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Sustainable Operation Management in Seawage Treatment Plant by Utilizing Vegetative Bacteria

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Abstract

Sustainability management in industrial operations is essential to minimize environmental negative impacts. In the context of industrial wastewater management, one aspect that needs attention is the reduction of ammonia levels in wastewater. This study aimed to identify the effectiveness of using vegetative bacteria in reducing ammonia levels in industrial wastewater. This study used an experimental research method. Data collection techniques were carried out by literature study and field observation. The collected data were statistically analyzed to evaluate the effect of using vegetative bacteria on ammonia levels. The results showed that the use of Free Flow bacteria was effectively used to reduce ammonia levels in WWTP wastewater in the experiment in tank 3 (sample from the aeration tank), Free Flow bacteria can adapt well to wastewater that has been aerated which has existing bacteria. This can be seen in the TSS, COD and Ammonia parameters which have decreased. Ammonia reduction up to 95% and COD reduction up to 85%, and TSS reduced by more than 80%. This method can be an alternative in achieving the sustainability of WWTP operational management.

Keywords: *Management Operations, Shu and Pressure, Vegetative Bacteria, Ammonia.*

INTRODUCTION

Wastewater is a waste liquid from households, industries, and other public places and usually contains materials or substances that can endanger human life and disturb environmental sustainability (Wahyudi, 2022). In wastewater there is an Ammonia compound, a chemical compound with the formula NH3 which is an indicator of air pollution in the form of odor. Ammonia gas is a colorless gas with a pungent odor, usually ammonia comes from microbial activity, the ammonia industry, waste treatment and coal processing. Ammonia in the atmosphere will react with nitrate and sulfate to form highly corrosive ammonium salts (Putra et all, 2021). The high concentration of ammonia in wastewater is a serious problem because it can adversely affect the aquatic ecosystem and threaten the survival of aquatic organisms.

High ammonia in wastewater can threaten aquatic organisms directly. Aquatic organisms, such as fish, shrimp, and other organisms, are highly susceptible to high ammonia levels. (Sumantri & Cordova, 2011) Ammonia can damage their respiratory system and affect normal growth and development. Therefore, there is a need to address this environmental sustainability management to maintain the sustainability of aquatic ecosystems and protect aquatic organisms, the reduction of ammonia levels in the outlet of wastewater sources is an urgent need in environmental management and wastewater treatment.

An approach that can be used to overcome these problems is to utilize vegetative bacteria. Vegetative bacteria is a term used to describe the general shape of bacteria when they are in the active growth and reproduction phase. In this phase, bacteria are usually spherical or rod-

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shaped, and they perform all cellular activities necessary for survival and reproduction (Fifendy, 2017). Vegetative bacteria have the potential to play a role in breaking down ammonia (NH3) into safer compounds such as nitrate (NO3-) and nitrite (NO2-), as well as other organic compounds that can be used by other organisms in the food chain. This process is known as nitrification, where ammonia is converted to nitrite and further to nitrate by nitrifying bacteria (Lestantun et all, 2021). This study aimed to identify the effectiveness of using vegetative bacteria in reducing ammonia levels in industrial wastewater.

LITERATURE REVIEW

STP

STP stands for "Standard Temperature and Pressure". STP is a reference condition used in chemistry and physics to measure and compare gas properties (Suhami, 2020). STP conditions are defined as follows:

1. Temperature: 0 degrees Celsius (0°C) or 273.15 Kelvin (K).
2. Pressure: 1 atmosphere (atm) or 101.3 kilopascals (kPa).

At STP conditions, 1 mole of ideal gas will occupy a volume of about 22.4 liters. This is the basis for many calculations in chemistry and physics, including stoichiometry and gas mass ratio calculations. When people refer to STP conditions, they are usually referring to specific temperature and pressure parameters that are used as standard references in various scientific experiments and calculations.

Vegetative Bacteria

Vegetative bacteria are the common form of bacteria that are active and growing. In this phase, bacteria live their daily lives, performing various cell functions such as metabolism, reproduction, and growth (Lestari & Hartati, 2017). Vegetative bacteria have diverse cell shapes, and they can move, divide, and perform various biological activities. This vegetative phase is different from the sporulation phase, in which some types of bacteria form descent-resistant structures called spores to protect themselves from unfavorable environmental conditions. When conditions become more favorable, the spores can develop into vegetative bacteria again (Warani et all, 2022).

