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Ozone Method Recycling Domestic Waste to Prevent Waste Water Pollution

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ABSTRACT

This study aims analyze the physical-chemical quality of domestic wastewater in hotel areas and analyze the biological quality of domestic wastewater which includes total coliform bacteria in hotel areas. The research data was obtained by conducting observation and laboratory analysis with the assessment of several standardized thresholds for environmental quality standards Regulation No. P.68 of 2016 and PP No. 22 of 2021. The results of the total coliform parameter after the application of ozonation, the results are obtained with a value of 2900 Most Probable Number/100 milliliters which is still below the maximum allowable threshold value; total suspended solid parameter test, obtained results with a value of 5 miligram/liter or under limit 30–400 miligram/liter which is the maximum allowable value limit. The oil/fat parameter obtained a value of <2 miligram/liter while the quality standard value was 5 miligram/liter; the ammonia parameter yielded 0.58 miligram/liter, while the maximum allowable limit was 10 miligram/liter; the biochemical oxygen demand parameter yielded <2 miligram/liter, while the maximum allowable limit was 12–30 miligram/liter; the chemical oxygen demand parameter yielded <4 miligram/liter, and the maximum allowed limit was 80–100 miligram/liter. The use of ozone can be an option in the process of recycling domestic wastewater in a sustainable manner proven to reduce levels of waste, viruses and its main pathogens total suspended solid, Ammonia, chemical oxygen demand, biochemical oxygen demand, Oil and Grease, as well as total coliform biological bacteria so that it can be reused by the community.

Keyword: domestic wastewater; green technology; ozone; total coliform; waste recycling.

INTRODUCTION

The impact of increasing population growth (Munawir et al., 2022d), always followed by economic activities that encourage infrastructure development, including: business areas, hotel areas, and settlements (Ferguson et al., 2013; Howard and Israfilov, 2002; Munawir et al., 2019). On the other hand, the need for land for the construction of various infrastructure (Munawir, 2017), facilities is not supported by integrated waste management (Ciuta et al., 2015; Lima et al., 2021). The phenomenon resulting from the impact of unmanaged waste is an important issue because it results in permanent pollution of groundwater and rivers (Han et al., 2015; Herianto et al., 2019), so that the role of the institution becomes important (Munawir et al., 2021). A good understanding of the recycling process of sustainable waste management is essential for establishing effective conservation and management strategies and for future pollution control (Hoang et al., 2017; Darban and hajilo, 2017; Cao et al., 2018). The increase in population in West Bandung Regency has resulted in a higher need for space for residence and the need for clean water consumption (Rusdiyanto et al., 2020). The development of economic centers, especially hotels, if the waste management is not controlled, can be a threat to the condition of groundwater and rivers which are the daily consumption of the community (Tian et al., 2013; Calender et al., 2013; Amin, 2021; Nguyen et al., 2020). If this condition is not properly anticipated, it has the potential to increase pollution thereby increasing the impact on public health, pregnant women and other prolonged illnesses (Wang et al., 2008; Naveen et al., 2017). Due to trash, this phenomena causes polluted places to develop, such those near the Cikapundung River (Rusdiyanto et al., 2021), water, waste, energy and food pollution in Brazil (Caiado et al., 2021) and food waste pollution in Singapore (Ma et al., 2021). Effective domestic wastewater treatment is needed to reduce or eliminate pollutants that can have an impact on the environment (Syafrudin, 2018; Kubanza and Simatele, 2019). Environmental pollution can be caused by the entry of pollutants into clean water sources, namely groundwater or rivers (Lumaela et al., 2013; Billota and Brazier, 2008; Brown et al., 2009). If waste is discharged into rivers as pollutant receiving water bodies it can have an impact on pollution (Sulistyowati et al., 2023), on the other hand domestic wastewater that is not treated properly will cause contamination of aquatic ecosystems (Mucha et al., 2023). Wichmann et al (2009) as stated by Wijaya and Soedjono (2017), that discharges from daily human activities, industrial activities and from wastewater treatment plants can have a negative impact on the surrounding environment (Susilo et al., 2020; Miranda et al., 2021). Household waste water is produced by a variety of daily human activities, such as bathing, using the toilet (feces and urine), washing clothes, washing cooking and dining utensils, and consuming liquid leftovers (Pratiwi et al., 2019; Tazkiaturrizki et al., 2018). (1) Safe handling and disposal of human faeces (feces and urine) was stressed by the WHO. According to Primary et al. (2020), Domestic wastewater typically has five primary features, namely that it contains suspended particles, bacteria, parasites, and viruses, as well as organic and inorganic components. Domestic wastewater can also be a contributor to environmental pollution if it is disposed of without treatment (Khaq et al., 2017). According to UNWWDR (2017), that globally, more than 80% of wastewater is discharged without adequate treatment. What was conveyed by UNWWDR is in line with what was conveyed by the Director of PPA, Director General of PPKL, Ministry of Environment and Forestry, corroborated by Luckmi Purwandari (2021) on the Tempo website that 59 percent of rivers in Indonesia are heavily polluted due to discharge from various industrial, domestic, and livestock waste activities. According to Ferguson et al. (2013) stated that to overcome a problem a strategic initiative is needed which focuses on targeting the problem at hand. To reduce negative impacts on the environment (Munawir et al., 2022a), To safely dispose of domestic wastewater or recycle it so that it can be reused, extensive and sustained efforts are required (Tripathi et al., 2021; Rusdiyanto and Munawir, 2023). The results of domestic wastewater treatment must meet established environmental quality standards, as stipulated in Regulation 68/2016 of the Minister of Environment and Forests relating to the highest criteria permitted for household wastewater concerning the maximum standards allowed for domestic wastewater. Irianto (2017) writes about how to manage waste, namely in 2 ways: (1) managing waste to be discharged into the environment without causing pollution; (2) the utilization of waste can be reused through certain treatments. Therefore, efforts to minimize water pollution due to domestic waste can be realized through environmentally sound recycling of waste. On this basis, the focus of this research is to examine the recycling of domestic waste so that it can prevent wastewater pollution due to the impact of the threat of residential clean water consumption. This study aims to: 1) analyze the physical-chemical quality of domestic wastewater in hotel areas 2) analyze the biological quality of domestic wastewater which includes total coliform bacteria in hotel areas. This study has been carried out in the Resort Domestic Waste hotel area around the Lembang community settlement, West Bandung Regency, West Java Province, Indonesia in 2022.

