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REVIEW ARTICLE

Characterization of domestic wastewater based on BOD, COD and TSS parameters

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Abstract

The negative impact of domestic waste water discharge is a decrease in water quality in the receiving water body due to reduced dissolved oxygen, which can result in the death of aquatic organisms. Increased concentrations of BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), and TSS (Total Suspended Solid) in domestic waste can have a negative impact on the environment through a series of interrelated processes such as triggering the phenomenon of eutrophication, where algae growth becomes uncontrollable and disrupts the balance of aquatic ecosystems. When BOD and COD levels increase, it indicates an excessive accumulation of organic matter and pollutants in the water, resulting in a decrease in dissolved oxygen due to oxygen consumption by microorganisms that decompose the organic matter. Several previous studies related to the quality characteristics of domestic wastewater were analyzed to determine its quality in the parameters of BOD, COD, and TSS. As a result, most of the domestic wastewater quality has a quality that exceeds the required quality standards. The average quality of domestic wastewater in the parameters of BOD, COD, and TSS is 541.9 mg/L, 1318.4 mg/L, and 1986.8 mg/L, respectively. The BOD and COD ratio shows 0.4, domestic waste must go through the seeds to be decomposed.

Keywords: Domestic Wastewater, BOD, COD, TSS.

INTRODUCTION

Waste is a waste product from the production process both industrial and domestic (household) (Novilyansa et al., 2020). Domestic wastewater is one type of waste produced from daily human activities in households. The characteristics of this wastewater are very important to understand, because they are directly related to its impact on the environment and public health. Domestic wastewater usually consists of used washing water, food waste and another daily activity axcept toilets, which contain various pollutants, both organic and inorganic (de Zeeuw and Drechsel, 2015).

According to the Regulation of the Minister of Environment and Forestry No. 68 of 2016, domestic wastewater must be treated before being discharged into water bodies to prevent further pollution.

In the context of wastewater management, the physical, chemical, and biological characteristics of domestic wastewater are key parameters that need to be considered. Physical characteristics include color, odor, temperature, and the amount of suspended solids, while chemical characteristics include Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, and nutrient concentrations such as nitrogen and phosphorus. These parameters not only describe the quality of wastewater but also provide an indication of the potential pollution that can be caused if the water is discharged without adequate treatment (Omer, 2019).

The negative impacts of untreated domestic wastewater discharge can be significant. One of the main problems is the decline in water quality in the receiving water body due to reduced dissolved oxygen, which can lead to the death of aquatic organisms. In addition, the presence of hazardous substances such as ammonia can trigger the phenomenon of eutrophication (Akinnawo, 2023), where algae growth becomes uncontrolled and disrupts the balance of the aquatic ecosystem (Dubey and Dutta, 2020). Therefore, a thorough understanding of the characteristics of domestic wastewater is essential for designing an effective treatment system. By understanding its characteristics comprehensively, we can take the necessary steps to ensure that domestic wastewater does not pose a threat to the ecosystem and human health. A review of these characteristics can also support the development of better policies and regulations in water resource management in the future.

MATERIALS AND METHODS

This study uses descriptive analysis to describe the characteristics of domestic wastewater quality based on BOD, COD and TSS parameters. This study will describe each existing parameter. Then the analysis is carried out by collecting various sources of previous research from google scholar based on domestic waste keywords. The results of the analysis regarding the quality of domestic waste are then compared with the domestic waste quality standards P.68/Menlhk-Setjen/2016.

RESULTS AND DISCUSSION

Water Pollution

According to Government Regulation Number 82 of 2001 concerning Water Quality Management and Water Pollution Control and Law No. 23 of 1997 concerning Environmental Management, water pollution is the process of entering water pollution is the entry or introduction of living things, substances, energy and/or other components into water due to human activities resulting in disturbances that cause a decrease in water quality. Water pollution is characterized by physical changes in water including odor, color, and taste (Shomar and Hawari, 2017). Anything that enters a body of water can be said to be a pollutant factor, but this only occurs under certain conditions, such as high concentrations of materials(Goel, 2006).

Water pollution is caused by waste generated from human activities. In this case, the increasing population will be directly proportional to the increasing amount of waste produced. The high amount of pollutants (waste) discharged into water bodies and exceeding the natural capacity to remediate naturally, can cause negative impacts on the environment and human health.

