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Effectiveness and Adaptability of Water Hyacinth (*Eichornia Crassipes*) Mart. Solm in its Role in Reducing COD and BOD Levels in Petroleum Liquid Waste

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ABSTRACT

This study aimed to determine the effectiveness and ability of water hyacinth (*Eichornia crassipes Mart. Solm*) in reducing the COD and BOD levels in petroleum liquid waste. Petroleum liquid waste is one type of waste that pollutes the environment if it is not treated first. In this study, the biological treatment techniques were carried out using the phytoremediation techniques. Phytoremediation is an effort to reduce and improve the quality of waste by using plant agents so that the levels of pollutants contained in the waste can be reduced. The phytoremediation techniques are carried out using a simple bioreactor with various concentrations of petroleum liquid waste, namely control (0% waste), 10% waste, 20% waste, and 30% waste. The results of this study showed that the water hyacinth plant was able to tolerate liquid petroleum waste, which was indicated by the water hyacinth plant being able to survive up to a concentration of 30% for approximately 2 months. On the basis of the measurement of BOD and COD of petroleum liquid waste before phytoremediation was carried out, it was 20 mg/l and 10.04 mg/l, respectively. At 10% effluent concentration, the BOD and COD values decreased to 4.11 mg/l and 14.7 mg/l, respectively. At 20% effluent concentration, the BOD and COD values also showed a decrease to 3.73 mg/l and 9.14 mg/l, respectively. At 30% effluent concentration, the BOD and COD values showed a decrease to 3.73 mg/l and 1.22 mg/l, respectively. The ability of the water hyacinth plant to reduce the BOD and COD values can show its effectiveness to be used as a phytoremediation agent for petroleum waste.

Keywords: COD, BOD, phytoremediation.

INTRODUCTION

The method of processing crude oil into petroleum products is carried out in oil refineries. Petroleum refineries exist in various companies that process crude oil into several products based on their fractions. The activities carried out include exploration and exploitation of petroleum. The scope of exploitation is starting from evaluating the reservoir content, taking oil from the bowels of the Earth to producing it into various products that can be used by the community as a transportation fuel. On the basis of the activities carried out, it will produce by-products in the form of various kinds of waste consisting of liquid, solid, and gas waste (Igirisa et al., 2016). The resulting liquid waste comes from the separation of crude oil and water. Crude oil is usually stored in tanks and wastewater is stored in holding ponds. However, if the waste enters water bodies or land, it will cause very serious pollution to the environment. The waste generated must be processed first; thus, the components of the waste that pollute the environment can be reduced or eliminated and the negative impact caused by the presence of waste can be minimized (Nurhayati, 2010). Oil and gas exploration and production will generate waste in the form of solids, gases and liquids where 80% of the waste is liquid waste. Liquid waste comes from produced water which is one of the largest

by-products of processing oil and natural gas (oil and gas). The characteristics of produced water will vary according to the source, field conditions, chemicals used in the petroleum production process, and the depth of the reservoir, but the characteristics of produced water will not differ much when compared to oil or natural gas produced.

Crude oil has a chemical component or composition, which when it is polluted or spilled into the sea, will cause changes both chemically and physically. Among these changes, there will be dispersion, formation of layers, evaporation, polymerization, the occurrence of emulsions and the formation of clumps. The changes that occur are driven by the movement of wind waves, currents and tension from the surface. The content of hydrocarbons in water is volatile and when dissolved in water it will form a thick layer (Yulia *at al.,* 2012). Water hyacinth (*Eichhornia crassipes*) is a type of aquatic plant that floats and is often used as a pollutant-absorbing aquatic plant. Water hyacinth has a high growth speed; thus, this plant is considered a weed that can damage the aquatic environment. Water hyacinth easily spreads through waterways to other bodies of water. Although water hyacinth (*Eichhornia crassipes*) is considered a weed in waters, it actually plays a role in capturing heavy metal pollutants. Several studies have shown that aquatic plants are able to decompose the liquid waste; thus, the wastewater discharge becomes better. Before the waste is discharged into the sewer, the waste is channelled into a ditch to a shelter in the yard of the house, which is planted with aquatic ornamental plants. This is where the wastewater undergoes a decomposition process. One alternative to domestic wastewater treatment is by filtration using plant media that is efficient, and effective (Rahmawati & Warsito, 2020).

