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# EXAMINATION OF HOUSEHOLD WASTEWATER FROM OFFICES OF THE OIL AND GAS INDUSTRY IN MUDI FIELD, TUBAN INDONESIA

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## ABSTRACT
Office activities in the oil and gas industry in Tuban East Java, produce domestic wastewater. The wastewater is connected to the waters around the offices. It is necessary to test whether the waste water that comes out of the oil and gas industry office meets the processing standards, so that it can be channeled into the river. This study aims to determine the quality of domestic wastewater at the inlet and outlet sections of the oil and gas industry offices in Mudi Field and possible alternative domestic wastewater treatment systems. The research was conducted by taking samples at the inlet and outlet of office domestic waste. The sample was then tested for 7 parameters namely pH, BOD, COD, ammonia, oil and grease, TSS, and total coliform. The parameters used are based on Permen LHK No. 68 of 2016 concerning the quality of domestic wastewater. The results showed that the pH value at the inlet was 7.84 and 7.8 at the outlet. The BOD value at the inlet was 33.65 mg/L and the outlet was 5.73 mg/L. The COD value at the inlet was 55.95 mg/L and the outlet was 28.42 mg/L. The TSS value at the inlet is 13 mg/L and the outlet is 13 mg/L. The value of fats and oils at the inlet is 1.6 mg/L and the outlet is 1.6 mg/L. The ammonia value at the inlet was 1.42 mg/L and the outlet was 5.83 mg/L. The total coliform value at the inlet was 3/100 mL and the outlet was 460/mL. Based on the results of laboratory tests compared to permitted water quality standards, the quality of domestic wastewater at the offices of the oil and gas industry in the Mudi Field still meets the quality standards. Meanwhile, an alternative system for treating domestic wastewater from offices in Mudi Field apart from filtration is a biological method namely using photosynthetic bacteria (PSB).

**Keywords:** Domestic Wastewater, Offices, Oil And Gas Industry, Water Quality, Mudi Field

## 1. INTRODUCTION
The need to research and manage wastewater discharges from industrial operations has become increasingly critical, particularly in the oil and gas sector, due to its potential environmental consequences (Qiao et al., 2023). Operational activities inherent in the oil and gas industry, including those located in the Mudi Field Tuban Indonesia, consistently generate domestic wastewater that requires careful assessment before being released into the surrounding ecosystem (Sabry et al., 2009; Patimah., 2020). Such evaluation is critical to ensure compliance with established treatment standards, thereby reducing potential ecological damage and ensuring the sustainability of water resources (Raman et al., 2016; Emelly et al., 2024). Enforcing strict wastewater management protocols is not only an environmental safeguard but also a cornerstone of responsible industrial practice, aligning operational objectives with ecological preservation. A comprehensive strategy that includes waste minimization, recycling maximization and appropriate

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treatment or disposal methods is essential for oil and gas companies to effectively navigate waste management challenges (Paton & Fletcher, 2008; Patimah 2022).

Furthermore, the integration of advanced technologies and innovative treatment methodologies can significantly improve the efficiency and effectiveness of wastewater treatment processes thereby minimizing the environmental impacts of oil and gas operations (Raman et al., 2016; Merabano et al., 2025). This requires a comprehensive understanding of the composition and characteristics of the wastewater generated, along with the application of appropriate treatment technologies to reduce potential environmental impacts. Proper wastewater management not only maintains water quality but also contributes to the conservation of biodiversity and the overall health of aquatic ecosystems (Patimah et al., 2022).

The extraction and treatment of oil and natural gas at Chuban Regency, East Java, inevitably generates both liquid and solid waste streams, posing major environmental challenges for the surrounding ecosystems. The location of the Mudi Pad B which serves as an office complex for the oil and gas industry. The increasing energy consumption in Indonesia reaching 114 Million Tons of Oil Equivalent, underscores the urgency of diversifying the country's energy mix and mitigating the environmental impacts associated with fossil fuel extraction (Haekal et al., 2020; Patimah et al., 2023). The office complex at Mudi Pad B generates approximately 2.5 cubic meters of domestic wastewater per month, with discharge rates subject to fluctuations. The existing domestic waste capacity at PAD B is 400 $m^3$ with 150 workers. This wastewater originates from various sources within the facility including offices, canteens, toilets, bathrooms, mosques, and general operational activities within the Mudi field. The problem of plastic waste in Indonesia is also an important issue that must be addressed, by managing plastic waste into fuel (Maghfira et al., 2021).

