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PHYTOREMEDIATION OF WASTE WATER OF DETERGENT BY BAMBOO WETLAND SYSTEM

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ABSTRACT

Simple technology solve water pollution is to utilize the wetlands. Bamboo wetland system is a wetland planted with bamboo. The main components of domestic waste water containing detergent. Detergents cause of eutrophication, and carcinogenic. The research objective was to analyze the influence of pollutant loads and the retention time of the water quality, analyzes the factors bamboo wetland system operating conditions as wastewater treatment, and formulates the development of a model to optimize the management of domestic waste water. This study was conducted in laboratory scale, the first stage using a completely randomized design with two factors, the initial concentration of detergent and retention time. The second phase to determine the factors that affect operating conditions using the Taguchi method. Observation of water quality with the parameter of chemical oxygen demand (COD) and detergents as Methyle Blue Active Substances (MBAS). Results of the study treatment pollutant load of 12 g detergent / liter of water and the retention time of 30 days, showing the interaction and primary treatment significantly affected water quality. COD reduction efficiency of 80.11%. Factors that influence the operational conditions factor initial conditions detergent, retention time, aerobic conditions, and the type of red-yellow podzolic soil. Development of bamboo wetland system model, designed as a shallow pool, in the embankment or the banks planted with bamboo. Bamboo wetland system can be applied as a domestic waste water treatment park, as well as useful for preventing abrasion on the edge of the river and reduce seawater intrusion.

Keywords: ***Waste detergent, COD, bamboo wetland system.***

1. INTRODUCTION

Domestic wastewater is the highest volume of detergent. Aside from the settlements, detergents are also used in the car wash business and motor vehicles, as well as the laundry business continues to increase. This is in line with the production of detergents world, estimated at 2.7 million tons / year, with annual increases of 5% (Rochman, 2009).

Technology wetlands is planned or controlled processing system which has been designed and built using natural processes involving plants, the media, and microorganisms to treat wastewater. Plants are most often used in artificial wetlands in Europe and the United States are marsh plants such as *cattail* and *Bulrush*, water grass species *Phragmites australis, Juncus effuses, Typha latifolia, Schoeplectus locustri, Azolla microphylla* and *Eichornia crassipes* (water hyacinth). All water plants used are classified weeds relatively no economic value even causes problems for the environment (Khiatuddin, 2003).

We should look for alternatives and discovered plants that have the potential to be developed on this wetland system. One is bamboo. An advantage of using bamboo plants that can produce biomass which many benefits to society, both in terms of ecological functions, as well as socio-economics, and aesthetics, among others; as raw material for the craft industry and home furnishings, bamboo shoots into a source of nutrition, active carbon material, as an ornamental plant, the plant greening, reducing air pollution and noise pollution, and minimize the impact of global warming.

2. LITERATURE REVIEW

Detergents are very harmful to the environment because of some studies mention that the detergent has the ability to dissolve the substance to be carcinogenic, for example 3.4 benzonpyrene, besides disruption of health issues, the content of detergent in the water will cause odor and bad taste. In the long term, water that has been contaminated with sewage detergents potential as one of the causes of cancer. Detergents decomposition process will generate residual benzene when reacted with chlorine to form a compound that is very dangerous chlorobenzene (Lutfi, 2009; Switarto and Sugito, 2012).

Environmental costs can be reduced so that it needs to be studied and discovered wastewater treatment technologies that can be applied by the public. Among the methods that a lot of attention today is the wastewater treatment technologies wetland systems. This system is recommended because it can treat domestic wastewater, agricultural and some industrial waste, odorless, cost planning, operation, and low maintenance and do not require high skills (Ginting, 2008).

The term phytoremediation is derived from the English word phytoremediation; the word itself is composed of two parts of the word, namely phyto derived from the Greek word python meaning "plant" and a remediation derived from the Latin word remedium which implies "cure", in this case means "to solve the problem by repairing the faults or flaws ". Thus phytoremediation can be defined as: the use of plants to remove, move, stabilize, or destroy contaminants both organic and inorganic compounds (Mangkoedihardjo and Samudro, 2010).