RESEARCH METHOD

The location and the time of study

Sampling of water, data and information will be carried out from January to November 2022 in the Hospitality area Resort Domestic Waste hotel area, West Bandung Regency, West Java Province, Indonesia. Domestic waste water is geerated by various daily human activities both from hotel areas and community settlements, including bathing, using the toilet (feces and urine), washing clothes, washing cooking and eating utensils, and consuming leftover fluids has become a major problem. Residents around Lembang, West Bandung Regency, are experiencing a clean water crisis, so this study aims to test the physical-chemical quality of domestic wastewater and analyze the biological quality of domestic wastewater which includes total coliform bacteria. Water sampling was carried out at 5 locations that could enter community residential areas, as depicted in Figure 1. Sampling of domestic wastewater is working from 20 January to 21 July 2022 at the coordinate points: S 06°49’05.8” and E 107°36’32.8”.

Data analysis

The number of domestic wastewater samples collected at the Hospitality area Resort in the West Bandung Regency was counted and calculated to produce the primary data. Secondary data was gathered from relevant publications and organizations, such as the West Bandung Regency Environmental Service, Regulation 68/2016 of the Minister of Environment and Forests relating to the highest criteria permitted for household wastewater, and the Government Regulation (PP) No. 82 of 2001, which was later replaced by the Government Regulation (PP) No. 22 of 2021. By observing (Munawir et al., 2022c) and collecting water samples using the study phases shown in Fig. 2, the research data was acquired. At the point of the segment when residential waste sampling is done, the next processes are taking water samples, reading temperatures, measuring the degree of acidity, and checking for additional suspended compounds. then each water sample was analyzed. Each water sample is then examined in the laboratory in Bandung City, Java Province West, Indonesia, for total suspended solid (TSS), Degree of Acidity (pH), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Coliform. Data from the lab tests were then compared to current quality requirements and classified according to each location’s environmental quality criteria.

Water sampling activities using plastic jerry cans, glass bottles, and plastic bottles with a volume of 2 liters + 500 milliliter (mL). A 1 liter plastic bottle is used for the total suspended solid (TSS) and detergent parameters,

