© 2022 IJNRD | Volume 7, Issue 5 May 2022 | ISSN: 2456-4184 | IJNRD.ORG

Treatment of Washing Machine Greywater for Reuse in Irrigation

S Haribabu[1, a)], R Joshuva Ratna Raj[2, b)], J Bill Clinton[3, c)], S Nishanth[4, d)], C Hari Karan[5, e)]

[1]*Assistant Professor, Civil Engineering, Panimalar Engineering College, Chennai, India.*

[2,3,4,5]*UG Scholar, Civil Engineering, Panimalar Engineering College, Chennai, India.*

Corresponding author[a)]haricivil.hb@gmail.com
[b)]joshuratnraj39@gmail.com
[c)]jclinton587@gmail.com
[d)]nishanths459@gmail.com
[e)]harishpec2018@gmail.com

Abstract. This paper presents the results obtained from washing machine wastewater treatment using conventional methods namely precipitation/coagulation and the flocculation process with adsorption on granular-activated carbon (GAC) and an alternative method, membrane filtrations, namely ultrafiltration (UF) and reverse osmosis (RO). Chemical analyses showed that parameter values of untreated wastewater like temperature, pH, sediment substances, total nitrogen and phosphorous, COD, BOD5, and the amount of anion surfactants had been exceeded in regard to Slovenian regulation. These regulations can be used as requirements for wastewater reuse and make treated wastewater an available source for the existing water supply.

The study of conventional treatment was based on a flocculation with $Al_2(SO_4)_3 \cdot 18H_2O$ and adsorption on GAC. Membrane filtrations were studied on a pilot wastewater treatment plant: ultrafiltration (UF) and reverse osmosis (RO) units. The membranes used in this experiment were ceramic UF membrane and spiral wounded – polyethersulfone – RO membranes. The quality of the wastewater was improved by both methods and the specifications of a concentration limit for emission into water were confirmed.

The disadvantage of GAC is that there is no possibility of any kind of selection, which is essential for recycling and re-use, while permeate coming from RO met the required regulation as well as requirements for reusing in washing process. However, the economical analyses showed that the membrane filtrations are more expensive compared to the GAC treatment process.

INTRODUCTION

As pressures on water resources grow around the world and as new sources of supply becomes increasingly scarce, expensive, or politically controversial. Physical water scarcity and water stress have been a source of concern to the scientific community .Water stress is more like an economic scarcity where there is a lack of economic support for the sufficient amount of water infrastructure which leads to the availability of inadequate amount of portable water. The decreasing level of uncontaminated water(water crisis) has pushed many scientists into developing techniques for reusing and recycling of contaminated water Numerous studies have been conducted on the present and future water scarcity situation.

A couple of studies reported that Ethiopia, Eritrea, Nigeria, Uganda,Tanzania, Niger, and Somalia will have renewable water resources below the calculated threshold of 1500 m3/capita/year by the year 20306,7.Ethiopia comes under the economically scarce zone along with most of the African countries where water poverty index (WPI 35–48) was reported severe including surface water index (SWI = −0.95 to −0.90) and groundwater index (GWI = −0.75 to −0.50)6,7; this desperate situation drives the need for some important measures to be developed and among such measures, wastewater treatment and its re-usage remains the promising solution. Wastewater treatment is an ancient technique but the necessity of saving water and wastewater treatment have been felt in the last few decades decades due to the increasing water pollution and water demand.. Wastewater has been divided according to the source of generation;therefore, Washing Machine wastewater (Wmww) i.e.laundry wastewater (LWW) is one of the sources among others. Studies have reported the average daily WmWW Or LWW LWW effluents discharge from textile industries, high rise apartments, low rise apartments, individual houses, , bars, hotels& hospitals as 189 L, 246 L, 1280 L, 2080 L, and 624 L, respectively. Washing Machine(Laundry)wastewater is generated during the washing of clothes at household and industrial levels; the pH of household and industrial LLW is approximately 5.6, with chemical oxygen demands demands (COD) of almost 4800 mg·L−1 , while LLW of hotels has COD value ranging from 400–1200 mg·L−1 . Laundry wastewater also contains average total suspended solids of 0.08 mg·L−1, iron (0.037 to 0.72 mg·L−1), and phosphate (94.65 mg·L−1). Linear alkyl benzene sulfonates (LAS) was detected (12.24 to 1023.7 mg·L−1) in 30 different LLW samples from Brazilian commercial facilities12. LAS has been found in downstream from raw sewage outfalls in different receiving bodies, such as river.. Some of these pollutants had been found threatening the local environment of of disposal site, as well as toxic to the human. Furthermore, LAS has a promising characteristic, i.e., inhibition of biological activities.

