8 billion people will live under absolute water scarcity condition. In Asian and African region, people under a threshold of water stress would Rice to three billion in 2025[1]. In India per capita surface water availability in the years 1991 and 2001 were 2300 m^3 (6.3 m^3/day) and 1980 m^3 (5.7 m^3/day) respectively and these are projected to reduce to 1401 m^3 and 1191 m^3 by the years 2025 and 2050 respectively [2]. Domènech L. and sauri D. (2010) [3], also estimate total water requirement of the india in 2050 is estimated to be 1450 km^3 which is higher than the current availability of 1086 km^3.

Greywater often contains valuable nutrients for gardening and irrigation and as a consequence there is no need to buy expensive mineral fertilizer. Technological advancement, latest findings and public acceptance makes greywater to be a potential source of water saving and alternative source of water supply. Now days several developed and developing countries having greywater treatment systems which is successfully executed for non-potable uses. But in many countries, reuse of greywater is not practiced due to lack of knowledge of treatment process, stringent reuse standards and the possibility of spreading of disease due to the presence of pathogens in greywater

2.GREYWATER

Wastewater is generally combination of black water and greywater. Generally greywater is wastewater produced from baths, showers, laundries, dishwashers, hand basins, washing machines, and kitchen sinks [4,5,6,]. Some other authors exclude wastewater originating from kitchen sinks given its high content of oil and food particles [7,8,9,10].Greywater is distinct from black water in the amount and composition of chemical and biological contaminants[11].

2.2 Characteristics of Greywater

Greywater used for this study was collected from the Girls hostel at Sardar Vallabhbhai National Institute of Technology campus, Surat, Gujarat, India. It is the combination of water coming from bathroom, shower, floor washing, wash-basin, and laundries. Table 2 shows the characteristics of

the greywater used in this study.

Table 1 Characteristics of Greywater

Sr. No.	Parameters	unit	Value
1	Turbidity	NTU	127.92 ± 43.06
2	COD	mg/L	225.90 ± 73.61
3	Total Solid	mg/L	549.21 ± 106.89

2.3 Greywater Treatment Options

According to the techniques adopted for removal of contaminants, treatment methods can be classified as physicochemical and biological methods. Physicochemical methods include screening, grit removal, sedimentation, sludge thickener, ion-exchange, multimedia filtration, adsorption, reverse osmosis and ultrafiltration. Biological methods are broadly classified as aerobic and anaerobic. Aerobic methods are further divided as suspended growth (viz. activated sludge process, aerated lagoon, waste stabilization pond, etc.) and attached growth (viz. tricking filter, rotating biological container, constructed wetlands, etc.). Anaerobic treatments comprise contact beds, up-flow anaerobic sludge blanket reactors, sludge digesters, and anaerobic ponds [12].

3.MATERIALS AND METHODS

3.1 Filter media

In present study four different media (Jute coir rope, Rice husk, Pine wood pieces and Marble stone) were used for process. The selection of filter media is based on their availability in local market. All type od media washed thoroughly with clean water to remove the impurities

3.2 Operation of Filters

3.2.1 Treatment of greywater with different media

Fresh greywater was taken out from bottom outlet of the collection barrel and fed into the filters from top. For cleaning of media initially these filters run with tap water for different retention time (6h & 16h) for 14-16 cycles; this practice also indicated the contribution of media in the quality of tap water. Filters were filled with greywater which was uniformly distributed. Filters operated for different retention times (i.e. 2 hr., 4 hr., 6 hr., 8hr. and 16hr.) for 12-15 cycles. The treated effluent was collected from the bottom of different filters.

3.2.2 Maintenance of filters (Cleaning of media)
It was observed that there was a scum layer after 12 – 15 days that completely cover the media by which filter got clogged. For cleaning purpose, first of all, greywater was emptied from it. Than every media was taken out and kept separately. Every media was then washed with clean water until clear water comes, dried and then again filled into filter.

