Journal of Informatics
Electrical and Electronics Engineering, 2024,
Vol. 00, Iss. 00, S. No. 117, pp. 1-7
ISSN (Online): 2582-7006

Domestic Wastewater Treatment Using Natural Filtration and Solar Distillation Processes

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How to cite this paper: M. Prajapati, S. Sharma, N. Sengar, "Domestic Wastewater Treatment Using Natural Filtration and Solar Distillation Processes," *Journal of Informatics Electrical and Electronics Engineering* (*JIEEE*), 2024.

https://doi.org/10.54060/a2zjournals.jieee.117

Received: 09/02/2024
Accepted: 14/08/2024
Online First: 01/09/2024

Abstract

Fresh water is most important daily requirement for human survival. On one hand many regions/countries are facing challenges related to availability of potable water for drinking and daily needs, on other hand water is wasted daily from different domestic applications. Processing and reuse of domestic waste water can help bridge gap between demand and supply. Present study describes a domestic waste water treatment process using combined natural filtration and solar distillation methods. In the natural filtration process husk fiber, activated carbon and coconut husk fiber were used as filters. For solar distillation a pyramid shaped distillation unit is used. The samples of domestic waste water were collected from laundry, kitchen and house cleaning applications. The pH, TDS (total dissolved solids) and DO (dissolved oxygen) values of domestic waste water samples and water after treatment were tested. The results after treatment reveal that the values of TDS, pH, and dissolved oxygen are close to the standard values required for potable water which can be further used in different applications.

Keywords

Natural filtration, solar distillation, total dissolved solids, domestic waste water, water treatment

1. Introduction

The availability of potable water in comparison to total available water is very less. This less amount of water is renewed by rainfall and other methods. Demand of fresh water is increasing at a fast pace as the population is increasing and the per capita water requirement is also rising [1]. Ground water, surface water and rainwater are the most commonly available natural resources [2]. Water is being saline due to intrusion of seawater near coastal areas [3]. Organic and inorganic compounds and heavy toxic metals, suspended solids are major contaminants in wastewater [4].

Knowledge about the kind of pollutants in wastewater helps to identify the best approach of wastewater treatment [5]. General methods of wastewater treatment are filtration, incineration, chlorination, coagulation, flocculation, reverse osmosis, distillation etc [6]. The treated waste water can be reused in different applications where quality of water is not so important. After checking the quality and adding required minerals it can be used in general applications [7].

There may be availability of physical, chemical and biological substances in waste water. Drinking of such water may lead different kind of diseases. Water after treatment should be tested in laboratories for quality checks. [8-10].
Aravind M. A. and Rahna L. explained in their results that coconut husk fiber is effective in removing COD, BOD and that reduces the conductivity of wastewater [11] Shivang Sharma et.al. stated that low-cost rice husk is helpful in efficient bacterial deactivation process [12]. R. Priyanka and Sri M. Vagishused activated carbon, rice husk and pebbles for filtration work and got good results like decreased in TDS value and increased in D.O. value. [13]. Sadon, F. N. et al claimed that rice husk has ability to remove heavy metals like Fe, Mn, Cd, Zn, Cu with 90 to 100% efficiency. [14] A. Carmalin Sophia et.al. explained in their work that rice husk may be helpful to removal of E. coli with around 99% efficiency [15]. V. Kiruba Devi et. al. stated that by using proper testing of TDS, pH and D.O. values the treated wastewater can be reused for other applications [16].

R. Asadiet. al. did their experimental work on sanitary wastewater samples using solar distillation and claimed that solar distillation unit is helpful to remove organic and inorganic contaminants [17].

This work is to evaluate the performance of natural filtration and solar distillation in domestic wastewater treatment process. This experiment leads to work in daily life domestic applications like laundry, kitchen and house cleaning. The use of natural available resources like rice husk and coconut husk make this filtration process nature friendly. Combining the process of natural filtration and solar distillation makes it a unique approach.

The rest of the paper is organized as follows: in section 2, the setup of the wastewater management is explained. Section 3 gives the results and discussion of the current research. The last section 4 explains the findings and conclusion of the current research work.

2. Wastewater Treatment Experimental Setup

This work focused on study of domestic wastewater treatment by natural filters and solar distillation. Three different samples were taken from laundry, kitchen and house cleaning domestic applications. Parameters like total dissolved solids, pH and dissolved solids were determined with different experiment setup of filtration and distillation. Rice husk, coconut husk fiber and activated carbon were used for natural filtration process. Pyramid shaped glazed glass is used for distillation unit. First the natural filtration and after it solar distillation process was performed on waste water samples.

