Quest Journals
Journal of Architecture and Civil Engineering
Volume 8 ~ Issue 9 (2023) pp: 01-06
ISSN(Online) : 2321-8193
www.questjournals.org

Research Paper

Neutralizing The pH Level of Greywater to Solve The Crisis of Clean Water

Lies Kurniawati Wulandari[1*], Munasih[1],I WayanMundra[1],
[1]*Department of Civil Engineering, National Institute of Technology (ITN),*
Malang,Indonesia. 65145

ABSTRACT: *The growing demand for clean water has become an undeniable imperative, coinciding with the exponential rise in the global human population. This issue is particularly pronounced in developing nations. However, the predicament extends beyond mere water scarcity, as the generation of wastewater continues to surge alongside the diversification of human activities and the escalating consumption of freshwater resources. In the context of this study, diligent endeavors have been undertaken to address this pressing issue by implementing a novel approach that combines the treatment of greywater and rainwater. This innovative technique is deployed to meet the escalating demand for clean water in Indonesia, with a specific focus on urban areas exemplified by Malang City. The core of this treatment method revolves around a meticulously designed sand filtration system. Complementing this process, auxiliary substances are introduced to effectively neutralize pH levels, specifically through the use of Poly Aluminium Chloride (PAC) and sodium carbonate (Na_2CO_3), both of which hold the theoretical capacity to rectify water acidity.The outcome of this comprehensive study, predominantly concentrated on pivotal water quality parameters such as pH, unequivocally demonstrates the efficacy of this treatment amalgamation in enhancing wastewater quality. This straightforward yet impactful technology bears the potential for widespread implementation, offering a promising solution to the prevailing clean water crisis. Nonetheless, it is imperative to acknowledge the need for further research and development to refine and expand upon these findings in the quest to alleviate the widespread water scarcity crisis.*

KEYWORDS: *pH, turbidity, water crisis, clean water, filtration.*

***R**eceived 02 Sep, 2023; **R**evised 11 Sep., 2023; **A**ccepted 13 Sep., 2023 © The author(s) 2023.*
P**ublished with open access at **www.questjournals.org

I.INTRODUCTION

One of the most significant contributors to environmental pollution is domestic liquid waste, primarily originating from households and settlements, with a predominant composition of bathroom and kitchen wastewater (Sugiharto, 2008). Astonishingly, an estimated 60% to 85% of the total clean water usage ultimately transforms into domestic liquid waste. Within this waste stream, approximately 75% consists of household waste (Metcalfe, 1989). When categorized by type, domestic waste can be classified into two categories: greywater and blackwater (Said, 2017). Blackwater encompasses toilet waste, primarily human feces, while greywater comprises waste from activities such as bathing, washing, cooking, and various other household chores (Wulandari, 2019). In this study, our focus lies on greywater waste and the exploration of methods to effectively process and reuse it for various human activities. The inescapable reality is that greywater waste production exhibits a persistent upward trajectory, mirroring the global surge in human population and the ever-expanding array of anthropogenic activities.

The challenge of managing household wastewater presents itself in numerous countries, particularly in developing nations (Jing et al., 2015), Indonesia included. Beyond the issue of high greywater generation, the inadequacy of drainage systems poses a significant threat to environmental sustainability. Typically, greywater disposal occurs through open ditches that eventually discharge directly into rivers, bypassing any form of treatment (Notoatmodjo, 2003). This unprocessed discharge results in the contamination of clean water sources and the surrounding ecosystems, subsequently impacting human health. Furthermore, the pollution of water resources, compounded by population growth, exacerbates the clean water crisis. To address these pressing issues, a solution is imperative—one that tackles both challenges simultaneously.

National Institute of Technology, Malang, Indonesia

One pivotal parameter serving as a yardstick for water quality, including the suitability of wastewater for release into water bodies, is pH (Wardana, 1999). The Minister of Environment and Forestry of the Republic of Indonesia's Regulation (Permen LHK) No. 68 of 2016, which outlines Domestic Wastewater Quality Standards, stipulates rigorous water quality criteria. The pH level is prescribed to fall within the range of 6 to 9; any deviation from this range indicates the presence of excessive pollutants that exceed the environment's capacity to absorb, potentially endangering nature and human well-being.