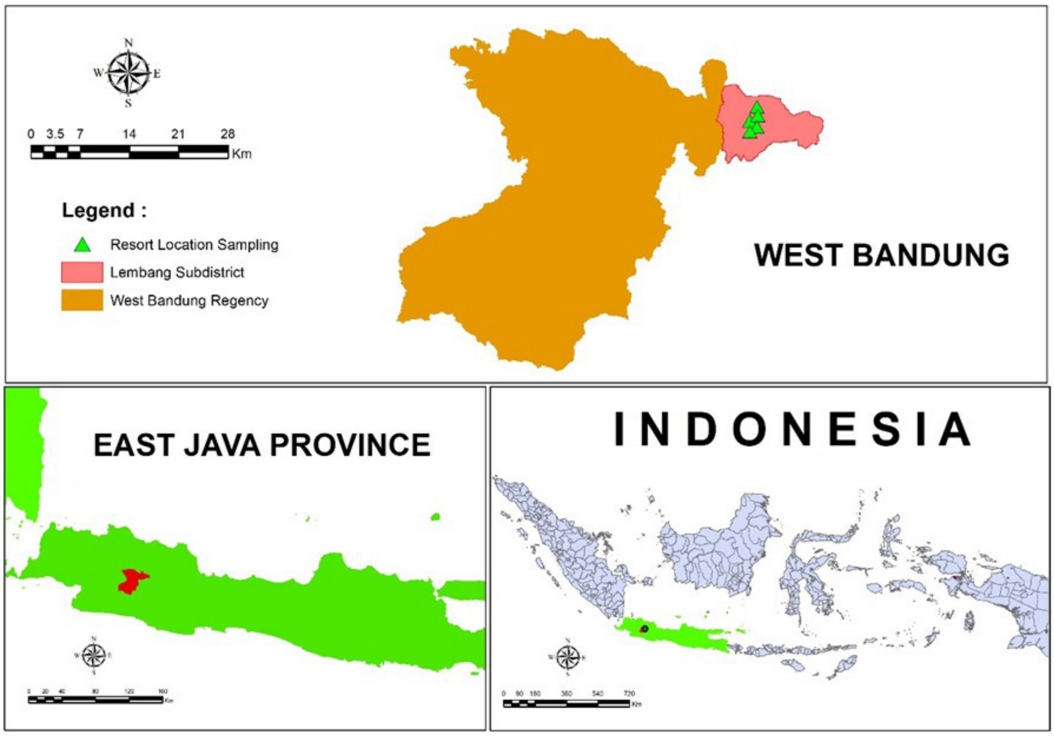

Figure 1. Geographic location of the study area in the research location hospitality area, West Bandung Regency in Indonesia

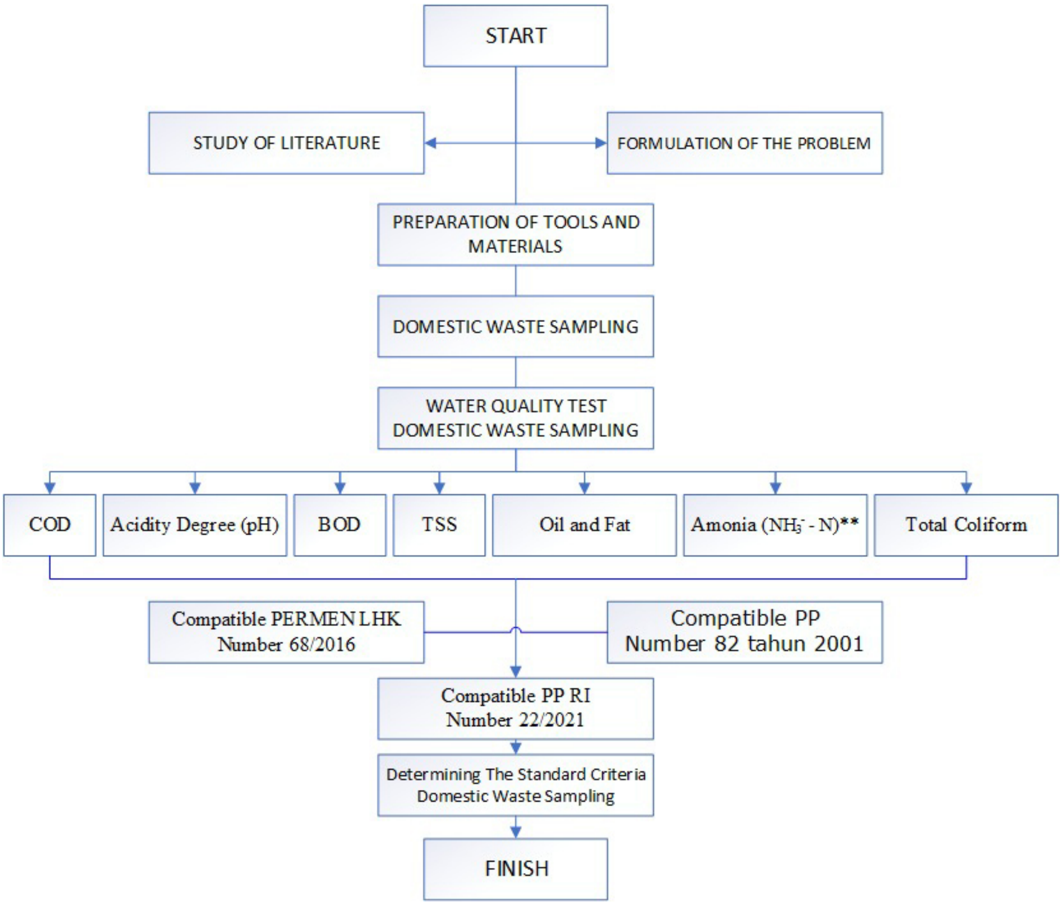

Figure 2. The study flowchart

which is then carefully covered and placed in an ice box to maintain the water's temperature and prevent harm to or changes to the parameters' quality. Use a 250 mL Winkler vial to sample water for dissolved oxygen (DO) and biochemical oxygen demand (BOD) levels. To take samples of domestic wastewater for chemical oxygen demand (COD) tests, 250 mL plastic bottles were used and after the samples were taken, they were preserved by dripping 0.5 mL of H_2SO_4. Table 1 lists techniques and instruments for evaluating the quality of water.