Washing Machine Wastewater Discharge:

The results of this study elucidated two important observations, including the maximum weekly flow rate and the average laundry water demand. Table 2 illustrated the average flow rate from Sunday to Saturday. The total average flow rates were calculated for the next seven days, followed by the quantitative and qualitative analyses.

Characterization Of Laundry Wastewater:

Volatile organic acids and linear alkyl benzene sulfonates (LAS) can be examined by high performance liquid chromatography (HPLC). UVS pectrophotometryis also ideal for the analysis of anionic surfactants (Jamrah, et al., 2011; Jamrah, et al., 2008; Jurado, et al., 2006; Akyuz and Roberts, 2006; Al-Mughalles, et al., 2012; Chen, et al., 2008; Udayakumar, 2015; Wangkarn, et al., 2005). Nitrate, nitrite, phosphate, fluoride and bromide can be tested by ion chromatography. Similarly, alcohols can be quantified by gas chromatography.

Environmental effects of Washing Machine waste water:

Wastewater comes out of the laundry process with additional energy (heat), lint, soil, dyes, finishing agents, and other chemicals from detergents.[1] Some laundry wastewater goes directly into the environment, due to the flaws of water infrastructure. The majority goes to sewage treatment plants before flowing into the environment. Some chemicals remain in the water after treatment, which may contaminate the water system. Some have argued they can be toxic to wildlife, or can lead to eutrophication.

General influence of Washing Machine waste:

Data show that United States has more than 35,000 laundries. On average, a single laundry can discharge 400 m3 of wastewater every day. Annually, about 5.11 km3 laundry wastewater is produced, which can fill 1,460 Superdomes in New Orleans.

Chemicals in detergents:

Several common detergent ingredients are surfactants, builders, bleach-active compounds and auxiliary agents. The surfactants can be classified into anionic, cationic and nonionic surfactants. The most widely used surfactant linear alkylbenzene sulfonate (LAS) is an anionic surfactant.

In builders, sodium triphosphate, zeolite A, sodium nitrilotriacetate (NTA) are the most important substances. Bleach-active compounds are usually sodium perborate and sodium percarbonate. Enzymes and fluorescent whitening agents are added into detergents as auxiliary agents.

Environmental harm of surfactants:

Surfactants are surface active agents, as they have both hydrophilic and lipophilic; theseperties and are widely used in various washing process. With the lipophilic tails, surfactants are biologically active. Anionic surfactants have the ability of binding to bioactive macromolecules like enzymes, DNA, peptides, causing changes of surface charge and the folding of polyp eptide chain(structure o different. Cationic surfactant can bind to the inner membrane of bacteria, and by this way disorganize the bacteria through their long alkyl chain. Nonionic surfactants are able to bind to both proteins and phospholipid membrane, leading toleakage of low molecular mass compounds by increasing the permeability of membranes and vesicles. This may result in serious damage in cells or even cell death.