This study endeavors to formulate a straightforward greywater waste processing technology suitable for widespread community adoption. Domestic wastewater treatment can be executed individually or integrated, provided that the treated water meets the requisite standards for discharge into water bodies (Cahyadi, 2008). As proposed by Said and Hartaja (2015), the selection of wastewater treatment technology should align with the specific characteristics of the wastewater in question. One such technology grounded in wastewater characteristics is physical processing, achieved by filtering out pollutants present in the wastewater. Additionally, chemical methods can be employed, involving the addition of specific substances to degrade dissolved organic matter and normalize the water's pH level. This research adopts a dual-pronged approach, combining both physical and chemical methods. The physical aspect is realized through sand filtration techniques, while the chemical facet incorporates the use of Poly Aluminium Chloride (PAC) and soda ash (Na_2CO_3) to neutralize the pH of greywater waste.

II. METHOD

This quantitative study employs an experimental methodology to conduct an experiment aimed at treating greywater waste through a combination with rainwater to produce clean water. The materials utilized in this research encompass Poly Aluminium Chloride (PAC), sodium carbonate (Na_2CO_3) or soda ash, sand, household greywater, and rainwater. The source of the greywater waste is the drainage channels within residential areas situated in Bontang City, East Kalimantan Province, Indonesia. The equipment employed includes a pH meter, digital scales, measuring cup, PVC pipe, filter box, and turbidity meter. The research unfolds with the initial step of dissolving varying concentrations of PAC and soda ash (ranging from 10 to 40 ppm) in 1000 ml of distilled water, which is later combined with the greywater waste in a storage pond. Subsequently, the mixture of greywater waste and rainwater is directed into a filter box containing layers of sand with thicknesses of 10cm and 20cm, while the water flows through at a rate of 2 liters per minute. The study involves observations based on two critical parameters: pH and turbidity. Data collected are analyzed utilizing the linear regression method. Moreover, the results of measuring the pH and turbidity of the treated water are compared against the SNI standard number 6989.59:2008 to gauge compliance. In addition to the experimental setup, this study also investigates and quantifies the production of greywater within the residential areas under examination. The underlying concept of this simple treatment process can be succinctly outlined as follows:

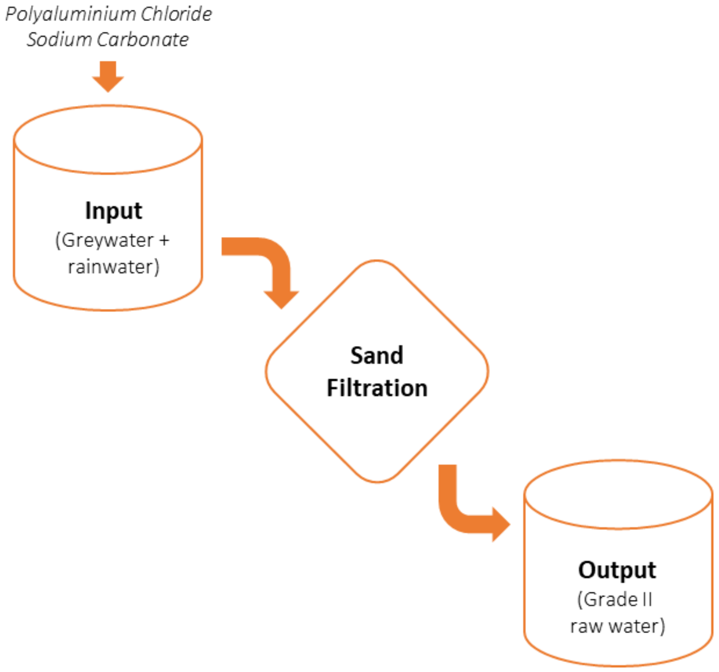

Figure1: The concept of greywater treatment

III. RESULT AND DISCUSSION

The primary focus of wastewater treatment in this study centers on greywater waste. This choice stems from the fact that it represents the highest proportion of liquid waste generated in residential areas. Moreover, greywater waste is readily accessible as it can be directly sourced from drainage canals. The observations in this study primarily revolved around the pH parameter, which serves as the principal indicator and also mirrors the state of other chemical parameters within the water. In parallel, turbidity was monitored as it signifies the physical quality of the water. Visual cloudiness in water is indicative of a high concentration of dissolved or suspended pollutants. By way of comparison, the initial pH level of the wastewater before treatment stood at 5.2, while the targeted pH range conforms to Class II water standards, falling between 6 and 9. This underscores that the pH level of the wastewater was excessively acidic and necessitated adjustment towards a more neutral value. The treated water comprised a 50% blend of greywater and rainwater. Four treatment scenarios were implemented: the first involving 10 ppm PAC and 10 ppm soda ash, the second employing 20 ppm PAC and 20 ppm soda ash, the third utilizing 30 ppm PAC and 30 ppm soda ash, and the final treatment combining 30 ppm PAC with 40 ppm soda ash. Figure 2 provides an overview of the pH measurement results at the initial stage of water treatment for each combination of PAC and soda ash treatments.