Table 1. Reference of physico-chemical and biological parameters for the quality of domestic wastewater

No.	Parameters	Unit	Methods/Tools used
1	Oil and Fat**	Mg/l	5520 B
2	TSS	Mg/l	2540 D
3	pH	-	4500-H*-B
4	Amonia (NH_3^- – N) **	Mg/l	4500-NH_3-F
5	BOD	Mg/l	5210 B
6	COD	Mg/l	5220 B
7	Total coliform***	Jml/100 ml	9222 B

Based on analytical protocols from the Indonesian National Standard (SNI) regarding water and waste water, the water sample analysis method was carried out, including BOD_5 SNI 6989.72:2009; pH SNI 06–6989.11:2004; COD SNI 06–6989.73:2009; TSS SNI 06–6989.3:2004; Total coliform SNI 01–2897:1992; Refer to the Standard Procedures for the Examination of Water and Wastewater for any additional domestic wastewater parameters (APHA, 2005). As a reference in analyzing data from domestic wastewater laboratories in this study, using class I, II, III and IV water quality standards. This is because the source of clean water comes from groundwater which is one of the raw water sources used in West Bandung Regency.

Domestic waste water recycling can refer to Appendix VI Environmental Protection and Management Implementation PP of the Republic of Indonesia No. 22/2021, which regulates water classes into classes 1, 2, 3 and 4.

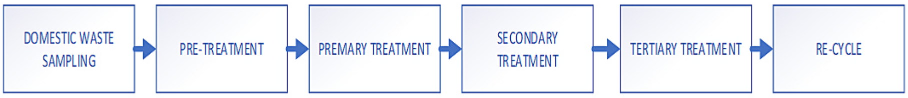

Figure 3. Recycled domestic wastewater treatment scheme

Table 2. Class of water parameters of environmental quality standards

Water class	Information
Grade 1	Intended as raw drinking water, and/or other designations that require the same water quality as that use.
Grade 2	Intended for infrastructure / facilities purposes. Water recreation, freshwater fish farming, animal husbandry, water for irrigating crops, and or other designations that require the same water quality as these uses.
Grade 3	Intended for freshwater fish farming, animal husbandry, water to cultivate plants, and/or other purposes that require the same water quality as these uses.
Grade 4	Intended to irrigate crops and/or other designations that require the same water quality as those uses

RESULTS AND DISCUSSION

Conventional technology in wastewater recycling process

Conventional technologies that are widely used in wastewater recycling processes are chemical processes, which use coagulation and flocculation methods (UNICEF, 2020). The chemicals commonly used in the coagulation process are PAC, alum or kapu, etc. The process of coagulation – flocculation is a wastewater treatment method that functions to remove the particles contained therein. Coagulation is a physical chemical process by mixing the coagulant into wastewater and then stirring it rapidly, the aim is to destabilize colloidal particles, flocculation and then the destabilized particles turn into macroflocs so that they are easily deposited. The effectiveness of coagulation-flocculation is influenced by various factors, including the type of coagulant, coagulant dose, pH, and stirring speed (Husaini et al., 2018). In the chemical processing process, several tools are needed, including coagulation reaction tanks and agitators, flocculation reaction tanks and agitators, clarifiers for the sedimentation process (Figure 4). The following illustrates the coagulant- and flocculant-based waste water recycling process (chemically):

One option in processing domestic wastewater recycling can be done by utilizing ozone (Chavez et al., 2019). Ozone is able to eliminate harmful substances, colours, odors and microorganisms directly without any harmful by-products or residues. Ozone has many advantages (eltechozone.com) :

a) More effective than chlorine in eliminating viruses and bacteria
b) Reacts quickly and easily decomposes in wastewater and does not cause harmful residues
c) Micro-organisms killed by ozone will not be able to grow back
d) Product handling is easy and can be produced on site
e) Able to increase levels of dissolved oxygen (Dissolved Oxygen) in wastewater
f) Able to reduce BOD and COD and other contaminants
g) Clean and safe so that it is easy to store and does not require a large space
h) Cost-effective because it can eliminate routine chemical spending when compared to conventional chemical processes.