2.1. Filtration

Filtration is basic process of removing contamination from waste water by using physical, chemical and biological process. The output water of filter can be used in different applications and can help to save the scarcity of water. There are many filtration processes, among some are UV filter, infrared filter, activated carbon filter and reverse osmosis.

Figure 1. Activated carbon, rice husk fibre and coconut fibre respectively

In this setup coconut husk fiber, activated carbon and rice husk fiber is used for filtration. Activated carbon has the property to remove residual disinfectants and organic contaminants from water supply. It helps to extract hazardous contaminants from wastewater. Rice husk and coconut fiber are easily available to use as natural filtration [18].

Figure 2. Schematic and actual image of waste water filtration using activated carbon, rice and coconut husk fibre

The experimental setup for natural filtration is shown in Fig. 2. Laundry, kitchen and house cleaning waste water samples from author house are used as water samples. The experiment work is performed at University of Kota, Rajasthan. Results of the experiments of filtration are shown in table 1.

Table 1. Experimental observations of natural filtration water treatment

S.No.	Waste Water Sample	Before Filtration Reading			After Filtration Reading		
		TDS (PPM)	pH	D.O. (mg/L)	TDS (PPM)	pH	D.O. (mg/L)
1	Laundry Waste Water	2900	9.1	3.2	2370	7.9	6.4
2	Kitchen Waste Water	390	5.5	2.3	372	6.8	3.4
3	House Cleaning	893	7.8	3.1	870	7.7	4.2

2.2. Solar Distillation

Solar distillation system is best unit to use freely available solar radiation in waste water treatment. In remote areas this application is best suited to waste water treatment from small scale to large scale. Water from these distillation units by adequate quality control can also be used in commercial applications like distilled water in batteries and hospitals [19].

Wastewater samples generally include dissolved solids, water hardness in terms of magnesium, calcium and other mineral compounds, nitrates and chlorides, fluorides, heavy metals etc. Solar distillation unit may remove these up to level of 99.9% [20].

The wastewater samples after treatment from natural filtration process are used as sample wastewater for distillation process. Experiment setup with distillation unit was used and the values of total dissolved solids, pH and dissolved oxygen were determined to evaluate the water quality. The developed solar distillation experimental set up was earlier used to treat the industrial waste water samples [21]. The design details of the solar distillation still are presented in table 2 and shown as images in fig. 3. The experimental setup observations are presented in table 3.

Table 2. Design details of solar distillation unit [21]

S. No	Parameter of distillation unit	Size
1.	Inner box base area	50cm × 50cm
2.	Inner box aperture	46cm × 46cm
3.	Base area of outer box	50.2cm × 50.2cm
4.	Outer box aperture area	3025 sq.cm.
5.	Height of inner box	15cm
6.	Inner box height with absorber plate	15cm
7.	Height of outer box	15.2cm
9.	Inclination angle of glass glazing	30^{o}

Figure 3. Schematic of solar distillation still and distillation of waste water after filtration

Table 3. Experimental observations for distillation of water after natural filtration

S.No.	Waste Water Sample	Before Distillation Reading			After Distillation Reading		
		TDS (PPM)	pH	D.O. (mg/L)	TDS (PPM)	pH	D.O. (mg/L)
1	Laundry Waste Water	2370	7.9	6.4	126	7.3	8.7
2	Kitchen Waste Water	372	6.8	3.4	70	7.5	7.4
3	House Cleaning	870	7.7	4.2	111	7.4	7.4

3. Results and Discussion

Result of wastewater samples treated with natural filtration and solar distillation work are presented below in fig. 4, 5 and 6. From Fig.4, 5 and 6 it can be seen that the TDS and pH value is reduced and D.O. value is increased after water treatment by natural filtration and solar distillation methods.