4.RESULTS & DISCUSSION

4.1 Performance of Different Media during Greywater Treatment

4.1.1 Marble chips
The grain size distribution for Marble chips from 4.75 -20 mm. The maximum removal 75.65%, 59.14%, and 43.16% were obtained for turbidity, COD and total solids, respectively at 8h retention time. Nkwonta OI and Ochieng GM (2009) [13] reported that, a horizontal flow roughing filter able to reduce turbidity by 77% during winter and 85% in summer. Removal efficiency of turbidity has been reported up to 8189% for sand filter [14]. TSS and COD removal by different size gravel media was 53.45% and 71.44% respectively [15].

4.1.2 Jute coir rope
COD removal efficiency obtain by this media is 59.03% in 8h retention time. Its Porous structure is helping to develop the dense matt of particles and thus reducing the COD with time. In the initial stage, COD of effluent greywater was high (150-200 mg/L) but it decreased as time progressed. In case of turbidity, jute coir rope was removing 79.78% in 16h retention time which is highest in all. Study on organic material such as bark, wood chips, wheat straw showed reduction of 55 - 99.9% and 51 - 98% for BOD and COD, respectively [16].

4.1.3 Rice husk
Very light weight material almost floats in water and Porosity of rice husk about 83.61%. It contents of cellulose (32.24%), hemicellulose (21.34%), mineral ash (15.05%) as well as high percentage of silica in its mineral ash [17]. In case of turbidity, rice husk was showing tremendous results as compare to other media. It showed up to 81.94% removal in turbidity at 16h retention time, as time increases percentage removal also increases. The removal of 30.82% and 55.31% were obtained for total solids and COD, respectively at 8h retention time. One of the study conducted on rice husk as sorbent with chemical treatment showed that heavy metals reduction in effluent [18].

4.1.4 Pine wood
In case of turbidity, pine wood was showing removal of 52.96-73.98%. Removal at 48.14% and 51.18% were obtained for total solids and COD, respectively. COD removal and pH reduction by pine wood trickling filter observed by 60-70% [19]. Chanakya H. et al (2014) [20] reported that influent pH changed from 6.1 to 7.8 in the bark filters. This observed decline was due to release of organic acids from the bark and probably due to the production of hydrogen ions during nitrification.

Among the all four media maximum turbidity removed by rice husk; maximum COD reduction by marble chips media and maximum total solid reduced by pine wood media at different retention time.

4.2 Effect of retention on removal efficiency
For this study, these filters were operated for 5 different retention time i.e. 2h, 4h, 6h, 8h & 16h. It was observed that removal efficiency of a filter media is vary with the retention time.

4.2.1 Turbidity
Maximum Removal efficiency of turbidity was 75.64%, 81.94%, 73.98% and 79.78% in Marble Chips, Rice Husk, Pine Wood and Jute coir rope respectivelyIt was observed that as retention time increases, removal efficiency in terms of turbidity also increases up to 8h RT, while it decreases for 16h RT in case

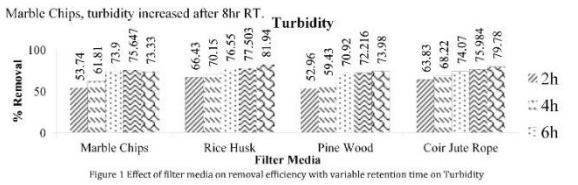

Figure 1 Effect of filter media on removal efficiency with variable retention time on Turbidity

4.2.2 Chemical Oxygen Demand (COD)
Maximum Removal efficiency of turbidity was 59.26%, 55.30%, 51.81% and 59.03% in Marble Chips, Rice Husk, Pine Wood and Coir jute rope respectively. It was observed that Marble chips gives batter removal efficiency in terms of COD in all retention time. It's maximum removal efficiency found at 6h RT. For Rice Husk and Coir Jute Rope, It was observed that as retention time increases, removal efficiency also increases upto 8h RT, while it decreases for 16h RT. For Marble Chips and Pine wood, it was observed that as retention time increases, removal efficiency in terms of COD also increases upto 6h RT, while it decreases for 8h & 16h RT.