Some mechanism in phytoremediation, among others (Schnoor, 2002); Fitoekstraksi, contaminant uptake by plant roots and translocated or accumulation of the compound to plant parts such as roots, leaves, or stems. Rizofiltrasi, the use of the roots of plants to absorb and precipitate metal contaminants from wetlands or groundwater. Fitodegradasi, a condition where the contaminants are absorbed into the plant transformed by the enzyme activity. Fitotransformasi, making organic contaminants from soil and groundwater and then metabolized or ditansformasi by plants. Fitostabilisasi, a phenomenon produced certain chemical compounds to immobilize contaminants in the rhizosphere. Fitovolatilisasi, occurs when plants absorb and release contaminants into the air through the leaves, can also contaminant compounds are degraded before being released through the leaves.

3. RESEARCH METHODS

This research was conducted in the greenhouse of the Faculty of Agriculture, Islamic University of Riau (UIR), Jalan Kaharuddin Nasution number 113, Pekanbaru, the material used is a type of Bamboo Jala (*Schizotachyum zollingeri* Stend) the age of seven months, the land of red-yellow podzolic, marshland sapric, raw water from Sungai Kampar, Riau Province, Indonesia, and detergent brand "Rinso Anti Noda". Design of artificial wetlands using transparent plastic container of rectangular and round shaped plastic pot containers perforated as a medium soil where the plants grow bamboo, then flooded the appropriate treatment of waste water. The first stage uses a completely randomized design in factorial 4 x 4. Factors A detergent wastewater is composed of 4 levels with different initial concentrations namely; A0 = river water without the addition of detergents, A1 = river water plus 4 g detergent / liter of water, river water plus A2 = 8 g detergent / liter of water, and A3 = river water plus 12 g detergent / liter of water. Factors W is the dwell time consists of 4 levels, namely; W0 = 0 days, W1 = 10 days, W2 = 20 days, and W3 = 30 days. The second stage uses the Taguchi method, there are eight conditions of treatment variables, namely; number of bamboo plants, the concentration of detergent, soil organic matter, soil type, condition of aerobic-anaerobic, medium thickness, porosity, and retention time, each consisting of two levels: a high level and low level, each performed three times replications. The data were analyzed statistically using SPSS application. If the F count larger than F table then conducted further tests with Test Honestly Significant Difference (Tukey, HSD) at 5% level (Oramahi, 2009).

4. RESULTS AND DISCUSSION

The test results mean COD content of waste water, treatment of various initial concentrations of detergents and the restention time in the bamboo wetland system, as presented in Figure 1.

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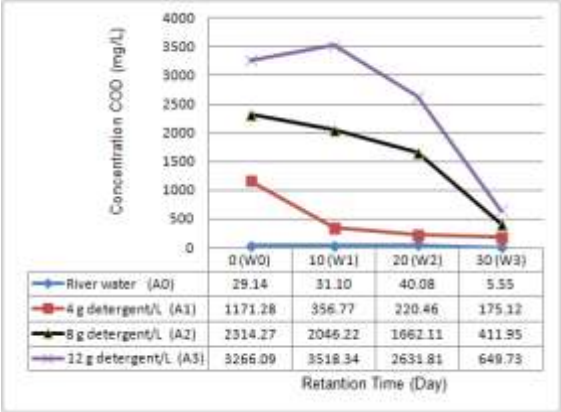

Source: *Data Processed (2014).*

Figure 1. Decreased Levels Of COD Treatment Process Various Initial Concentration Detergents And Retention Time In Bamboo Wetland System.

The mean levels of COD in Figure 1, note the treatment of river water added detergent concentration of 12 g / liter of water in this study, the waste water COD levels reached 3266.09 mg / L. In beransur-ansur content of pollutants in waste water showed a decrease process, and at the end of the study with a retention time of 30 days COD successfully reduced to 649.73 mg / L, meaning a decline of 80.11%. Interaction detergent treatment initial concentration and residence time, providing a different effect in lowering levels of COD. Likewise, the main treatment of various initial concentrations of detergents and residence time, resulting in significantly reduced levels of COD.

COD test aims to determine the amount of oxygen needed by oxidant ingredients, for example potassium dichromate, to oxidize organic materials contained in the water. COD test usually produces oxygen demand value higher than the BOD test, because the materials are stable against biological reactions and microorganisms can participate oxidised in the COD test. For example, cellulose is often not measured by BOD tests as difficult oxidized through biochemical reactions, but can be measured through COD test. 96% COD test results conducted for 10 minutes will roughly equivalent to a BOD test results for 5 days (Kassam *et al*., 2005; Putra, 2009).