The untreated discharge of domestic wastewater into the river raises concerns about potential ecological damage. The direct release of untreated domestic wastewater into the riverine environment can lead to a reduction in the biodiversity of aquatic organisms, primarily due to the introduction of hazardous and toxic substances (Wijsen, 2021; Patimah, 2020). The waste problems in Indonesia are exacerbated by the over-accumulation of solid waste, where the daily waste production often exceeds the capacity for reduction and processing (Muhammad & Budihardjo, 2019). Indonesia faces significant challenges in waste management particularly in urban areas due to factors such as limited waste management capacity, inadequate infrastructure, inconsistent regulatory enforcement, and a general lack of public awareness regarding waste management issues (Pramiati et al., 2021). One of the critical problems in waste management in cities is the low level of organic waste processing compared to the existing organic waste composition (Muhashiby et al., 2021). Solid waste management is a pressing issue, especially in developing countries like Indonesia, due to population growth, rising living standards, and changing lifestyles (Rosesar & Kristanto, 2020).

Effective waste management strategies are crucial for mitigating environmental pollution and promoting public health, and the implementation of appropriate wastewater treatment technologies is essential to address the challenges associated with domestic wastewater discharge from industrial facilities (Sarasati et al., 2021). To ensure environmental sustainability waste management must be integrated into municipal waste management and economic activities with government support for infrastructure, and human resources training (Satori et al., 2020). Furthermore, the uncontrolled dumping of solid waste has severe environmental consequences including groundwater and soil contamination, air pollution, and the spread of diseases

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highlighting the need for improved waste management practices in Indonesia (Maniatis et al., 1987). Indonesia's contribution to global solid waste is substantial, with a significant portion of waste management practices remaining underdeveloped impacting policy implementation across different regions (Rahman et al., 2020). Therefore, a comprehensive analysis of the domestic wastewater management practices at the Mudi Pad B oil and gas field is warranted to assess the potential environmental impacts and identify opportunities for improvement.

## 2. METHOD

The oil and fueloline enterprise in Tuban, East Java produces family wastewater that`s launched into the surrounding waters (Patimah et al., 2022). To ensure that the wastewater meets the preferred remedy benchmarks while currently being discharged into the waterway, it's far important to evaluate the great of the wastewater on the channel and outlet of the workplace offices (Akhobadze, 2018; Ostoich et al., 2017; Nikuze et al., 2020) This doesn't forget factors to determine the great of family wastewater on the channel and outlet of the oil and fuel line enterprise workplace inside the Mudi Field and to discover optional residential wastewater remedy frameworks that may be connected (Patimah et al., 2022). As within the taking after picture