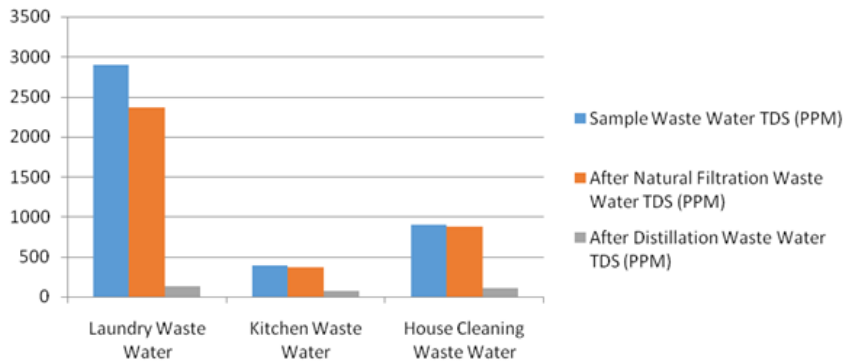

Figure 4. Comparative TDS value before and after water treatment

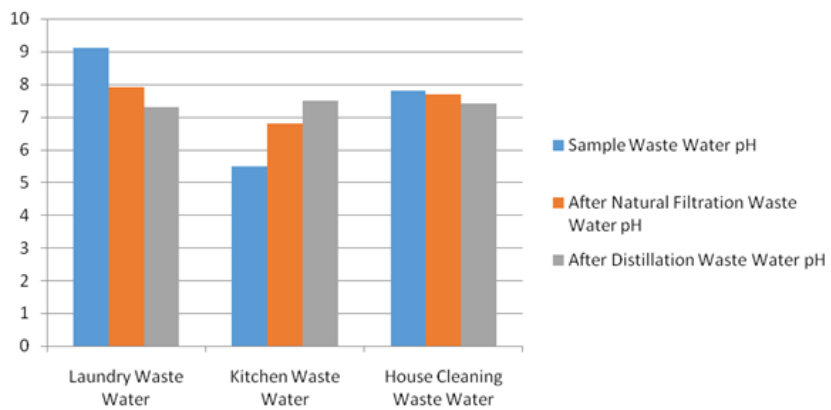

Figure 5. Comparative pH value before and after water treatment

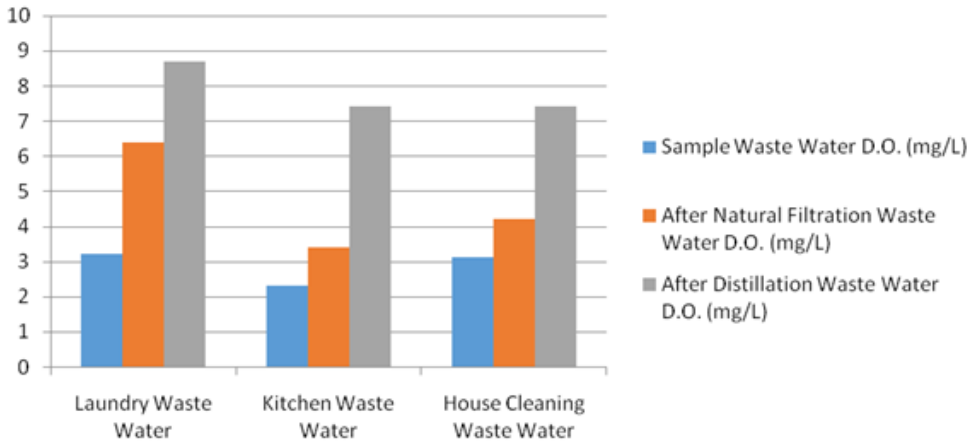

Figure 6. Comparative D.O. value before and after water treatment

It can be seen that for laundry wastewater sample the initial value of TDS was 2900 ppm, pH was 9.1 pH and D.O. was 3.2 mg/L. After natural filtration the value was 2370 ppm, 7.9 pH and 6.4 mg/L and after solar distillation the value became 126 ppm, 7.3pH and 8.7Mg/L. Overall the Total Dissolved Solid value reduced to 4.34 %. For kitchen wastewater sample TDS was 390 ppm, pH was 5.5 pH and D.O. was 2.3Mg/L. After natural filtration the value was 372 ppm, 6.8 pH and 3.40Mg/L after solar still distillation the value became 70 ppm, 7.5 pH, 7.4Mg/L. Overall the Total Dissolved Solid value reduced to 17.94 %. For house cleaning waste water sample initially TDS was 893ppm, pH was 7.8 pH and D.O. was 3.1Mg/L. After natural filtration the value was 870 ppm,7.7 pH and 4.2Mg/L and after solar still distillation the value became 111 ppm, 7.4 pH and 7.4 mg/L. Overall the Total Dissolved Solid value reduced to 12.43 %.

4. Conclusions

Results of the experiments show that treatment based on combined use of natural filtration and solar distillation helps in waste water treatment. The value of the total dissolved solids is reduced to 4.34%, 17.94%, 12.43% after treatment in laundry, kitchen and house cleaning wastewater samples, respectively. The values of the TDS, pH and D.O. are near the standard values and after the quality testing of the minerals it can be used further in different applications. This option of combining both the treatment methods gave good results and it can be explored further in different waste water samples. The combined processes can be upscaled as per the requirement. This research work will be helpful in designing simple, cost-effective waste water treatment systems for households and residences.

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