One of the waste treatment methods is using the phytoremediation method. Phytoremediation is a technique of using green plants to remove, limit or change environmental contaminants (heavy metals) (Das, 2018). Phytoremediation refers to the natural ability of certain plants to bioaccumulate, degrade, or create harmless defenses in soil and water through natural, biological, chemical, or physical plant processes. Aquatic phytoremediation has been proven to be able to remediate industrial waste and maintain aquatic biodiversity (Nario et al., 2014). The choice of plant species for oil phytoremediation is not only determined by the amount of shoot biomass accumulation, which reflects fast and vigorous growth, but more importantly the accumulation of root biomass. Comparison of shoot and root growth rates is an illustration of the allocation of resources owned by plants. In relation to phytoremediation, it is preferable for plant species that allocate a lot of resources to their root system (Priyanto, 2012).

EXPERIMENTAL

Tools and materials used

The tools used were plastic basins, sample bottles, separating funnels, Erlenmeyer flasks, beakers, measuring cups, jerry cans, filter paper, serological pipettes, spectrophotometers, test tubes, and analytical balances. In turn, the materials needed are distilled water, laboratory test materials for COD and BOD test parameters, water hyacinth (Eichhornia crassipes), and wastewater samples from separator IV.

Sample collection and preparation

Sampling was carried out at a refinery of the petroleum industry. Sampling was performed using a ballast in which a sample bottle could be placed; then, the sample was tested in the laboratory to determine the chemical parameters, namely BOD, COD and physical parameters, namely pH and temperature at the initial conditions. There were 3 treatments in this study with each treatment having a waste concentration of 10%, 20%, and 30% waste. Each basin contains water hyacinth weighing 100 grams and a separate control basin contains plain water and water hyacinth without any waste treatment. Determination of the concentration variation is to establish the concentration that can still be tolerated by water hyacinth in carrying out phytoremediation. Prior to phytoremediation testing, the plants were acclimatized in order to work optimally. After testing the phytoremediation for 2 months, the chemical and physical parameters were measured again to determine the effectiveness of water hyacinth in reducing pollutants in the waste with different concentrations.

Design of experimental study

Data analyze

The data obtained are presented in the form of tables, pictures and analyzed statistically. Various treatment variables with different concentrations were analyzed using multivariate and their correlation was determined using Pearson correlation.

RESULT AND DISCUSSION

Waste that can be disposed of into the environment has to contain a pollutant load that meets environmental quality standards. In petroleum processing, various types of products and various types of waste will be produced. Several physicals, chemical, and biological parameters contained in the waste are needed to monitor the quality of the waters (the main environmental source that is the place for waste disposal). The parameters that are routinely carried out are temperature, acidity, ammonia, sulfide, BOD, COD, Phenol, oil, etc. Phytoremediation is one of the efforts to overcome the environmental pollution caused by the presence of pollutants from waste, including waste from petroleum processing. Wastewater in the separator is a waste collection pond that has followed several processing processes before being discharged into the waters. On the basis of the measurement of several parameters such as pH, temperature, BOD, and COD before treatment, it was established that the pH value was 7.85, the temperature was 33.7°C, BOD was 20 mg/l, COD was 10.04 mg/l. This value is still below the environmental quality standard for petroleum liquid waste. In order to reduce the pollutant load before entering the waters, it is necessary to carry out biological testing using phytoremediation techniques. Phytoremediation is a waste treatment technique using biological agents in the form of plants that can act as hyperaccumulators for heavy metals contained in waste. According to Truua et al., (2015) Implementation of phytoremediation in wetlands for the treatment of wastewater or polluted water originating from various sources allows the removal of organic and inorganic pollutants from water in an environmentally friendly and economically viable manner.