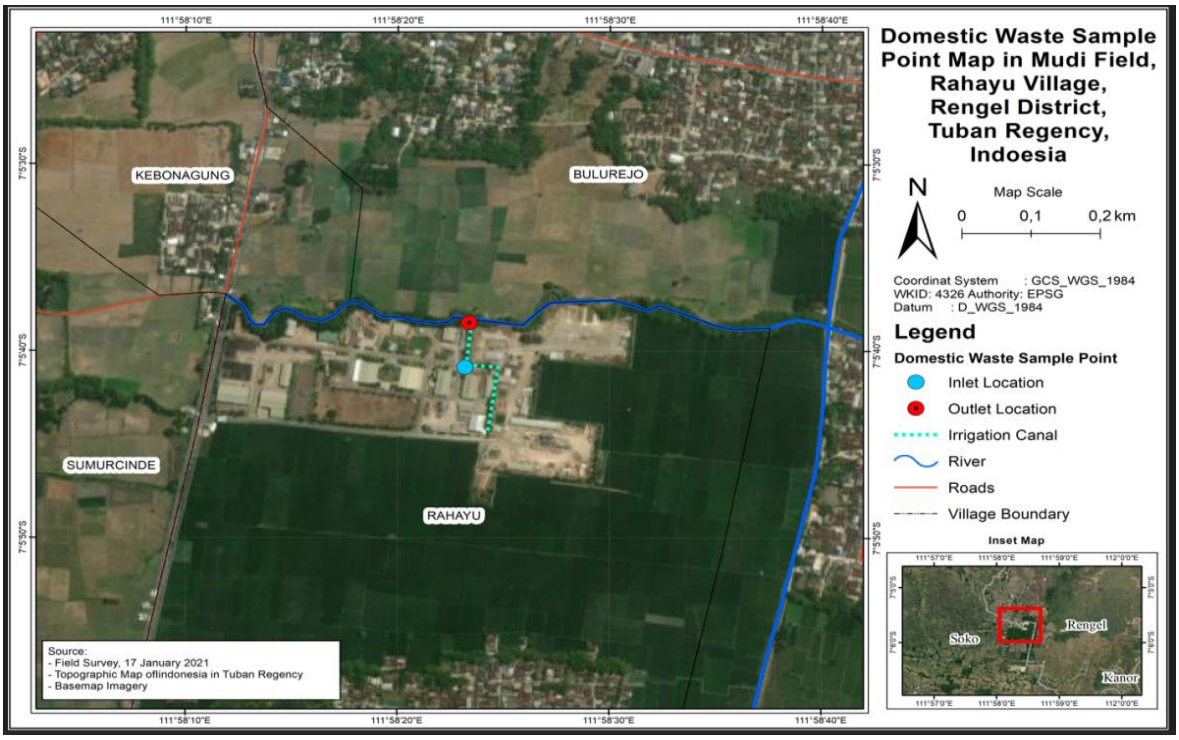


**Figure 1**. Map of Research Locations and Sampling

Wastewater tests were collected from the gulf and outlet of the household wastewater framework and analyzed for seven parameters: pH, Natural Oxygen Request, Chemical Oxygen Request, alkali, oil, and oil, Add up to Suspended Solids, and add up to coliform. The about were at that point compared with the wastewater quality benchmarks stipulated within the Control of the Serve of Environment and Ranger service of the Republic of Indonesia No. 68 of 2016 (Patimah et al.,

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2023). The question of this mindset was testing water tests in Mudi Oil and Gas Field, Tuban, and East Java. Considering the basic quality measures determined by the 2016 Environment and Forestry No. 68 management about alternative measures for domestic wastewater quality in IPAL suitable for wastewater treatment in Mudi Pillow B Oil and Gas Field. Collect information on domestic wastewater parameters and use the information obtained afterward.


**Figure 2**. Comprehensive Assessment of Wastewater Quality

## 3. RESULT AND DISCUSSION

The oil and gas industry in Tuban, East Java produces residential wastewater that's released into the encompassing waters (Patimah et al., 2022). To guarantee that the wastewater meets the specified treatment guidelines sometime recently being discharged into the waterway, it is fundamental to assess the quality of the wastewater at the channel and outlet of the office offices (Patimah et al., 2023). The parameters for testing wastewater tests are based on Permen LHK Number 68 of 2016 concerning household wastewater quality benchmarks comprising chemical and organic parameters can be seen within the taking after figure.

