

EFFECT OF pH ON DOMESTIC WASTEWATER TREATMENT EFFICIENCY WITH BIOFILTER MEDIA PLASTIC MINERAL WATER BOTTLE CAP

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ABSTRACT

Effect of pH on Domestic Wastewater Treatment Efficiency with Biofilter Media Plastic Mineral Water Bottle Cap.

Domestic wastewater can be defined as water that comes from human activities and contains various types of harmful pollutants, such as TSS. Direct discharge of these pollutants into water-receiving bodies can cause pollution of aquatic ecosystems. Therefore, it must be treated to meet the appropriate air quality standards before being discharged to the air-receiving body. This study aims to determine the effect of pH on the efficiency of domestic wastewater treatment using mineral water plastic bottle caps with an anaerobic biofilter method. The study was conducted using an experimental method in two anaerobic biofilter reactors, with variations in the number of treatments of 100 and 300 bottles of bottle cap media and contact times for 0 days and 4 days, respectively. Anaerobic biofilter research results show that pH influences the efficiency of domestic wastewater treatment with mineral water plastic bottle caps in accordance with quality standards. The optimum pollutant removal value was found at a contact time of 4 days, which was 46% on 300 pieces of media. The use of a biofilter with a plastic bottle cap media can be an alternative to treating organic wastewater that has a low load, such as household wastewater. Further research can be done by adding more pores in the bottle cap media to improve the performance of the biofilter, as well as increasing the contact time variation treatment and the amount of bottle cap media used.

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INTRODUCTION

All human activities produce waste. A small amount of waste does not pose a problem, but if it accumulates in large quantities, it can lead to pollution and imbalance the environment. Wastewater can be easily defined as water that comes from human activities and contains a variety of immediate and long-term dangerous contaminants. Liquid waste can be divided into domestic and industrial waste based on its source, while the contaminants contained in waste can be divided into organic and inorganic contaminants and are usually dissolved or in suspended form [1].

According to Minister of Environment Regulation No. 68/2016, domestic wastewater quality standards consist of TSS, pH, fat, total ammonia, BOD, and total coliform, and if all of these parameters are directly discharged into the receiving water body, it will cause water pollution. Therefore, it must first be processed so that it meets good water quality standards

before being discharged into the receiving water body. Most domestic wastewater contains organic materials, making it easier to manage. Domestic wastewater treatment usually uses biological treatment methods that utilize microbial activity to decompose organic pollutant compounds in wastewater. There are several ways to process waste that are environmentally friendly and efficient, one of which is processing waste with biofilm using a biofilter system [2]. This biofilter system can be used for domestic waste processing and has been proven to be effective in reducing the contaminant load of wastewater quality parameters [3].

The biofilter process's effectiveness in applications is greatly influenced by the type and form of media used. It is important to know that the purpose of biofilter media is to provide a surface for bacteria and microorganisms to colonize [4]. The commonly used biofilter media are made from non-corrosive materials that are resistant to decay and chemical degradation, such as ceramic ring media, Kaldnes media, bioball media, honeycomb media, crystal biomedial, and so on. One alternative biofilter medium that can be used is plastic bottle caps for mineral water. Plastic mineral water bottle cap media, known for its small diameter and durability, is made of plastic and features a surface that allows for easy expansion through the addition of pores in the form of holes. Apart from the type and form of media, the pH condition of wastewater is also very important to support the life of microorganisms, which will reduce pollutants. The type of biofilter used in this research is an anaerobic biofilter. Plastic bottle caps are used as a medium for growing and developing biofilm-forming microorganisms (attached growth). If there is a biofilm layer on top of the media, it will break down organic pollutants into CO₂ and H₂O. Wastewater treatment with the biofilm process has several advantages. Easy to operate, produces little sludge, is resistant to fluctuations in waste volume and concentration, and has excellent suspended solids removal capabilities with low nutrient requirements. The methane gas produced can be used as an energy source [5].

The goal of this study is to examine the effect of pH on reducing TTS levels in domestic wastewater using a biofilter process with plastic mineral water bottle caps as a medium.

MATERIALS AND RESEARCH METHODS

This type of research employs a randomized complete block design and is pure experimentation. The research focused on domestic wastewater from a household in the Sungai Besar sub-district of Banjarbaru City, using the grab sampling method. The biofilter variations employed in the study included a control group that did not use bottle cap media, as well as groups of 100 and 300 bottle caps. The duration of media contact was 0 days and 4 days, with 9 replications carried out. Data on TSS levels, pH, and temperature will be measured before and after treatment and analyzed using the two-way Anova test.

Before the bottle cap media is used in the biofilter reactor, it must go through a seeding process using household wastewater to grow biofilm-forming bacteria for two weeks. After the biofilm is formed, the media is then put into the reactor, and waste water is added, which has been taken using the grab sampling method. In the first day variation, which lasts for 0 days, the waste flows directly through the media in the biofilm reactor. Next, for the second-day variation, the waste water will be left for 4 days.