Azimi and Pendashtech (2016) expressed the opinion of Dionysiou (2012), that the ozone-based oxidation process is an environmentally friendly technology capable of degrading various organic pollutants. The ozonation process is realized in

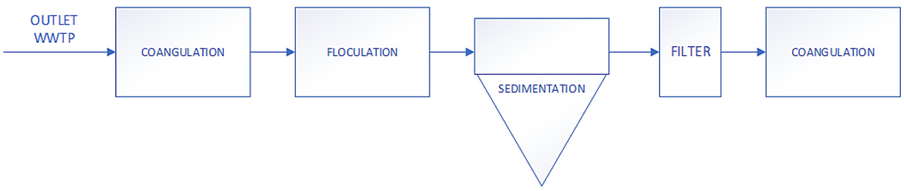

Figure 4. Coangulation flocculation-based domestic waste recycling process flow

three steps: 1) Formation of ozone; 2) Dissolving ozone in wastewater; 3) Oxidation of organic matter (Oshea and Dionysiou, 2012). According to Mota (2008) in Azimi and Pendashtech (2016), one of the non-photochemical advanced oxidation processes is the ozonation process. This is reinforced by the opinion of Keisuke and Yuan (2018) explaining that A sophisticated ozone-based oxidation technique can utilise ozone, a powerful oxidant, in wastewater processing (AOPs). AOP is highly efficient and requires short treatment times when compared to traditional processes without biological sludge production (Domingues et al., 2021). Ozonation of wastewater has several other advantages such as increased dissolved oxygen, decreased chemical oxygen demand, and improved aesthetic characteristics due to reduced turbidity and color (www.absoluteozone.com). According to Egbuikwem et al. (2020) explained that ozone reacts with organic compounds either directly as ozone molecules, or indirectly through the formation of secondary oxidants such as H_2O and HO_2. In the ozone-based treatment process, less equipment is needed, including an ozonation reaction tank (Figure 5). The following illustrates the ozone-based waste water recycling process:

According to the Oxford English Dictionary, green technology is technology whose use is intended to reduce or eliminate the effects of environmental effects of human activity. Telli (2020) explained that green technology is used as a sustainable technology, this is related to both the long- and short-term effects of something on the environment. Green and eco-friendly technologies cover energy efficiency Munawir et al. (2022b), recycling, health and safety issues, renewable resources and more (Oller et al., 2011; Telli, 2020). Green technology is a sustainable technology. Sustainability is defined as an effort to create a balance in the provision of resources for present and future generations. SDGs 6 contains provision of access to clean water and sanitation for all by 2030 (Telli, 2020). Sustainable treatment system is a new term and is defined as a type of treatment or a combination of different types of treatment that can recover raw materials so that natural resource sustainability can be achieved provided that there is full utilization or recycling of all waste from the treatment facility (Boczkaj and Fernandes, 2017). Although wastewater treatment can contribute to the preservation of available water resources, there are major challenges in its implementation in terms of energy efficiency and sustainability (Radhika et al., 2019). Zimi and Pendashteh (2016) wrote a proposal from Anastas and Zimmerman (2003) about 12 principles of green engineering which describes guidelines for scientists to design effective materials and a foundation for engineers and scientists to create reliable systems and efficient materials. through a technical and scientific approach in an ecological perspective. The following are the 12 tenets of green engineering,; 1). It should be assured that all inputs and outputs of materials and energy are as naturally innocuous as feasible,; 2) prevention of waste generation is better than treating it after it has arisen; 3) separation and purification efforts must be part the conceptual framework; 4) To maximize mass, energy, and temporal efficiency, systems must be designed; 5) In terms of the consumption of materials and energy, the system must generate an output that is more useful than the input,; 6) entropy and complexity should be viewed as an investment when designing recycling and Re-use; 7) system durability should be a design objective; 8) inappropriate system capacity or capability must be considered as a design defect; 9) Multi-component products must be strived to become a single unit so as to facilitate disassembly and minimize the variety of materials; 10) Process and system design must include interconnectivity integration with available energy and material flows;11) performance metrics including system performance design can be relied upon after commercialization; 12) The design should be based on renewable inputs and available throughout the life cycle. Green technology is being used in wastewater treatment with the following goals in mind: objectives reducing and conserving the

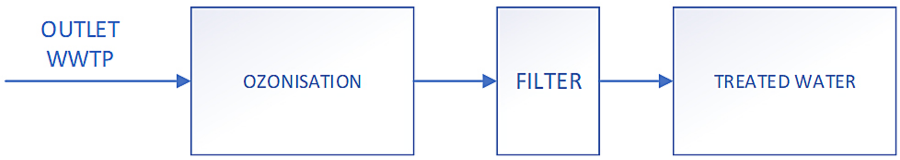

Figure 5. Ozone-based domestic waste recycling process flow

use of water and non-renewable energy sources; (ii) preventing contamination and improper use of water and other natural resources; (iii) protecting biodiversity, habitats, and ecosystems; and (iv) making sure that future generations can meet their own needs (Azimi et al., 2016). Using ozone in the waste water recycling process isn't more difficult than traditional chemical treatment methods that use coagulants and flocculants with a chemical basis. This is because the conventional chemical treatment process requires more equipment (coagulation reaction tank and agitator, flocculation reaction tank and agitator, clarifier) compared to the processing method using ozone. In addition, the absolute need for coagulants and flocculants exists in each process cycle (Boczkaj and Fernandes, 2017). Ozone utilization may be a viable solution for recycling home wastewater in a sustainable way (Keisuke and Yuan, 2018).