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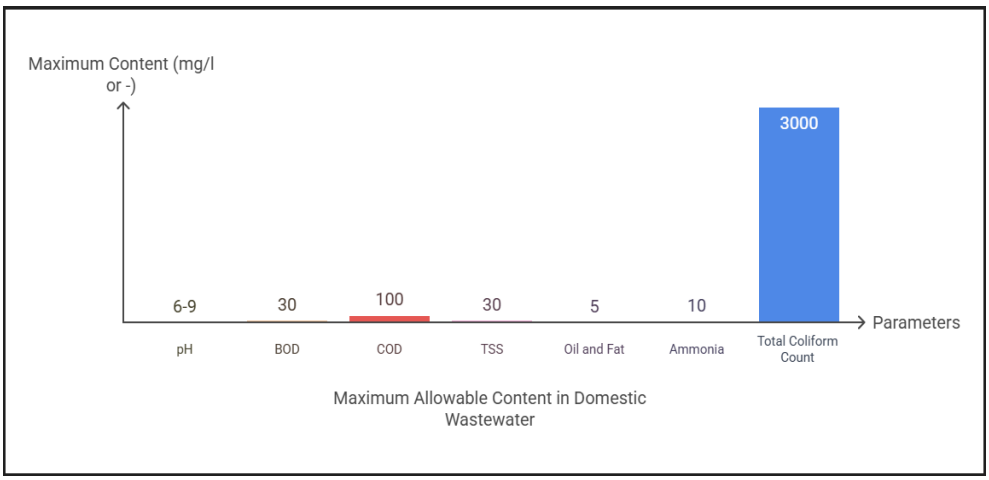


**Figure 3.** Maximum Allowable Content in Domestic Wastewater

The test comes about incorporates chemical and organic parameters utilized for the investigation of residential wastewater quality within the Mudi field office. The parameters tried were pH, BOD, COD, Smelling salts, TSS, Oil, and Fat and Add up to Coliform. The characteristics of residential wastewater within the Mudi Cushion B field were decided by taking tests of household wastewater at the gulf and outlet of the Mudi Cushion B field office. Based on the results of testing household wastewater samples within the research facility.

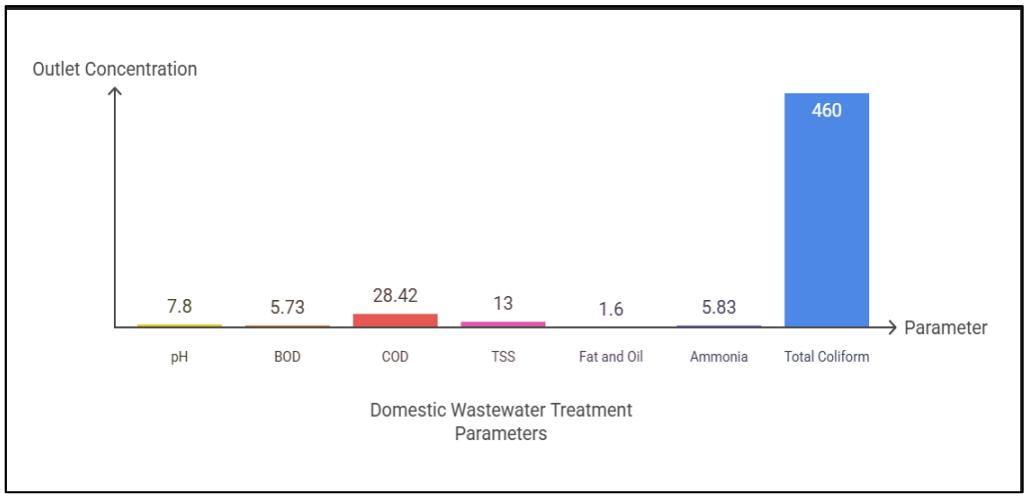


**Figure 4**. Domestic Wastewater Treatment Parameters

Discourse of household wastewater quality measures utilizing physical, inorganic chemical, natural chemical, and natural parameters. Residential wastewater quality standard testing parameters incorporate TSS, pH, BOD5, COD, alkali ($NH_3$), oil and fat, and add up to coliform. The physical parameter utilized is as it were one parameter, specifically adding up to suspended

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strong (TSS). TSS could be strong in water that's gotten or caught when sifted. The buildup is dried at a temperature of 103-105ºC (Granata et al., 2017; Magfhira et al., 2021).