On the basis of phytoremediation of waste treatment using water hyacinth (*E. crassipes*) for approximately 2 months, it was found that the measurement parameters carried out showed significant results. The petroleum liquid waste observed in this study is the value of BOD and COD. The initial BOD and COD of liquid petroleum waste in this study were 20 mg/l and 10.04 mg/l, respectively. At 10% effluent concentration, the BOD and COD values changed to 4.11 mg/l and 14.7 mg/l, respectively. At 20% effluent concentration, the BOD and COD values after 2 months of testing were 3.73 mg/l and 9.14 mg/l, respectively. At 30% effluent concentration the BOD and COD values became 3.73 mg/l and 1.22 mg/l, respectively. The existence of fluctuations during the phytoremediation process in the waste is due to the role of water hyacinth plants and microbes around the roots that work together to reduce pollutants. According to Ningrum et al., (2020) the phytoremediation process using water hyacinth can increase the efficiency of removing the COD content of wastewater. The plant rhizosphere has microorganisms that interact with each other to degrade organic compounds contained in the waste. These compounds are used as a source of nutrients for microbes which will then be converted into simpler compounds. The number of water hyacinth plants used in phytoremediation will affect the decrease in the COD and BOD values of waste. Water hyacinth root morphology after testing using different concentrations showed changes. This can be seen from the roots of the water hyacinth plant which were more abundant than before acclimatization. Branching and a large number of fibrous roots in water hyacinth will make it easier and faster to absorb pollutants contained in the waste (Figure 1). According to Rahmawati & Warsito (2020) the process of absorption of substances contained in liquid waste is carried out by the roots of the water hyacinth plant with meristem tissue. This happens due to the attraction by the water molecules in the plant. The substances that have been absorbed by the roots will enter the stem through transport vessels (xylem which will then be passed on to the leaves. The greater the growth of the plant, the greater the surface area of the roots to absorb the existing pollutants compared to small plants.

This study used multivariate analysis using SPSS. On the basis of the data obtained, the average predictions of control, 10% treatment, 20% treatment and 30% treatment are 5.34, 5.38, 6.34, respectively. The standard deviation values for the control variables, 10% treatment, 20% treatment and 30% treatment were 1.126, 1.124, 0.270, respectively. The magnitude of the relationship between variables when viewed from the Pearson correlation value obtained control data for 10% treatment of 0.959, control data on 20% treatment of 0.947, control data on 30% treatment of 0.947. The value obtained means that the relationship between the two variables is very strong and the variable has a positive correlation coefficient; thus, it can be concluded that if the concentration

a) b)

Figure 1. Morphological conditions of water hyacinth (a) Before phytoremediation (b) After phytoremediation

of the treatment increases, the resulting value will also increase from the initial state. The value of the coefficient of determination is 0.921 or equal to 92.1%. This value means that 92.1% of the control that occurs can be explained by using the treatment variable or there is 92.1% is the effect of water hyacinth treatment on decreasing levels of BOD and COD, while the remaining 7.9% must be explained by other causal factors.

CONCLUSIONS

Water hyacinth plants have the ability to survive in petroleum liquid waste, which can be seen from their resilience and are able to grow and develop during the phytoremediation period of petroleum liquid waste. Water hyacinth plants are able to reduce the BOD and COD levels in petroleum wastewater from initial concentrations of 20 mg/l and 10.04 mg/l to 4.11 mg/l and 14.7 mg/l at a waste concentration of 10%; 3.73 mg/l and 9.14 mg/l at 20% waste concentration and 3.73 mg/l and 1.22 mg/l at 30% effluent concentration.Water hyacinth can be used as a phytoremediation agent in biological treatment of petroleum liquid waste.

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