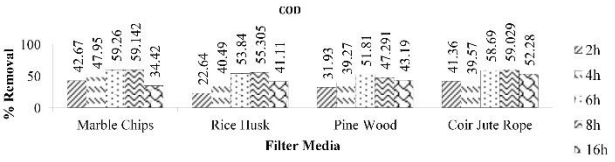

Figure 2 Effect of filter media on removal efficiency with variable retention time on COD

4.2.3 Total Solids (TS)
For all media filters (Marble Chips, Rice Husk, Pine Wood & Jute coir rope), as retention time increases, percentage removal also increases upto 8h RT, while it decreases for 16h RT. At 8h RT, the percentage removal was maximum i.e. 43.16%, 30.15%, 48.14% and 43.53% respectively. Dalahmeh S.,(2013) [19] reported that 56% removal of solids by sand filter in 4h residence time of greywater. **T.S.**

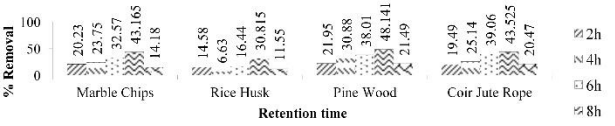

Figure 3 Effect of filter media on removal efficiency with variable retention time on COD

Removal efficiency is maximum at 8h RT in most of the cases. From the above observations and analysis we can say that 8h RT is most efficient retention time for primary filter treatment but there do not such a significant difference between 6hr RT and 8hr RT those retention times.

5. CONCLUSION
Greywater is precious source of water to meet the required water demand by reusing after proper treatment. This study is an attempt to evaluate performance of Marble chips, Rice husk, Pine Wood and Jute coir rope as locally available filter media for greywater treatment. Greywater treatment was given by coarse filtration only; no further treatment is applied to greywater. Performance of media in sequence and results obtained in experimentations, the following conclusions were drawn:

- ✓ Jute coir rope is most suitable media for treatment of greywater; it has maximum removal of 79% turbidity, 59% COD, 44% total solids and 10% alkalinity. Suitability of marble chips media comes after Jute coir rope which is followed by Rice husk media and Pine wood media.
- ✓ 8h RT is most efficient retention time in retention time observed for primary filter treatment. At 8h RT, all media have maximum removal efficiency; but at 6h RT, the removal efficiencies for all filter media is almost same to the removal efficiency of 8h RT. Thus it can be stated that 6h RT is the best suitable retention time for these filter media.
- ✓ There some drawback in some filter media like pint yellow colour occurred in all three organic media (Rice husk, pine wood and jute coir rope) effluent.

REFERENCE:

[1] UN-Water, 2006. *Water: A shared responsibility. Paris*. The United Nations World Water Development. ISSN Report 2.

[2] Kumar R., Singh R D. and Sharma K. D., 2005.*Water resources of India*. Curr. Sci. 89 794–811.

[3] Domènech L. and Saurí D., 2010. *Socio-technical transitions in water scarcity contexts: Public acceptance of greywater reuse technologies in the Metropolitan Area of Barcelona*. Resources, Conservation and Recycling, 55 (1), pp. 53-62. doi:10.1016/j.resconree.2010.07.001

[4] Dixon A., Butler D., Fewkes A. and Robinson M., 1999. *Measurement and modelling of quality changes in stored untreated greywater.* Urban Water, 1, 293-306.

[5] Ledin A., Eriksson E. and Henze M., 2001. *Aspects of groundwater recharge using grey wastewater.* In: P. Lens, G. Zeemann and G. Lettinga (Editors), Decentralised Sanitation and Reuse, London, pp. 650.

[6] Ottoson J., and Stenstrom T.A., 2003. *Faecal contamination of greywater and associated microbial risks.* Water Research, 37(3): 645-655.