Based on the most extreme TSS standard of wastewater quality guidelines, it is 30 mg/L. The TSS test is performed on the channel and the same information is displayed at 13 mg/L. The estimates of the TSS values for both focuses are still far below the standard estimate. This means that the water condition is still in a larger category. The chemical parameters tried in household squander incorporate pH, BOD, COD, and Alkali ($NH_3$). The pH values from the test come about at the gulf and outlet don't appear a noteworthy contrast. The pH esteem at the channel contains a higher number, which is 7.84, and at the outlet, it is 7.8. The pH esteem allowed agreeing to the quality guidelines for household wastewater is between 6 and 9. This appears that both focuses are in great condition and still meet the quality guidelines. The following parameter is Biological Oxygen Demand (BOD), which measures the oxygen needed for microbial oxidation of wastewater. BOD is typically represented as BOD5, reflecting the measurement taken over 5 days at a temperature of 20°C (Benvenuti et al., 2018; Nikuze et al., 2020; Ostoich et al., 2017). The BOD5 quality standard esteem is 30 mg/L. The test appears to have an esteem at the gulf of 33.65 mg/L and the outlet of 5.73 mg/L.

There is a significant difference between the BOD conditions at the inlet and the outlet. The BOD condition at the inlet is higher and exceeds the quality standard limit because it is influenced by the high organic matter. The high organic matter can be caused by various community activities that occur at the inlet such as washing activities in irrigation water flows or the presence of organic waste carried in the water. The taking after the parameter is chemical oxygen ask (COD), which is the oxidation ready of common compounds in wastewater with chemical courses of action (dichromic destructive) into carbon dioxide and water. The COD testing plan is uncommonly fast, which is around 3 hours with a completion time of around 95% of the entire handle (Benvenuti et al., 2018; Nikuze et al., 2020; Ostoich et al., 2017).

The typical chemical oxygen demand (COD) value in domestic wastewater is reported to be 100 mg/L. The results of the conducted tests reveal that the COD value at the inlet measures 55. 95 mg/L, while the outlet exhibits a value of 28. 42 mg/L. This indicates a reduction in COD from the inlet to the outlet. A lower COD value signifies that less oxygen is required to mitigate the contaminant load. The results obtained at both sampling points fall below the established COD threshold for domestic wastewater, thereby demonstrating compliance with the relevant residential wastewater quality standards. Another important inorganic parameter evaluated is ammonia ($NH_3$). Ammonia quantifies the total amount of ammonia gas released in domestic sewage. It is noted that concentrations of ammonia ($NH_3$) exceeding 0. 5 mg/L are deemed toxic to fish, whereas a concentration of $\leq$ 0. 2 mg/L is considered harmful to sensitive fish species, as stipulated in Government Regulation of the Republic of Indonesia Number 82 of 2001 regarding Water Quality Management and Water Pollution Control. The average concentration of ammonia ($NH_3$) in domestic wastewater is typically around 10 mg/L. The test results indicate that the ammonia ($NH_3$) concentration at the inlet is 1. 42 mg/L and at the outlet is 5. 83 mg/L. The findings at both locations indicate that the ammonia ($NH_3$) levels are within acceptable limits and compliant with the established quality standards for residential wastewater (Miller et al., 2023; Maddah, 2022; Hashim et al., 2021).

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The second parameter of interest is oil and fat, which are categorized under natural chemical standards generally derived from kitchen waste. The typical concentration of oil and fat in household wastewater is established at 5 mg/L. The analytical results for oil and fat measurements conducted at three distinct locations consistently indicated a value of 1.6 mg/L across all sites. Consequently, it can be concluded that all locations comply with the quality standards for oil and fat in household wastewater. The final parameter examined is the complete coliform natural parameter. The total coliform count represents the number of E. coli (Escherichia coli) organisms present in every 100 mL of sample. E. coli typically forms blue colonies when incubated at 37°C for 24 hours. The acceptable quality standard for total coliform in domestic wastewater is 3,000/100 mL. Testing was performed at the inlet, revealing a concentration of 3/100 mL, while the outlet exhibited a concentration of 460/100 mL (Ramli and Ghazi, 2020; Makki and Zghair, 2023).

These come about appear as an esteem that's exceptionally far away from the quality standard so both points meet the full coliform quality standard in agreement with the Control of the Serve of Environment and Ranger Service No. 68 of 2016. It can be concluded that the condition of the residential squanders still meets the quality standard but for the BOD parameter at the channel. This shows that household wastewater is in great condition and there's no wastewater treatment establishment, residential wastewater parameters can still meet the residential wastewater quality standard in understanding the Direction of the Serve of Environment and Ranger service No. 68 of 2016, as can be seen in Fig.