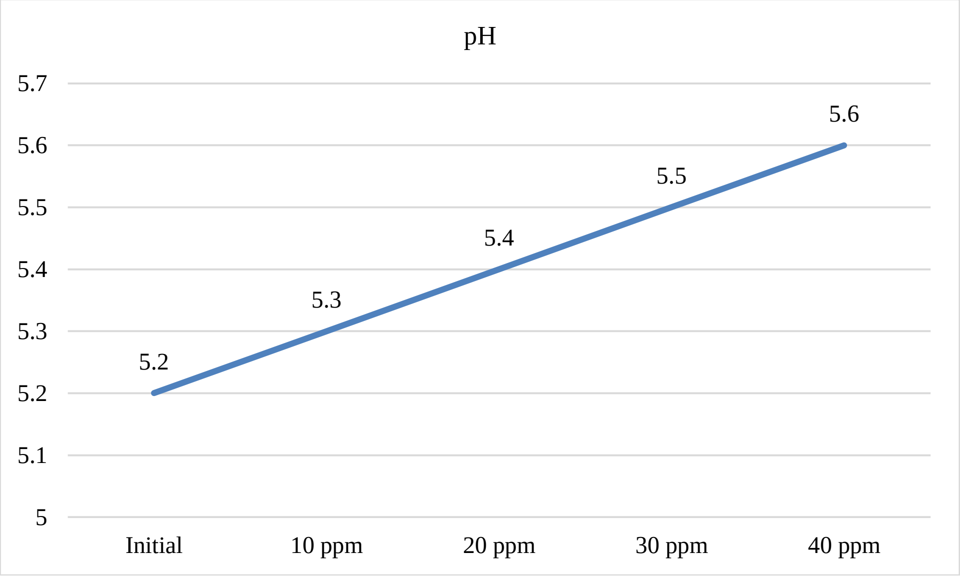

Figure2:pH level during the initial stages of treatment

In Figure 2, it is evident that the wastewater, despite the addition of PAC and soda ash, still exhibits a pH value below 6. This indicates that the water remains acidic and does not meet the criteria for Class II clean water. Consequently, further processing is necessary, employing filtration techniques to rectify this issue. Natural materials are employed as filter media to effectively remove suspended solids present in greywater waste, with sand being the selected material of choice. The filtration treatment is conducted incrementally, as per the conceptual framework of this study. Following the introduction of additional PAC and soda ash, the wastewater undergoes filtration using sand, which is placed within a filter box. Initially, the water is filtered through a box containing a 10 cm layer of sand. During this stage, observations are carried out to assess the resulting pH level. Subsequently, the treated water undergoes further processing within a filter box equipped with a 20 cm layer of sand. The summarized pH levels following the wastewater's passage through this comprehensive series of processing steps are presented in Table 1 below:

Table1: Data compilation of pH level based on each treatment

Thickness of sand filter (cm)	Discharge (liter/minute)	pH neutralizer (ppm)	Water pH
0	1	PAC 10 + Soda ash 10	5.4
		PAC 20 + Soda ash 20	5.6
		PAC 30 + Soda ash 30	5.3
		PAC 30 + Soda ash 40	5.5

Thickness of sand filter (cm)	Discharge (liter/minute)	pH neutralizer (ppm)	Water pH
10	1.5	PAC 10 + Soda ash 10	5.4
		PAC 20 + Soda ash 20	5.5
		PAC 30 + Soda ash 30	5.7
		PAC 30 + Soda ash 40	5.7
20	2	PAC 10 + Soda ash 10	5.8
		PAC 20 + Soda ash 20	5.8
		PAC 30 + Soda ash 30	5.8
		PAC 30 + Soda ash 40	6.0