[7] Al-Jayyousi O., 2003. *Greywater reuse: towards sustainable water management.* Desalination, 156, 181-192.

[8] Christova Boal D., Eden R.E. and McFarlane S., 1996. *An investigation into greywater reuse for urban residential properties*. Desalination, 106(1-3): 391-397.

[9] Little V. L., 2002. *Greywater Guidelines-The water conservation alliance of southern Arizona.* Tucson Arizona.

[10] Wilderer P.A., 2004. *Applying sustainable water management concepts in rural and urban areas: Some thoughts about reasons, means and needs.* Water Science and Technology, 49(7): 7-16.

[11] Shaikh, Sameer S.K. and Younus S.K., 2015. *Grey Water Reuse: A Sustainable Solution of Water Crisis in Pusad City in Maharashtra*. India International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169.

[12] Arceivala S.J. and Asolekar, S.R., 2007. *Wastewater treatment for pollution control and reuse*, 3rd edn. Tata McGraw-Hill Pub., New Delhi.

[13] Nkwonta O.I., Ochieng G.M., 2009. *Roughing Filter for water pre-treatment Technology in developing countries. A review*. Int. J. Phys. Sci., 4(9): 455-463.

[14] Abudi Z., 2011. *The Effect of Sand Filter Characteristics on removal Efficiency of Organic Matter From greywater*. Journal for Engineering Sciences, 4(2), 143-155.

[15] Al-Hamaiedeh H. and Bino M., 2010. *Effect of treated grey water reuse in irrigation on soil and plants Desalination*. 256 (2010) 115–119 doi:10.1016/j.desal.2010.02.004.

[16] Dalahmeh S., Pell M., Vinneras B., Hylander L., Oborn I. and Jonsson H., 2012. *Efficiency of Bark, Activated Charcoal, Foam and Sand Filters in Reducing Pollutants from Greywater.* Water Air Soil Pollution, 223, 3657–3671.

[17] Wan Ngah W.S. and Hanafiah M.A.K.M., 2008. *Removal of heavy metal ions from wastewater by chemically modified plant wastes as adsorbents: A review*. Bioresource Technology 99 (2008) 3935–3948 doi:10.1016/j.biortech.2007.06.011.

[18] Daifullah A.A.M., Yakout S.M. and Elreefy S.A., 2007. *Adsorption of fluoride in aqueous solutions using $KMnO_4$-modified activated carbon derived from steam pyrolysis of rice straw*. Journal of Hazardous Materials 147 633–643 doi:10.1016/j.jhazmat.2007.01.062.

[19] Dalahmeh S., 2013. *Bark and Charcoal Filters for Greywater Treatment Pollutant Removal and Recycling Opportunities.* Doctoral Thesis Swedish University of Agricultural Sciences Uppsala 2013.

[20] Chanakya H., Khuntia H., 2014. *Treatment of greywater using anaerobic biofilms created on synthetic and natural fibers*. Process Safety and Environmental Protection, 92, 186–192.

About the Author

Anudeep Nema is pursuing his Doctor of Philosophy degree at the Department of Civil Engineering, SVNIT, Surat, India, under the guidance of DR. Kunwar D. Yadav, Assistant Professor and Dr. R. A. Christian Associate Professor in the same department. I have completed M.Tech in Civil –Environmental Engineering and worked on greywater treatment.

Dr. Kunwar D. Yadav is presently an Assistant Professor in the Department of Civil Engineering, SVNIT, Surat, India. He holds the Ph.D degree in Environmental Engineering from IIT Kanpur. He is working in the area of Ecological sanitation and major focus on reuse and recycle of freywater and composting, vermicomposting of organic waste. He has published 54 international as well as national publications in reputed journals/conferences.

Dr. Robin A. Christian is presently an Associate Professor in the Department of Civil Engineering, SVNIT, Surat, India. He is focusing Wastewater treatment, Air pollution, Solid waste and Fuzzy Logic application to environmental engineering.