Compliance limit of WmWWreuse :

The comparative data analysis shown in has been done employing various recommendations emanating from various international standards for drinking water, irrigation water, water course discharge, cattle drinking water and construction water quality along with the laundry waste water characteristics noted by the authors. As indicated in all the parameters present in WmWW are under the permissible limit of water courses. However, the excessive presence of COD and LAS results in the unacceptable limits passing. Thus only treating COD and LAS can make WmWW water disposable to water courses.demonstrates that the permissible limit of water quality for irrigation and cattle feeding is to be easily achieved after specifically treating LAS, COD, TSS and total alkalinity. Water permissible limit forconstruction is achieved easily after initial stage of treatment of WmWW . There is daily use of water which needs low permissible limit to utilise it such as flash in toilet does not require good quality of water therefore LWW can be used directly. The acceptable limits for drinking water parametersare significantly high due to health impact. Although the effects of all kinds of chemicals present in Washing Machine waste Water.

Benefits of Using Treated Waste Water

Treating Washing machine waste water not only reduces the consumption of water, It also reduce the volume of water discharged in sewerage system. Consumers with water meters could therefore save money on both water Supply and waste water bill. And increasing the effective water supply in regions where irrigation is needed.

Biochar produced from natural adsorbents is cheaper than activated Carbon if pooduced from waste wood, bagasse fly ash, cotton and peat.

Moreover, the utilization of easy and locally available material will encourage the application of this research in other developing countries. In line with this, bio-char sourced from local woods was considered a good option to ensure cost-effectiveness. Biochar is the potential absorbent for absorbing synthetic organic carbon from wastewater; it was produced under controlled pyrolysis temperature, i.e. 700 °C. The morphological study of bio-char showed a promising surface of >500 m2/g; this large surface area will be great for the adsorption of wastewater contaminants.

Extensive studies have been performed on the indigenous and freely accessible adsorbent (i.e., teff straw which is one of the media in the study) since it is a part of the staple food of Ethiopian households. The treated straw can be used for the treatment of domestic and industrial wastewater at the lowest cost. DestaMuluBerhe, (2013) examined treated and untreated teff straw adsorbents for the textile effluent treatment and reported them as potential adsorbents for Cr, Ni, and Cu removal23. On the other side, Tadesse et al., (2015) demonstrated the effectiveness of agriculture waste materials as adsorbents; the study used teff adsorbent together with wheat bran, almond shell, coconut tree sawdust, and rice straw for the quantitative removal of Cr(VI) from leather industry wastewater.

The authors presented the Langmuir isotherm (R2 = 0.9739) and pseudo-second order model (R2 = 0.9999) which revealed the approach as a suitable wastewater treatment method. Wassie and Srivastava, (2016) reported teff straw as a mesoporous material with a pore diameter of 43.9 Å and surface area of 30.5 m2/g using scanning electron microscopy (SEM) analysis. They used this material for Cr(VI) metal removal from aqueous solution.

REVIEW OF LITERATURE

1) Linear Alkylbenzene Sulfonates (LAS) specifically which is found upto 30% of total detergent(2016) Author Name:Dr.Ramcharan

LWW were sampled from a domestic washing machine which program comprised of one wash cycle (rinse 1) followed by two sequential rinse cycles (rinse 1 and 2). The results of the analysis of LAS are summarized in Table 1. It is found that the amount of LAS is reduced by 41% after rinse 1 and 25% after rinse 2 (Table 1), respectively, when the UV method was used. Similarly, in the case of HPLC, LAS was reduced by 55% initially, and then by 38% later on. These results show that with each rinse the amount of LAS declines.

(Ramcharan, et al., 2016) also reported impact of temperature on LAS reduction and biodegradation under aerobic condition. When rinse one stored at 4°C for a period of 5 days with no added preservative showed a decrease in concentration of LAS by 31.84% while a 9.07% decrease was observed for samples stored in 15% methanol at the same temperature. Under aerobic condition LAS is biodegraded into acetoacitic acid and fumaric acid (Ramcharan, et al.,) .