Ammonia

Ammonia (NH3) is a chemical compound consisting of one nitrogen atom (N) and three hydrogen atoms (H). This compound has a sharp odor and gas characteristics at room temperature, but can become a liquid or solid at lower temperatures and higher pressures. Ammonia is widely used in various industries, including the chemical, agricultural, and food processing industries (Sari & Prayudyaningsih, 2015). Some of the main uses of ammonia include as fertilizer, cleaning chemicals, refrigerants in cooling systems, as well as raw materials in the manufacture of various chemical products such as plastics and pharmaceuticals. Ammonia can also be a hazardous substance if exposed to high concentrations or if used without proper safety measures as it can cause eye, nose, and throat irritation, and is potentially harmful if inhaled in large quantities (Sumama et all, 2018). Therefore, the use and handling of ammonia must be done carefully in accordance with applicable safety guidelines.

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METHODS

This research uses the experimental method. Experimental research is research conducted with a scientific approach using two sets of variables. The first set acts as a constant, which you use to measure differences from the second set. Quantitative research methods, for example, are experimental (Kurniawan, 2021). The current conditions of the seawater treatment plant are as follows:

1. The incoming wastewater volume is about 10-20 m^3 per day.
2. The air tank capacity is about 65 m^3 per day.
3. The COD concentration in the incoming wastewater is 599 ppm.
4. After the aeration process, the COD concentration becomes 228 ppm.
5. The BOD concentration in the outgoing wastewater ranges from 20-25 ppm, with a standard limitation of less than 30 ppm.
6. The ammonia concentration in the wastewater exceeds 15 ppm, with an incoming concentration of 21 ppm and after the aeration process to 13 ppm. The standard set is less than 10 ppm.

An experimental trial was conducted by adapting an aeration sample into a new environment, assuming that the bacteria present performed similarly to those in the field. On the first day, 6 L of wastewater from the aeration basin was put into the three basins, then filled with 2 L of inlet waste in basins 1, 2, and 3. Every day, a dose of 0.125 ppm of Free Flow bacteria that had been activated for 24 hours was put into basins 2 and 3, continuously until the COD and ammonia values dropped or reached the predetermined standard. Testing of these parameters was conducted using methods and equipment provided by HACH Instrument.

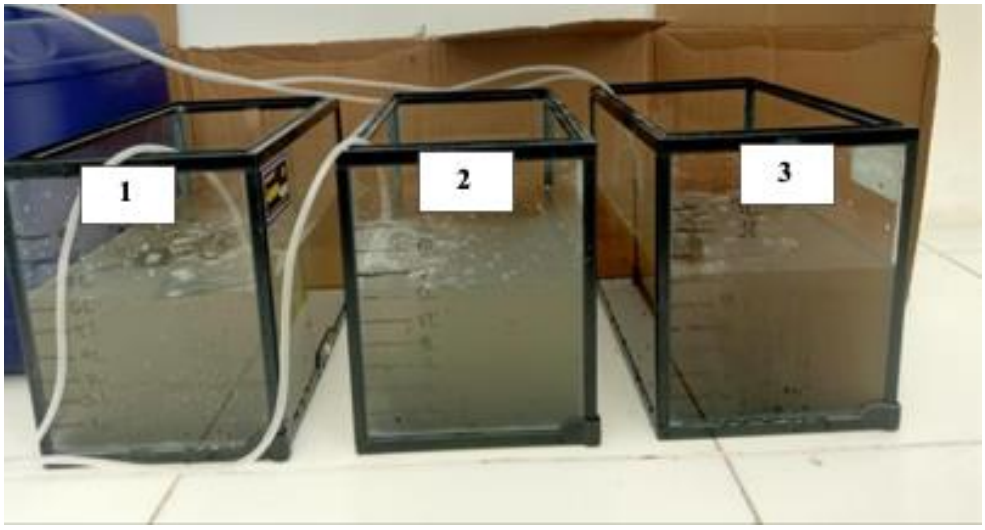

Figure 1: Experimenting with vegetative bacteria to reduce ammonia levels

Description:

Tank 1: Inlet without Free Flow Bacteria

Tank 2: Inlet with Free Flow Bacteria

Tank 3: Aeration with Free Flow Bacteria

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RESULTS

Parameters such as pH, TSS (Total Suspended Solids), NH3-N (Ammonia Nitrogen), COD (Chemical Oxygen Demand), and conductivity are parameters used in water quality analysis. These parameters provide important information about the condition of water in a particular location or water system, here are the results of the analysis in this study:

Table 1: Results of parameter analysis of pH, TSS, NH3-N, COD and Conductivity

Parameters						
Date	**Samples**	**pH (6 – 9)**	**TSS (mg/L) (<30 mg/L)**	**NH3-N (mg/L) (<10 mg/L)**	**COD (mg/L) (<100mg/L)**	**Conductivity (µS/cm)**
14/08/2023	Activation Bacteria Free Flow for Tank 2 &3					
15/08/2023	Inlet	6.07	94	21	599	612
	Aerasi	7.53	40	13	228	584
16/08/2023	Tank 1	7.77	83	18	544	607
	Tank 2	7.77	71	11	307	606
	Tank 3	7.34	32	5	146	593
17/08/2023	Tank 1	7.63	78	15	402	615
	Tank 2	7.68	55	6	220	620
	Tank 3	7.41	27	2	123	575
18/08/2023	Tank 1	7.63	71	11	374	611
	Tank 2	7.60	46	3	138	608
	Tank 3	7.45	22	1	105	590
19/08/2023	Tank 1	7.56	68	9	333	608
	Tank 2	7.59	37	1	112	610
	Tank 3	7.43	18	1	91	588
20/08/2023	Tank 1	6.07	94	21	599	612
	Tank 2	7.53	40	13	228	584
	Tank 3	7.77	83	18	544	607

Limit of PermenLKH-RI-No. P68-Menlhk-Setjen-2016

PH

pH is a measure of the level of acidity or basicity in water. The pH value of the initial inlet sample was 6.07, which is a slightly acidic value. To change it to a neutral to slightly alkaline condition (7-8), NaOH (Sodium Hydroxide) was used. This is done to prevent an overly acidic atmosphere in the wastewater.

TSS (Total Suspended Solids)

TSS measures the total amount of solids suspended in water. The analysis showed that the TSS value in all three tanks decreased. This decrease is faster in tanks that use Free Flow bacteria than those that do not use it. In Tank 2 there was a decrease of 60.63%, while in Tank 3 the decrease reached 80.85%, and in Tank 1 only about 27.66%. The decrease in TSS is a sign that the water treatment process is running well.

Ammonia (NH3-N)

NH3-N measures the concentration of ammonia in water. Like TSS, NH3-N values also decreased in all three basins.

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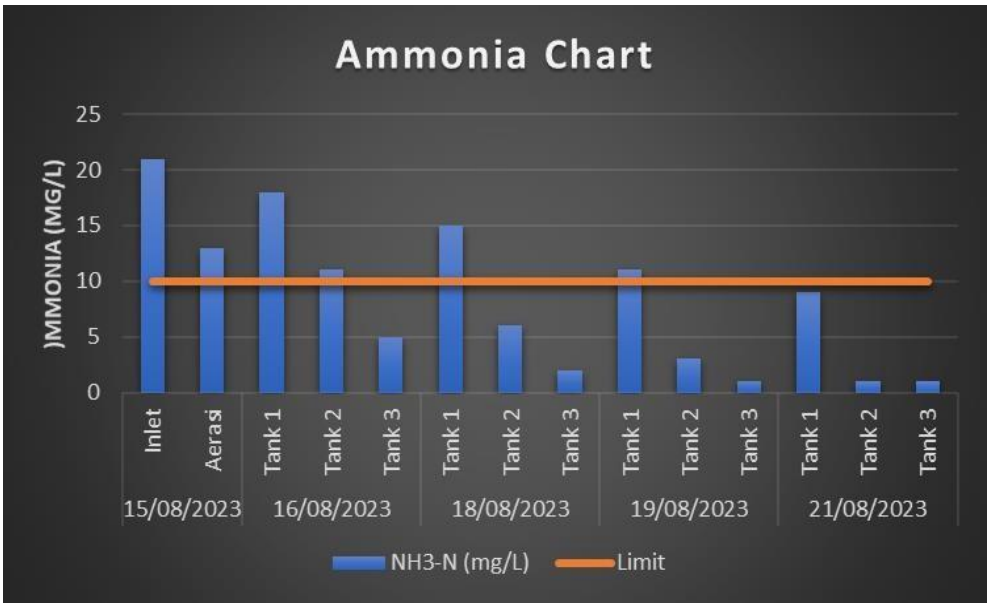

Figure 2: Ammonia Chart

The decline was faster in tanks that used Free Flow bacteria. In tanks 2 and 3, the reduction reached more than 90% (95.23%); in tank 1, it was only about 50% (57.14%). The decrease in NH3-N is good because ammonia can be a harmful pollutant in water.

COD (Chemical Oxygen Demand)

COD measures the amount of organic compounds that require oxygen to oxidize in water. Like TSS and NH3-N, COD values also decreased in all three basins. The decrease was faster in the basin that used Free Flow bacteria.