Results of laboratory analysis on the use of ozone domestic waste recycling test

The results of laboratory analysis research on the use of ozone tests for domestic waste recycling prove the success of domestic waste liquid from the recycling process such as bathing water, toilet water (feces and urine), laundry water, utensil cleaning water for cooking and dining, and leftover food or beverages. To comply with current requirements, the threshold standards must be met in liquid form using ozone technology. Based on the analysis in Table 3, Figure 6 and Figure 7, it is scientifically accepted that recycling using ozone can significantly reduce the levels of Oil & Grease, Ammonia NH_3^- – N, BOD, COD, TSS and Total Coliform. Tests were carried out using several methods of analysis of wastewater quality standards according to APHA. (2005) based on Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, as well as Minister of Environment and Forestry Regulation of the Republic of Indonesia No. P.68 of 2016 based on the analysis findings of the Sucofindo Cibitung Laboratory SBU with Quality Standards in accordance with Indonesian National Standards in Appendix I. The laboratory test results with the ozonation technique are presented in Table 3.

In Table 3 the results of laboratory analysis using ozone technology in the wastewater recycling process and green technology in domestic wastewater recycling compared to the quality standard of 30–400 mg/L obtained a TSS value of 16 mg/L in January and the laboratory results in July decreased to 5 mg/L, This result indicates that ozone has an impact on the removal of suspended particulates in wastewater. Coagulant or flocculant-like effects of ozone (Egbuikwem et al., 2018). The ozone process can reduce minimal solids into larger solids so that they are easier to filter (O'Shea and Dionysiou, 2012). The process of reducing the TSS pollutant load in residential wastewater can be negatively affected by increasing ozone levels because certain microscopic particles may be lost (Azimi et al., 2016; Dias et al., 2019). The results of laboratory analysis using ozone technology in the wastewater recycling process and green technology in wastewater recycling for the ammonia parameters obtained in January were 3.14 mg/L and reduced in July by 0.58 mg/L, below the level the required quality is 10 mg/L. This ammonia value is far below the typical threshold value, this is in accordance with the opinion of Krisbiantoro et al. (2020) who explained that ozone can reduce NH3--N as a result of the oxidation of eutrophication waste. The results of measuring the parameters of oil/fat obtained from laboratory results in January <3 mg/L and decreased in July with a value of <2 mg/L, where the results of ozone processing technology had a significant effect so that they did not exceed the threshold of 5 mg/L. The BOD laboratory results in January were 5.82 mg/L and reduced in

Table 3. Results of wastewater quality test after ozone treatment (Primary data, 2022)

No.	Parameters	Laboratory january	Laboratory july	Quality standards*	Quality standards**	Quality standards***
1	Oil and Fat (mg/L)	<3	<2	5	5	5
2	TSS (mg/L)	16	5	30	400	30
3	pH^	7,21	6,39	6,0 – 9,0	-	6,0 – 9,0
4	Amonia NH_3^- – N (mg/L)	3,14	0,58	10	10	10
5	BOD (mg/L)	5,82	<2	30	12	30
6	COD (mg/L)	14,29	<4	100	80	100
7	Total coliform (MPN/100 mL)	3100	2900	3000	2000–10000	3100

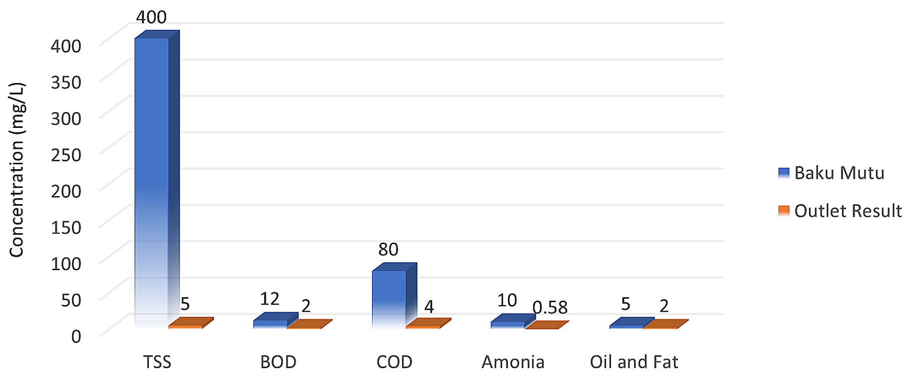

Figure 6. Outlet test results compared to quality standards–adjusted for the Indonesian National Standard (SNI) and the Minister of Environment and Forestry's Order No. P.68 of 2016: 23rd edition, 2005 of the APHA standard methods