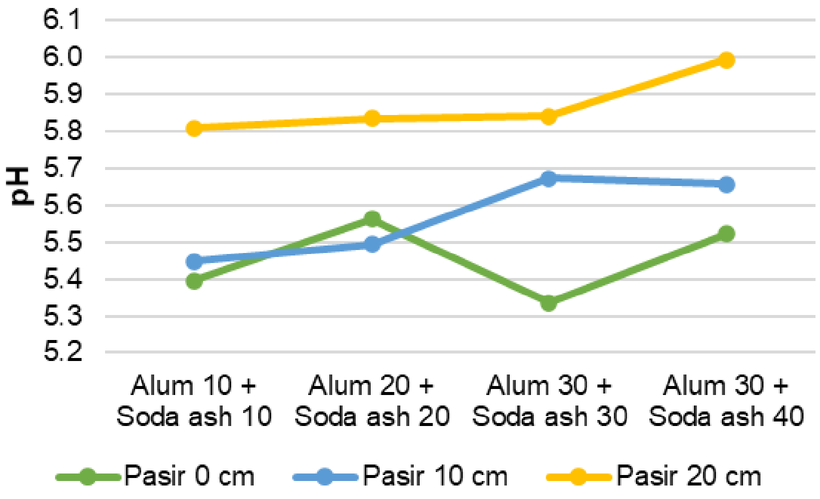

Figure3: Dynamics of pH level of greywater during treatment

In summary, it can be elucidated that the quality of treated water shows continuous improvement. This improvement is notably reflected in the pH levels, which steadily rise from the initial measurement (5.4) to conform with the SNI standard number 6989.59:2008 at the final processing stage (6.0). The treatment process was concluded as the water met the criteria for Class II water standards. This study successfully demonstrated that the combination of PAC and soda ash, augmented by sand filtration, effectively neutralizes the pH of greywater wastewater.To reinforce these findings, a statistical analysis was conducted using the linear regression method to ascertain the significance of the treatment's impact on pH level elevation and to derive relevant equations.

From the data presented in Table 1, it is evident that pH levels tend to increase in tandem with escalating concentrations of PAC and soda ash. This aligns with the theoretical premise that these two chemicals possess pH-neutralizing properties, particularly for acidic environments (Amri et al., 2019; Bacin et al., 2020). The visual representation of this pH level ascent toward neutrality is depicted in Figure 3. The most favorable pH levels fall within the pH range prescribed for Class II water (6-9), which is attained in the treatment involving a 20 cm sand layer combined with 30 grams of PAC and 40 grams of soda ash. This treatment results in a pH level of 6, meeting the criteria for Class II water as stipulated in the Government Regulation of the Republic of Indonesia Number 82 of 2001, governing the Management of Water Quality and Control of Water Pollution. The 20 cm sand thickness in the suspended solids filtration process also proves to be more optimal in eliminating suspended solids pollutants, contributing to the observed increase in pH levels.

Table2: The result of regression analysis

No	Independent Variable		Coef.	Sig.	Equation	R Square
1	Constant	C	5.429	0.000*	Y = 5.429 + 0.021 X1 + e	51.3%
	Sand thickness	X1	0.021	0.000*		
2	Constant	C	5.523	0.000*	Y = 5.523 + 0.005 X2 + e	4.6%
	PAC + Soda Ash	X2	0.005	0.100		
3	Constant	C	5.316	0.000*	Y = 5.316 + 0.021 X1 + 0.005 X2 + e	55.9%
	Sand thickness	X1	0.021	0.000*		
	PAC + Soda Ash	X2	0.005	0.018*		

Caption:
Dependent variable : pH
Level of significance : 0,05 (5%)
(sig.)* : Significant

Regression analysis was performed to assess the significance of the treatments applied to water quality, with a specific focus on the pH parameter. The results of this analysis are considered significant if the p-value is less than the predetermined significance level (α) of 0.05. Table 2 presents the outcomes of the regression analysis for the pH parameter. The subsequent regression graph illustrates the relationship between the treatments involving PAC and soda ash, as well as variations in sand thickness, and their impact on pH levels. The results of the regression analysis indicate that, on the whole, the treatments administered exert a significant influence on stabilizing pH levels. This significance is underscored by the p-values being smaller than the defined significance level (α) of 0.05. Moreover, a positive linear relationship is observed, signifying that increasing levels of PAC and soda ash have the capacity to elevate pH levels, initially inclined towards acidity. This positive effect is reflected in the positive coefficients. The combined impact of PAC and soda ash administration, coupled with sand filtration treatment, accounts for a 55.9% variation in pH levels. Previous research, as demonstrated by Bacin et al. (2020), has reported similar outcomes, emphasizing that the introduction of PAC and soda ash effectively enhances water quality by stabilizing pH and reducing turbidity levels. Comparable findings have also been documented by Amri et al. (2019), who successfully purified and stabilized the pH of raw water for PDAM Tirtanadi Martubung Medan through the use of PAC and soda ash. Nevertheless, it is important to note that water quality still necessitates further improvement through filtration treatment, as carried out in this study employing sand material.