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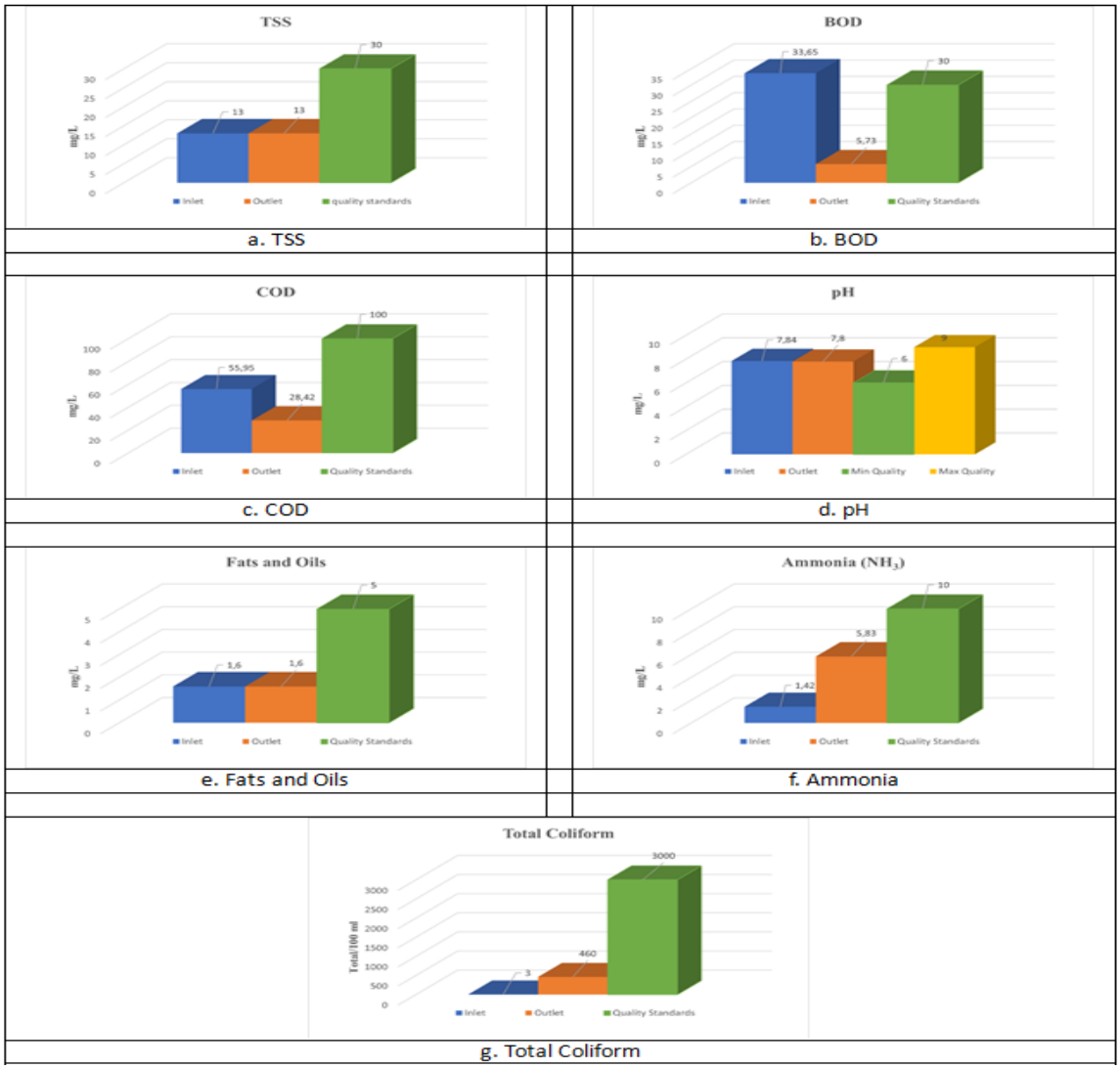