The work procedure for examining TSS pollutants (SNI. 06.6989.3.2004) requires tools such as glass beakers, Erlenmeyer glasses, volume pipettes, ovens, desiccators, pH meters, thermometers, analytical scales, glass funnels, gooch cups, and sample bottles. The materials needed are filter paper and distilled water. The process begins by drying the filter paper used in an oven and stabilizing the weight of the filter paper using a desiccator while continuing to weigh it using an analytical balance. Prepare the waste water to be examined, and stir the sample until it is homogeneous. Prepare a glass funnel, Erlenmeyer glass, and filter paper that has previously been dried. The sample is pipetted with a certain volume, poured into a funnel

that has been lined with filter paper with the same volume for each examination (100 ml), and left to wait for the waste water to be completely filtered into the Erlenmeyer glass. Carefully remove the filter paper from the filter apparatus and transfer it to a Gooch cup. Dry the filter paper in the oven at 103–105 °C for at least 1 hour, cool in a desiccator to balance the temperature, and weigh. The drying, cooling in a desiccator, and weighing stages are repeated until a constant weight is obtained or the weight change is less than 4% or less than 0.5 mg from the previous weighing.

RESULTS OF RESEARCH AND DISCUSSION

Laboratory examination results showed that TSS pollutant levels had decreased after processing with a biofilter process using plastic mineral water bottle caps. The average TSS level at 0 days with the addition of 0, 100, and 300 bottles of media was 55.17 mg/l, 46 mg/l, and 30 mg/l, respectively. The average TSS level on 4 days with the addition of 0, 100, and 300 bottles of media was 46.06 mg/l, 36.01 mg/l, and 24.91 mg/l. Before treatment, the average pH level was 6.5, and after treatment, the 0-day variation of 100 fruit and 300 fruit media had the same pH, namely 6. The average pH level for the 4-day variation without media (0 fruit), 100 fruit, and 300 fruits has a pH of 6.2, 5.5, and 5.5.

Table 1. Average percentage reduction in TSS and pH levels
in Domestic Wastewater

Contact Time	TSS levels before Treatment (mg/l)	Media Variations	pH	TSS levels After Treatment (mg/l)	Percentage reduction after treatment (%)
0 days	55.17	0	6.5	55.17	0
		100	6	46	17%
		300	6	30	45%
4 days	46.06	0	6.2	46.06	0
		100	5.5	36.01	22%
		300	5.5	24.91	46%

Table 1 shows that the average pH in trials without media was 6.5. In the variation of 100 fruit with a contact time of 0 days, the average was 6, and in treatment B1, 300 fruit with a contact time of 0 days, the average was 6. In the control variation with a contact time of 4 days, the average was 6.2; in the treatment of 100 fruit with a contact time of 4 days, the average was 5.5; and in the treatment of 300 fruit with a contact time of 4 days, the average was 5.5. From these results, we can conclude that some pH results align with quality standards, while others do not, indicating that pH is a parameter that can disrupt the biofilter process by bacteria [6]. The three stages of the anaerobic degradation process of organic compounds are as follows: In the hydrolysis process, a group of saprophytic bacteria break down complex organic materials. Activity occurs because insoluble organic substances such as polysaccharides, fats, proteins, and carbohydrates are consumed by saprophilic bacteria, where extracellular enzymes convert them into water-soluble organic substances. The second is the acidification process (acidogenesis). At this stage, acidogenic bacteria convert dissolved organic material into short-chain organic acids such as acetic acid, butyric acid, amino acids, and propionic acid. At this stage, the breakdown of organic compounds like glucose from carbohydrates into volatile acids significantly lowers the pH of the wastewater. The third stage is the methanogenic process, in which methanogenic bacteria convert volatile organic acids into carbon dioxide (CO₂) and methane gas (CH₄). At this stage, the waste water will produce a smelly gas [7].

Based on the analysis that has been carried out for wastewater conditions with a contact time of 4 days, there is a decrease in TSS levels even though the pH conditions are not at optimum levels. The longer the contact time of liquid waste with biomass or microorganisms, the more organic substances will be removed [8]. In addition, the deposition of suspended particles in wastewater can contribute to the decrease in TSS levels, as the anaerobic biofilter reactor, which is primarily a downflow reactor, does not operate continuously [9]. Waste water must continue to flow so that microorganisms can continue to receive the food supply contained in the waste water [10].

Variations in pH parameters on the 4th day of treatment have the potential to become a nuisance parameter. Variations in pH below the quality standard on the 4th day of treatment can impact the biofilter process, as it relies on the performance of bacteria to break down organic compounds, necessitating optimum pH parameter conditions (6–9). On the fourth day of treatment, if the pH is optimally controlled, it can increase the reduction in TSS levels and produce better results.

CONCLUSIONS AND RECOMMENDATIONS

Anaerobic biofilters with plastic mineral water bottle caps can be used as an alternative for domestic wastewater treatment. The average percentage efficiency of reducing TSS levels in domestic wastewater for variations in contact time of 0 days with variations in the number of bottle cap media of 100 and 300 is 17% and 45%, respectively. With variations in contact time of 4 days and variations in the number of media for bottle caps of 100 and 300, it was 22% and 46%. During variations in the contact time of 4 days, the pH decreased below optimum conditions and was below the quality standard. This was due to the process of bacteria breaking down organic substances into volatile acids, which negatively impacted the biofilter's performance.

Adding a chamber to the aeration process is one way for other researchers to keep working on biofilters made from plastic mineral water bottle caps to lower TSS levels using anaerobic methods. It is very important to keep the pH levels stable so that they are always at the best level for the growth of bacteria.

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