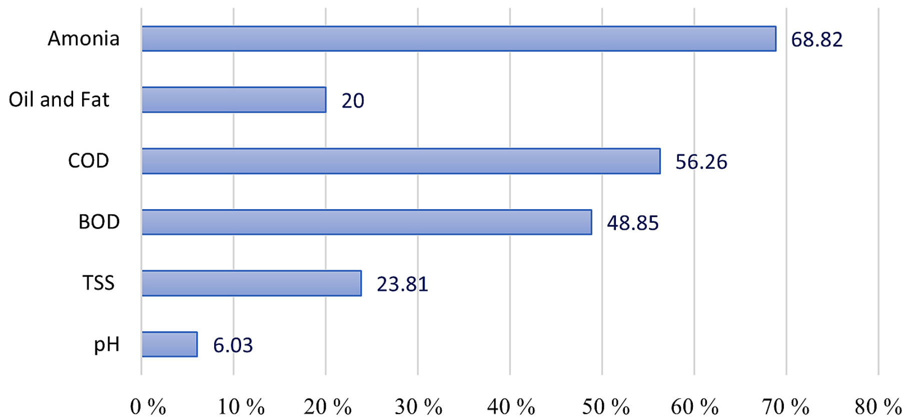

Figure 7. Percentage of WWTP effluent laboratory test results after ozone technology

July to <2 mg/L. The maximum threshold for the BOD parameter that is allowed is 12–30 mg/L, meaning that it is still below the specified quality standard threshold. While the results according to green technology and ozonation from laboratory tests for COD in January were obtained at 14.29 mg/L and in July it became <4 mg/L, this condition did not exceed the required maximum limit of 80–100 mg/L. This is consistent with the findings of Precious et al. (2020) which explains the significant effect of the application of domestic waste directly after the application of ozonation results in a decrease in the parameters of domestic waste so that it does not exceed the quality standard threshold and is very acceptable in environmental sustainability so that it does not become a pollutant load.

The results of the ozonation analysis using a combination of alum and lime have been shown to reduce BOD, COD and TSS levels (O'Shea and Dionysiou, 2012). The pH parameter test results obtained showed a value of 6.39 which still met the quality standard, namely 6.0–9.0. The results of this ozonation application test can add H+ ions so that they are close to the minimum value which has an overall impact on reducing domestic waste. The same results were shown by several studies with ozonation applications which explained that Due to the increased formation of H+ ions, the pH of ozonated water tends to fall (Oller et al., 2011; Krisbiantoro et al., 2020). Meanwhile, when coupled with the maximum quality standards that are allowed according to APHA. (2005) based on Regulation No. P.68 of 2016 issued by the Republic of Indonesia's Minister of Environment and Forestry in Appendix I, Government Regulation No. 22 of 2021 pertaining to the Implementation of Environmental Protection and Management and based on the findings of the Sucofindo Cibitung Laboratory's SBU study of the requirements for water quality and similar data, the results of the TSS parameter test after the application of ozonation, gotten outcomes with a value of 5 mg/L of 30–400 mg/L is the maximum permitted threshold value limit. The oil/fat parameter obtained a value of 2 mg/L, while the quality standard value was 5 mg/l; the ammonia parameter obtained results of 0.58 mg/L, whereas the maximum threshold allowed is 10 mg/L; the BOD parameter obtained results of 2 mg/L, whereas the maximum allowable threshold is 12–30 mg/L; the COD parameter obtained results of 4 mg/L, and the maximum allowable threshold was 80–100 mg/L (Figure 6).

Based on Figure 7, the percentage of laboratory test results in January 2022 and July 2022 shows a tendency to decrease the value of laboratory test results for domestic wastewater with parameter values still below the applicable maximum threshold. The parameters of domestic waste tend to decrease from the results of laboratory tests in January 2022 and July 2022 with the percentage of reductions in BOD 48,85%, COD 56,26%, Ammonia 68,82%, Oil and Fat 20%, TSS 23,81% and pH 6,03%. The results of the laboratory test showed a significant decrease, meaning that it was below the maximum permissible quality standard threshold. Observations in the field show that ozone and ultraviolet generators are very effective and efficient in reducing the content of domestic wastewater. The effective functioning of the two tools has resulted in an increase in the quality of the WWTP effluent thereby increasing its quality.