The amount of LWW may vary according to the user's mechanical efficiency and availability of water etc. documents a typical example of LWW flow rates from various sources such as apartments, bars, hotels, hospitals and prisons in Hong Kong, China. The flow rate varies from 132-2460 l/day. Table 3 gives the details of other chemicals of concern which are found in LWW. Significant amounts of ethanol were reported, whereas the amounts of butyric acid were found to be the highest for all acids. These significant contaminants need special treatment in order to make this water reusable. (Braga, et al., 2014) conducted an extensive testing of xenobiotic organic compounds in LWW. They identified 33 xenobiotic organic compounds, which included cleaning agents, fragrances, insect repellents, and antioxidants . This certainly confirms that cleaning agents as well as other chemicals used for deodorizing constitute complex compounds, resulting in the release of a high concentration and wide variety of pollutants intothe environment. Consequently, there is a need for well-considered innovative recycling and treatment techniques (Braga, et al., 2014).

2) Grey water Filtration System for Sustainable Water Culture(Dec 2001) Author:Dr.Ayoup M.Ghrair

Grey water Recycling System is must for anyone who cares about the environment to replenish the water shortage and reduces environmental pollution as well as a waste water production.

3) Reuse of Domestic Grey water for the irrigation of Food Crops(Aug 2005)Author:Dr.Sara Finley

More research is needed in the area of pathogens enumeration on crop surface so that easy detection methods, sampling regimes, and acceptable contamination limits can be agreed upon.

METHODOLOGY

- Trying different trails like 2kg,3kg,4kg,5kg of cloths being washed in Washing machine and collecting the 2nd 3rd and 4th discharged water (since 1st rinse water is too dark and requices other treatment process It is omitted) its weighed and corresponding ph value is being noted.
- Then using Alum and filtering to get clear water, its ph being noted.
- By comparing the values selection process is done.
- After selecting filter bed is prepared and water sample is collected Before and after passing the filter bed. And the water collected from Last layer is used for irrigation after checking the lab results.

Kg of Cloth	Rinse	Litres	Before Alum	After Alum
2kg	2	16L	7.9	6.9
	3	16.6L	7.7	6.8
	4	16.5L	7.6	6.8
3Kg	2	20L	8.3	6.8
	3	19.4L	8.1	7.2
	4	19.1L	7.7	6.8
4Kg	2	21.6L	8.5	7.3
	3	20.3L	8.1	7.3
	4	18.5L	7.9	6.8
5Kg	2	26L	9.4	6.8
	3	25L	8.8	6.9
	4	25.2L	8.5	7.2

TABLE 1.

Materials & Method Description

The different layers of the filter help to pull the dirty particles out of the water.

1. The cotton layer helps to absorb the micro dust particles, and keep the other layers of your filter from falling out into your water.

2. The sand layer acts as a coarse filter for large muddy particles and to keep the activated charcoal or clay particles from getting into the cleaned water.

3. The pebble attract large micro particals and is good for attracting and filtering out metallic particles.

4. The activated charcoal layer is amazing at trapping the impurities in its network of holes and tunnels.

Activated charcoal is carbon that has been treated with oxygen at very high temperatures. The oxygen eats away at the carbon and makes all kinds of tunnels and pores. Just three grams of activated charcoal can have as much surface area as a football field! As water passes through this porous charcoal, the little particles and impurities get trapped inside the charcoal. "Activated" means it has a slightly positive charge and works like a magnet on negatively charged impurities that are attracted and bind to the outside of the charcoal. After running your dirty water through the filter a number of times, it will appear to be nice and clean.

But even though it looks completely clear, it MUST be thoroughly sterilized before it could be used for drinking. Boiling water is a common technique for removing pathogens, but avoid doing so unless absolutely necessary. (Again, we DO NOT recommend drinking the water from this experiment, just to be safe!) Did you know that 75% of the earth's surface is covered by water? Most of it is salt water and can't be used for drinking; less than 1% of the earth's water can be used by people! As you saw with this experiment, filtering dirty water to make it clean enough to drink takes time and effort. It is very important to save the water we use every day and not waste it.