Domestic Wastewater

Domestic wastewater is the type of waste that is most produced by various human activities. Domestic waste can come from households, schools, lodgings, restaurants, offices, markets, and others (Oyelola and Babatunde, 2008). Domestic wastewater is grouped into two groups:

1. Grey water is domestic wastewater that comes from the kitchen and used washing water.

2. Black water is wastewater that comes from toilet waste.

Biological Oxygen Demand (BOD)

Biological Oxygen Demand is the amount of oxygen required by microorganisms such as bacteria to decompose organic matter through biological oxidation by aerobic decomposition. In general, aerobic bacteria need 5 days to decompose organic matter in water. The higher the BOD value, the more oxygen is needed by microorganisms to decompose organic matter. This also indicates that the level of water pollution is increasing (Ntengwe, 2006). In addition, increased BOD in water can also cause a decrease in dissolved oxygen levels so that it can threaten the survival of aquatic organisms.

Chemical Oxygen Demand (COD)

Chemical Oxygen Demand is the amount of oxygen needed to oxidize organic substances in liquids. The higher the COD level in the water body, the higher the organic matter in the liquid waste. A high COD value indicates a large amount of organic matter in the water, which can come from domestic, industrial, or agricultural waste. The higher levels of COD in water can cause a variety of diseases for humans due to the high amounts of organic pollutants, and the large number of microorganisms that are pathogenic and non-pathogenic (Prayoga, 2021). The comparison between COD and BOD values can provide information about the biodegradability of organic matter in a water sample. If the COD value higher than the BOD, then most of the organic matter in the water is difficult to decompose biologically. Comparison The value of BOD and COD ratio is higher than 0.6 then the wastewater can be easily biodegraded directly through biological processes. Meanwhile, less than that up to 0.3 then the wastewater needs to go through a seeding process so that the wastewater can be biologically treated and acclimatization of microorganisms will help in the degradation process of pollutants, but if the BOD/COD ratio is lower than 0.3 then the wastewater is highly non-biodegradable due to high toxicity (Abdalla and Hammam, 2014).

F. Total Suspended Solids (TSS)

Total Suspended Solid (TSS) or total suspended solids are solid particles present in water solutions. These particles are large enough to pass through a 0.45 micrometer pore filter. TSS consists of various materials, both organic and inorganic, such as clay, fine sand, mud, plankton, and other organic materials. The presence of TSS in high amounts can cause turbidity in water, inhibit the penetration of sunlight into the water, and interfere with the process of photosynthesis (Buana et al., 2021). High levels of TSS indicate pollution by solid particles that may come from soil erosion, industrial waste, or domestic waste (Du et al., 2022). In addition, the presence of TSS is related to turbidity. Where the higher the TSS value, the higher the turbidity value (Arafah et al., 2015).

Domestic Waste Quality Standards of Indonesia

Domestic waste quality standards are standards set to regulate waste quality. The existence of domestic waste quality standards will ensure the quality of waste to meet certain criteria before being discharged into water bodies, soil, or the atmosphere, so as to minimize the risk of pollution and damage to the environment. Table 1 is the domestic waste quality standard of Indonesia, based on the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number: P.68/Menlhk-Setjen/2016.

Table 1. Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number: P.68/Menlhk-Setjen/2016 concerning domestic wastewater quality standards

Parameter	Unit	Maximum level*
pH	-	6-9
BOD	mg/L	30
COD	mg/L	100
TSS	mg/L	30

Characteristics of BOD, COD, and TSS in Domestic Wastewater

Table 2 shows previous studies related to the characterization of domestic wastewater based on BOD, COD, and TSS parameters. The characteristics of domestic waste have an average BOD value of 541.9 mg/L, COD 1318.4 mg/L, and TSS 1986.8 mg/L. The highest measurement results of the BOD parameter came from grey water produced by household activities, namely 1791 mg/L, while the lowest measurement results showed a value of 43 mg/L which came from the Coal Mining Employee Mess Environment. The characteristics of the COD parameter in domestic waste ranged from 131 to 9667 mg/L. Identification of several COD measurement results, the highest levels were found in wastewater test samples originating from household waste, namely 1492 mg/L. The TSS parameter in domestic waste has a value ranging from 2 mg/L to 20200 mg/L. The highest measurement results were produced by household activities that blackwater in septic tank.