In Figure 8, the laboratory result value in January 2022 was 3100 MPN/100 mL and there was a decrease in the wastewater content in July 2022 to 2900 MPN/100 mL for the total coliform parameter. APHA (2005) based on Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. P.68 of 2016 in Appendix I which is used as a quality standard, Government Regulation Implementing Environmental Protection and Management No. The SBU of the Sucofindo Cibitung Laboratory regarding the quality of water quality standards and the like is 2000–10000 MPN/100 mL. This condition explains that the source of domestic wastewater from the toilet room (black water), bathroom (grey water) and from the kitchen is still below the maximum limit of environmental quality standards. Coliform bacteria are pathogenic bacteria, on the other hand these bacteria are indicators of water pollution by pathogenic bacteria (Sutrisno and Suciastuti, 2002). Water containing the coliform group is considered contaminated with human feces/feces (Rusdiyanto et al., 2021). To comply with quality standards, the ozone impact can considerably lower the amount of coliform. As stated by Precious et al. (2020) said that the use of ozone to treat water has been proven to be beneficial in lowering the numbers of microorganisms under study, so they can meet the criteria for reuse (Egbuikwem et al., 2020; Chavez et al., 2019). Environmentally responsible and cost-effective technology can reduce the use of ozone technology for treating trash contaminated with dissolved organic materials (Radhika et al., 2019). The advantage of using ozone in wastewater can remove viruses and bacteria because it is much better than chlorine and several other treatments (Khuntia et al., 2013; Herawati et al., 2023). the Minister of Environment and Forestry's Regulation No. PP.68 of 2016 in Appendix I, with a variety of testing methods, Environmental Protection and Management Implementation Government Regulation No. 22 of 2021 and based on the results of the analysis of the Cibitung Laboratory SBU, the results of laboratory tests on domestic waste parameters are still very acceptable because they

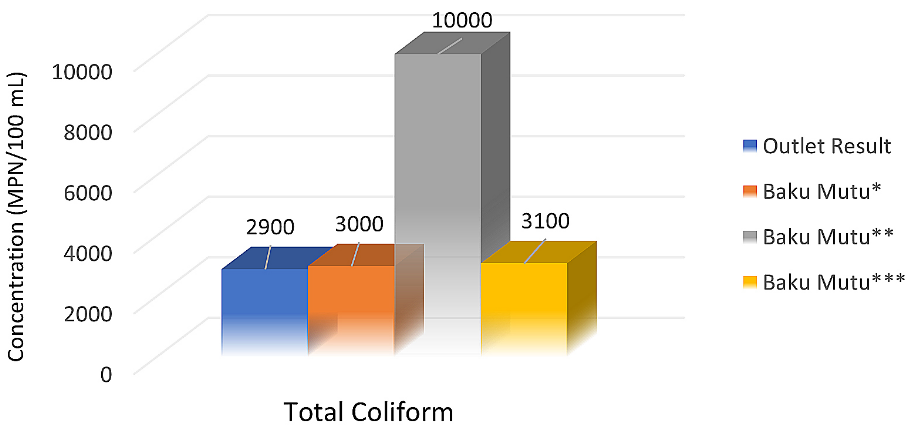

Figure 8. Outlet test results compared to several quality standards

are below the maximum threshold so scientifically the results of ozonization applications are very appropriate to be used to lower the amount of pollution from household garbage. Because there is no environmental pollutant load, it is known from the results of laboratory tests based on testing the residential wastewater recycling process that the results meet the technical requirements for reuse.

CONCLUSION

Using ozone applications and green technology, the physical-chemical quality of domestic wastewater can be the primary solution to ensure that clean water and groundwater quality remain in sustainable environmental conditions. Domestic waste recycling tests demonstrate the success of domestic waste liquid from Recycling processes such as water used for bathing or coming from the toilet (feces and urine), used for washing clothes, used for washing cooking and eating utensils, leftover food or drinks in liquid from using ozone technology which produces high levels of Ammonia, COD, BOD, TSS, Oil and grease can be reduced naturally. Green technology and ozone applications can also reduce the biological quality of domestic wastewater, especially the total coliform bacteria from domestic wastewater. The result is using ozone applications and green technology which can neutralize and eliminate viruses, bacteria and pathogens. pollutant load so that the quality of clean water will even groundwater remains in maintained environmental conditions. WHO emphasizes the significance of planning for and safely disposing of human waste (feces and urine). Comprehensive and sustainable efforts are required to ensure that home wastewater can be securely disposed of or recycled so that it can be utilized, in order to lessen negative environmental effects. In comparison to traditional chemical treatment methods that rely on chemical-based coagulants and flocculants, using ozone in waste water recycling is easier. The goals of using green technology are aligned with the use of ozone in wastewater treatment, including i) reducing and conserving the use of water and non-renewable energy sources; ii) preventing contamination and misuse of water and other natural resources; iii) protecting biodiversity, habitats, and ecosystems; and iv) ensuring the availability of resources for future generations. In order to recycle domestic wastewater in a sustainable way, using ozone may be an alternative.

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