RESULTS & DISCUSSIONS

Parameters	Units	Ground Water	Before Treatment	After Treatment
Chloride	mg/l	110	1495	137
Sulphate	mg/l	64	764	82.4
Total Dissolved Salts	mg/l	46.7	4346	804
Calcium	mg/l	60.3	360.7	78.6
Magnesium	mg/l	19	193	6.8
Total Hardness as CaCo3	mg/l	96	1696	224
Iron	mg/l	1.12	1.16	2.9

FIGURE 1.

Parameters	Units	Ground Water	Before Treatment	After Treatment
Total chlorophyll	mg/l	0.5	0.5	0.6
Conductivity	ms/cm	3.92	4.92	1.556
Nitrate	mg/l	16.3	40.3	3
Dissolved oxygen	mg/l	4.2	4.5	2.1
Lead as pb	mg/l	0.01	0.01	0.01
Nitrate	mg/l	0.01	0.01	0.01
Phosphate	mg/l	0.132	0.428	0.5
Phosphorous	mg/l	0.11	0.14	0.17
Chromium	mg/l	0.01	0.01	0.01
Copper	mg/l	3.85	6.85	5.89
Oil&greese	mg/l	10	50	21
Manganese	mg/l	0.01	0.01	0.01

FIGURE 2.

CONCLUSION

This study is of possibility for wastewater reuse is essential because of its Availability of waste water form washing machine.The waste water possesses the potential for reclamation and reuse. Such reclamation reuse of waste water discharged from washing machine is important to save water supply and significantly improve urban environments.

Good results were achieved using conventional methods.The waste water discharge can be used for irrigation,but in order to avoid diseases from water So this methods are especially effective in the case of minimizing the organic Pollutants to the point where wastewater is drained into communal sewage Or directly into a water.The disadvantage is that there is no possibility of

Any kind of selection, which is essential for recycling and re-use.The consumptions of chemicals can be reduced because of better separation characteristics of membranes compared to coagulation and adsorption methods. Waste water reuse after treatment for edible crops, garden plants And for small irrigation can become popular coping strategy in parts of the World where fresh water is an short supply and its vital we establish safe Practice of resuing treated water in order to productive in water scare future.

REFERENCES

1. Abed, M.A., Saxena, A. and Bohidar, H.B. A Physicochem. Eng. Aspects. 233: 181-187. (2004).
2. Aboulhassan, M., Souabi, S., Yaacoubi, A. and Baudu, M. International Journal of Environmental Science and Technology. 3: 327-332. (2006)
3. Ahmad, J. and Hisham, EL-D. Resources, Conservation and Recycling. 52: 973-978. (2008).
4. Ahmad, M., Lee, S.S., Dou, X., Mohan, D., Sung, J.K. and Yang, J.E. (2012). Bioresour. Technol. 118 : 536-544.
5. Bifeng, H., Xiaolin, J., Jie, H., Dongyun, X., Fang, X. and Yan, L. International Journal of Environmental Research and Public Health. 14 : 1-18. (2017).
6. Braga, J.K. and Varesche, M.B.A. Commercial Laundry Water Characterisation. American Journalof Analytical Chemistry. 5 : 8-16. (2014).
7. Central Pollution Control Board (CPCB). http://www.cpcb.nic.in/Water_Quality_Criteria.php. (2008).
8. Chen, B., Zhou, D. and Zhu, L. Environmental Science Technology. 41: 5137-5143. (2008).
9. Duarte, I.C.S., Oliveira, L.L., Buzzini, A.P., Adorno, M.A.T. and Varesche, M.B.A. J BrazChem Soc. 17 : 1360-1367. (2006).
10. Eremina, A.O., Golovina, V.V., Ugai, M.Y. and Rudkovskii, A.V. Russian Journal of Applied Chemistry. 77 : 775-778. (2004).
11. Faria, P.C.C. Water Res. 38 : 2043-2052. (2004).
12. Friedler. Environ Technol. 25 : 997-1008. (2004).