One example of a household activity that can cause an increase in BOD, COD, and TSS levels in water is washing. Generally, this activity involves detergent in the process. Detergent itself is an organic material that can be decomposed by microorganisms (Merrettig-Bruns and Jelen, 2009). Microorganisms present in waste will reproduce and actively decompose organic materials, thereby increasing oxygen consumption and increasing BOD values. Detergent also contains non-biodegradable compounds that are difficult to decompose naturally (Mousavi and Khodadoost, 2019). When these compounds are not degraded, they will still absorb oxygen when chemically reduced, thereby increasing COD values. In addition, detergents are composed of chemical components in the form of surfactants and tensides that can increase COD values because they are resistant to biological processes and can only be removed through intensive chemical processes. The use of detergents can also increase the concentration of solids that are not soluble in water so that TSS levels will also increase (Rusdianto et al., 2022).

Table 2. Previous research related to the characterization of domestic wastewater based on BOD, COD, and TSS parameters.

No	Title	Measurement Results			Source
		BOD	COD	TSS	
1	Characteristics of Household Wastewater (Grey Water) in a Middle to Upper Class Housing Complex in South Tangerang	125	304	77	(Suoth et al., 2016)
2	Analysis of Domestic Office Wastewater Quality	50	288	66	(Sulistia, Septisya, et al., 2019)
3	Characteristics of Domestic Waste in the Coal Mining Employee Mess Environment	43	135	2	(Fitriyanti, 2020)
4	Analysis of BOD, COD, and TSS Quality of Domestic Wastewater (Grey Water) in Households in Maros Regency 2021	166	344	111	(Natsir et al., 2021)
5	Characterization of Greywater Liquid Waste at Household Level Based on Emission Sources	400	1492	220	(Khotimah et al., 2021)
6	Analysis of Domestic Wastewater Treatment Plant (WWTP) Needs with Variations in the Number of House Connections (5R)	300	500	400	(Novilyansa et al., 2020)
7	Biodegradation of Domestic Waste Using Natural Inoculum from Tanks	1770	293	20200	(Doraja et al., 2012)

Table 2. Previous research related to the characterization of domestic wastewater based on BOD, COD, and TSS parameters.

No	Title	Measurement Results			Source
		BOD	COD	TSS	
8	Treatment of Restaurant Waste with Aerobic Biofilter Process	1319	1995	1564	(Zahra and Purwanti, 2015)
9	Planning Study of Domestic Waste IPAL Permata Tunggulwulung Housing Malang City with Constructed Wetland Technology	113.3	131	141	(Prasetyo et al., 2023)
10	Engineering Domestic Wastewater Treatment with Filtration Combination Method to Lower Water Pollutant Levels	1791	9667	225	(Faradila et al., 2023)
11	Reduction of Pollutant Load in Domestic Waste Using Moving Bed Biofilter Reactor (MBBR)	186	352	400	(Al Kholif, 2018)
12	Reduction of BOD, COD, and TSS Levels in Domestic Wastewater with Constructed Wetland System Using Apu Wood Plant (Pistisia stratiotes L.)	240	320	436	(Tampubolon et al., 2020)

Comparison of Quality Measurement Results with Domestic Waste Quality Standards

Figure 3-5 shows the comparison of domestic effluent quality with the required domestic effluent quality standards including BOD (3), COD (4) and TSS (5) parameters. Based on the results of measuring the quality of domestic waste samples taken from the waste effluent channel. The measurement results show that most of the domestic wastewater quality exceeds the required quality standards. In this case, if domestic waste is directly discharged into water bodies such as gutters, it can have a negative impact on the environment.

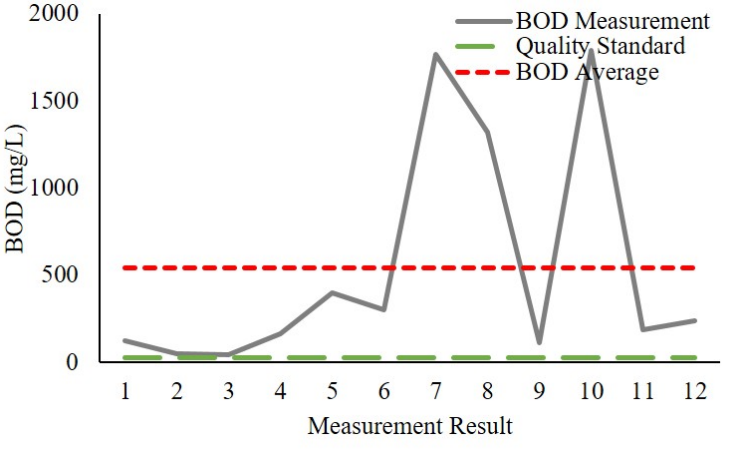

Figure 1.) Results of comparison between measurement values and BOD quality standards