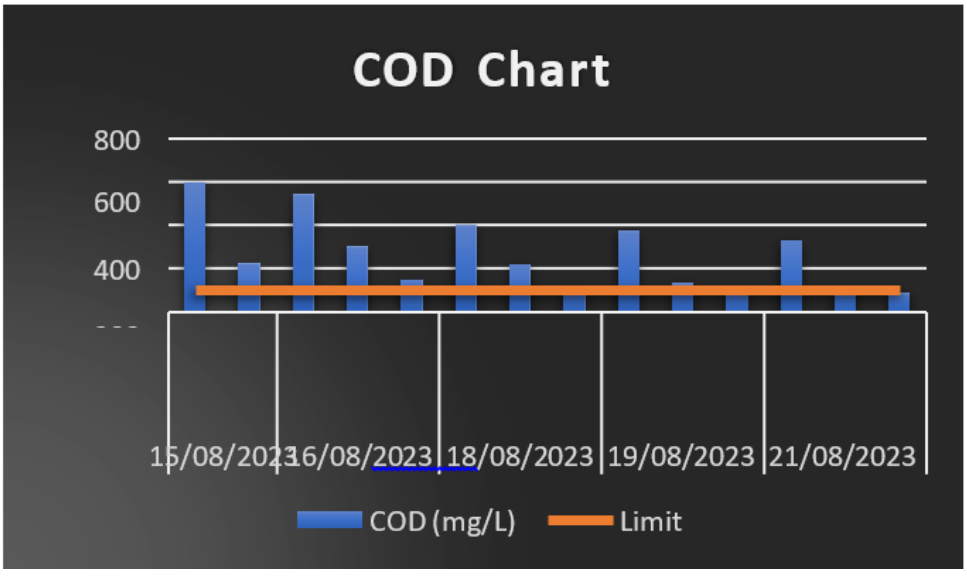

Figure 3: COD Chart

In tanks 2 and 3, the decrease reached more than 80% (81.30% for tank 2 and 84.81% for tank 3); in tank 1, it was only around 40% (44.41%). The decrease in COD indicates that the organic compounds in the water have been well oxidized during the treatment process.

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DISCUSSION

The use of Free Flow bacteria in reducing ammonia levels in WWTP (Wastewater Treatment Plant) wastewater in the experiment in Tank 3 (sample from the aeration tank) proved to be effective.

Some of the reasons for this effectiveness can be described as follows:

1. Adaptation to the Environment

Free Flow bacteria seem to have adapted well to the oxidized wastewater conditions in the Aeration Tank. This means that they have been able to grow and thrive in an oxygenated environment, as well as compete with other bacteria that may be present in the wastewater. This adaptability is important in ensuring that Free Flow bacteria can play an effective role in decomposing ammonia in wastewater.

2. Ammonia Biodegradation Efficiency

Free Flow bacteria seem to be very efficient in biodegrading ammonia in wastewater. This can be seen from the more than 90% (95.23%) reduction in ammonia levels in the tank. The ability of these bacteria to convert ammonia into safer compounds or even into elemental nitrogen present in the air is an important factor in reducing ammonia pollution in wastewater.

3. Use of Additive Bacteria

Free Flow bacteria may also have been added as a supplement to enhance the WWTP's ability to treat wastewater. These additive bacteria can help in addressing specific issues, such as the reduction of ammonia levels, and optimizing the performance of the WWTP.

4. Monitoring and Control

The wastewater treatment process involves good monitoring and control of bacterial activity. This includes the regulation of parameters such as dissolved oxygen, pH, temperature, and others that affect bacterial growth and activity. By setting these parameters appropriately, the use of Free Flow bacteria can be optimized.

Overall, the use of Free Flow bacteria in oxidized conditions such as Aeration Tanks in WWTPs has been proven to be effective in reducing ammonia levels in wastewater, which is an important step in the overall wastewater treatment process.

CONCLUSION

Observation results for 5 days show that the use of Free Flow bacteria effectively reduces ammonia levels in WWTP wastewater in tank 3, a sample from the aeration tank. Free Flow bacteria are able to adapt well to wastewater that has been aerated and has previous bacteria. This can be observed from significant changes in TSS (Total Suspended Solids), COD (Chemical Oxygen Demand), and ammonia levels.

Ammonia levels decreased by 95%, COD decreased by about 85%, and TSS decreased by more than 80%. These results show that the method of using Free Flow bacteria can be an effective alternative in achieving sustainability in the management of WWTP operations. With its ability to reduce ammonia levels and other parameters, this method can potentially reduce the negative impact of industrial waste on the environment and maintain the quality of wastewater discharged into waters, supporting the principles of sustainability in natural resource management.

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