**Figure 5**. Diagram of test results of 7 parameters against a quality standard

Based on Fig 2, the domestic wastewater parameter test compared to the quality standard shows that the value of each parameter is still below the quality standard. Therefore, the processing of domestic wastewater from offices in the oil and gas industry in the Mudi Field is declared safe to be discharged into the river. The results of the study showed that the pH at the inlet was 7.84 and the pH at the outlet was 7.8, indicating that the wastewater was still within the acceptable range. Biological Oxygen Demand at the inlet was 33.65 mg/L and at the outlet was 5.73 mg/L, meeting the standard of 30 mg/L (Akhobadze, 2018; Almanaseer et al., 2020; Negwamba & Dinka, 2019; Sabry et al., 2009).

Chemical Oxygen Demand at the inlet was 55.95 mg/L and at the outlet was 28.42 mg/L, which is also still within the limit of 100 mg/L. Total Suspended Solids of 13 mg/L both at the inlet and

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outlet, were below the standard of 30 mg/L. However, the ammonia levels were 1.42 mg/L at the inlet and 5.83 mg/L at the outlet exceeding the standard of 10 mg/L. In addition the total coliform count was 3/100 mL at the inlet and 460/100 mL at the outlet, exceeding the limit of 3000/100 mL (Patimah et al., 2020). Overall, domestic wastewater from oil and gas industry offices in the Mudi Field mostly meets the required treatment standards, except for ammonia and total coliform levels. To overcome the high levels of ammonia and total coliform, an alternative treatment system can be applied by utilizing photosynthetic bacteria as an addition to the existing filtration system (Paul & Banerjee, 2022).

Viable squander administration could be a ceaseless handle of overseeing the squander delivered as well as conceivable to diminish natural impacts (Zorpas, 2020). Household wastewater treatment from workplaces within the Mudi Oil and Gas Field employments the filtration strategy. The filtration strategy may be a basic residential wastewater treatment strategy that has been connected on a small scale or family. This filtration method can reduce the concentrations of COD, BOD and TSS in household wastewater before it is discharged into the river. A simple filtration method can be developed using sand, rendering it more environmentally friendly. Filtration using sand can lower TSS by 93%, reduce COD by 87%, and increase coliform by 93% (Alsar et al., 2022; Razali 2023; Cescon & Jiang, 2020).

Continuous sand filtration is an effective method for reducing total suspended solids (TSS), total dissolved solids (TDS), chemical oxygen demand (COD), and biological oxygen demand (BOD) in wastewater thereby ensuring that the water meets the standards for agricultural irrigation. This technique can be employed for direct wastewater filtration in the field. In addition to filtration methods, the use of photosynthetic bacteria (PSB) presents another relatively straightforward approach to waste treatment. PSB has proven to be highly effective in degrading pollutants in wastewater and can even enhance its value for agricultural applications. Research indicates that the use of PSB can reduce the COD of domestic wastewater to levels below 80 mg/l (Razali et al., 2023; Alsar, 2022; Patimah et al., 2023). Furthermore, various simple and cost effective wastewater treatment methods can serve as alternatives for treating domestic wastewater which typically does not require complex processes due to the relatively low concentration of contaminants.

## 4. CONCLUSION

Investigation of residential wastewater quality within the Mudi Tuban Oil and Gas Field, East Java was carried out with 7 parameters concurring with the Direction of the Serve of Environment and Ranger service No. 68 of 2016 which incorporate pH, BOD, COD, TSS, Smelling salts, oil and fat and Add up to Coliform. Based on the 7 parameters that have been tried, it appears that the quality of residential wastewater streaming into the river from workplaces within the oil and gas industry within the Mudi Field still meets the quality standard. The watched increment in smelling salts and adding up to coliform levels at the outlet requires advanced examination and potential optimization of the processing preparation. Besides, an elective residential wastewater treatment framework from workplaces within the Mudi Field other than filtration is the organic strategy to be specific by utilizing photosynthetic microscopic organisms (PSB).

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