Based on the table above, the ratio between BOD and COD shows 0.4. This indicates that the domestic waste generated requires a seeding process in order to be biologically decomposed. Increased concentrations of BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), and TSS (Total Suspended Solids) in domestic waste can have adverse effects on the environment through a series of interrelated processes. When BOD and COD levels increase, this indicates an excessive accumulation of organic matter and pollutants in the water, resulting in a decrease in dissolved oxygen due to oxygen consumption by microorganisms that decompose the organic matter. This decrease in oxygen has the potential to cause the death of fish and other aquatic organisms, as well as trigger excessive algae growth (eutrophication) that blocks light and damages aquatic ecosystems. In addition, high levels of TSS can block light and disrupt the process of photosynthesis

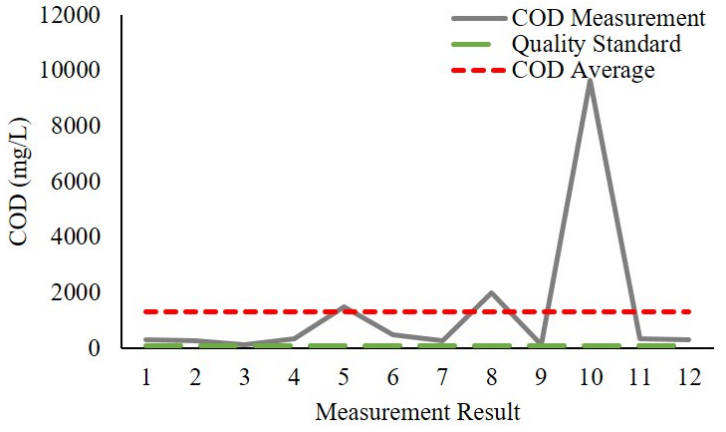

Figure 2. Results of comparison between measurement values and COD quality standards

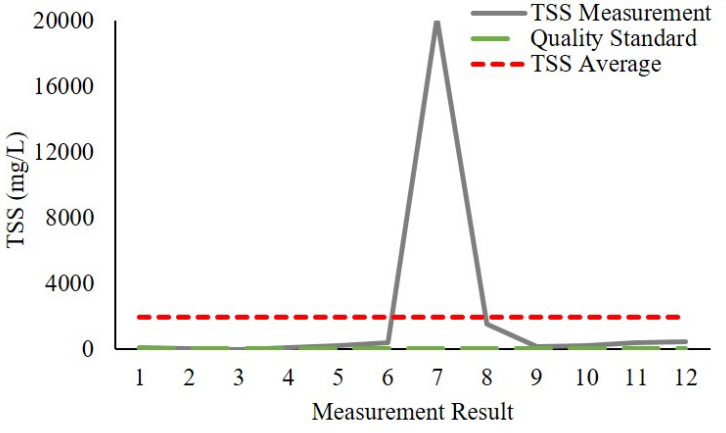

Figure 3. Results of comparison between measurement values and TSS quality standards

in waters, as well as increase sedimentation that damages habitats. As a result, water quality decreases, ecosystem health is disrupted, and the risk of disease spread increases, both for humans and animals.

CONCLUSIONS

Based on the results of the study, most of the domestic wastewater quality has a quality that exceeds the required quality standards. The average quality of domestic wastewater in the parameters of BOD, COD, and TSS is 541.9 mg/L, 1318.4 mg/L, and 1986.8 mg/L, respectively. The BOD/COD ratio shows 0.4, domestic waste must go through the seeds to be decomposed. Discharging domestic effluents directly into water bodies can lead to a decrease in environmental quality due to pollution and cause health issues.

Author contributions

Nur Fadillatur Ro'in, Farah Aini Dahalan: Conceptualization, analysis, draft writing, and editing.

Conflict of Interest

There is no conflict of interest in this study.

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Data availability

Data related to the findings of this study are available at the corresponding author.

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