IV. CONCLUSION

This research has generated empirical evidence that validates the effectiveness of PAC and soda ash, followed by a sand filtration process, in neutralizing the pH levels of greywater waste. By enhancing water quality through these measures, greywater waste can be transformed into Class II clean water. Based on the experimental results, it is recommended to use 30 grams of PAC and 40 grams of soda ash, along with a sand filter layer thickness of 20 cm. The optimal outcome of this water treatment process in the research achieved a pH level of 6.This study provides a valuable foundation for further development. Future researchers can aim to attain a pH level of 7 or even lower turbidity levels (Class I water). To achieve this, they may explore a combination of various filtration media techniques and experiment with different thickness treatments. Additionally, comprehensive water quality parameters can be considered for observation to ensure measurement results align more closely with real-world water quality standards and expectations.

REFERENCES

[1] Amri, Khairul, & Pasaribu, A. (2019). Pengaruh Penambahan PAC (*Poly Aluminium Chloride*) dan Soda ASH Terhadap Ph, Turbiditas dan TDS (*Total Dissolved Solids*) pada Air Baku PDAM Tirtanadi Martubung Medan. *Tesis; Universitas Sumatera Utara*, 1-110. http://repositori.usu.ac.id/handle/123456789/12104

[2] Angga Dheta SA. (2007). Pengaruh Lama Waktu Aerasi Terhadap Penurunan KadarAmoniak, Nitrit, Nitrat, Senyawa Organik, dan Zat Padat Air Limbah Domestik padaBakAerasiPrototipe IPALSistemLumpurAktif.Skripsi.UM.Malang

[3] Bacin, Jasniar Br, & Nuzila, C. (2020). Pengaruh Penambahan $AL_2(SO_4)_3$ dan Na_2CO_3 Terhadap Turbiditas dan pH Air Baku Pada Instalasi Pengolahan Air Bersih. *AMINA Jurnal Universitas Islam Negeri Ar-Rainiry*, 1(3): 139-147.

[4] Chen, S., Coffin, D., Malone, R. (1997). Sludge Production and Management forRecirculatingAquaculturalSystem.JournalofTheWorldAquacultureSociety28,303-315

[5] Jing,Z.,He,R.,Hu,Y.,Niu,Q.,Cao,S.,&Li,Y.Y.(2015).Practiceofintegratedsystemofbiofilterandconstructedwetlandinhighlypollutedsurfacewatertreatment.EcologicalEngineering, 75, 462-469.

[6] Maeng, M., Choi, E., & Dockko, S. (2015). Reduction of organic matter in drinkingwaterusingahybridsystemcombinedwitharockbiofilterandmembraneindevelopingcountries.InternationalBiodeteriorationand

Biodegration,102,223-230.

[7] Marsidi, R dan Herlambang, A. (2002). Proses Nitrifikasi dengan Sistem Biofilteruntuk Pengolahan Air Limbah yang Mengandung Amonia Konsentrasi tinggi. DalamJurnalTeknologi, Vol.3, No. 3, September2002: 195-204.

[8] Pemerintah Republik Indonesia (2001). Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air. Peraturan Pemerintah Nomor 82 Tahun 2001.

[9] Wulandari, Lies Kurniawati. (2019). Model Fisik Pengolahan Limbah Blackwater Pada Septictank Komunal Volume 1. Malang: Dream Litera Buana.

[10] Wulandari, Lies Kurniawati. (2019). Rancangan dan Hasil Model Fisik Blackwater pada Septicktank Komunal Standar Air Pertanian. Volume 2. Malang: Dream Litera Buana.

[11] Wulandari, Lies Kurniawati. (2022). *PengolahanLanjutBlackwaterMenjadiAirBersih*. Volume 2. Malang: Dream Litera Buana.