To determine the effect of early treatment of various concentrations of detergents and different retention time on the content of COD in waste water bamboo wetland system are presented in Table 1.

Table 1. Effect Of Initial Treatment Concentration Detergents And Retention Time Live Against The Cod Of Waste Water In Bamboo Wetland System.

Factor A		Factor W (Retantion time)			Mean A
waste water	W0	W1	W2	W3	
(mg/L)	0 day	10 days	20 days	30 days	
A0	29,14 ^{hi}	31,10 ^{hi}	5,55 ^{i}	2,45 ^{n}	26,47 ^{d}
A1	1171,28 ^{e}	356,77 ^{fgh}	220,46 ^{ghi}	175,12 ^{ghi}	480,91 ^{c}
A2	2314,27 ^{bc}	2046,23 ^{c}	1662,11 ^{d}	411,95 ^{fg}	1608,64 ^{b}
A3	3266,09 ^{a}	3518,34 ^{a}	2631,81 ^{b}	649,73 ^{f}	2516,50 ^{a}
Mean W	1695,19 ^{a}	1488,11 ^{b}	1138,62 ^{c}	310,59 ^{d}	
KK = 3,5 % HSD A/W = 122,89 HSD AW = 336,39					

Source: *Data Processed (2014).*

The numbers in rows and columns followed by the same lowercase letters, showed no significant difference based Honestly Significant Difference test (Tukey, HSD) level of 5%.

Data shown in Table 1, note the results of this study indicate that there has been a decrease in the concentration of COD. This indicates that the organic material contained in the waste water is mostly organic materials that are biodegradable.

The same thing was stated by Effendi (2003), that the composition of the solids contained in domestic waste, 70% is organic material.

Naturally streams can be contaminated on the surface area of water only. In the great river with heavy water flow, a small number will experience dilution of pollutants, so that the level of contamination is low. This causes consumption of dissolved oxygen needed by aquatic life and biodegradation will be quickly updated. But sometimes a heavy polluted river so that the water contains contaminants that are very large. COD indicates the amount of dissolved oxygen needed by microorganisms to break down or oxidize the waste material in the water. So the COD value does not indicate the actual amount of organic material, but only measures the relative amount of oxygen required to oxidize the waste material. If the high oxygen consumption indicated by increasingly smaller residual dissolved oxygen, then it means that the content of the waste materials that require high oxygen (Darmono, 2008).

Sabli research results (2002), domestic waste water treatment using the medium of land in wetland systems (without vegetation) COD removal efficiency is 68-87%, with the initial COD concentration of 280 mg / l to 795 mg / liter.

The purpose of wastewater treatment is to remove suspended material and floating, processing of biodegradable organic matter and reduce pathogenic organisms. Waste water treatment can be done naturally or with the help of the equipment. Natural wastewater treatment is usually performed with the aid of a stabilization pond. Highly recommended stabilization ponds for wastewater treatment in the tropics and developing countries, because the costs necessary to make it relatively cheap but requires a large area and a long retention time of 20-50 days (Asmadi and Suharno, 2012).

Taguchi method was originally intended to quality of manufactured products. However, in practice this method can also be implemented in the fields of engineering, biotechnology, marketing, to advertising. Taguchi method is an extension of the Design of Experiment (DoE) which aims to improve the manufacturing process for the product achieving good quality. This method is helpful in off-line Quality Control. Taguchi method works through three stages, namely; 1). System design is the process of applying engineering to produce a functional prototype design basis. Prototype model is set initial determination of the characteristics of a product or process design, 2). Parameter design is the investigation conducted to identify the establishment of minimum variation ability of the product or process. The term is derived from the custom design engineering parameters that institute to the characteristics of the product as a product or process parameters, 3). Tolerance design is a method of determining the tolerance that optimizes the manufacture of the product and the cost of his life. No other third purpose of this step is to produce a product or process that is robust (Robust) so that the Taguchi method is commonly known as the Robust Design Method. Taguchi method ensures the performance of a good quality right from the design phase of a product or process (Anonymous, 2011).

Results of analysis of the factors that influence the operating conditions decrease the efficiency of the detergent concentration as Methyle Blue Active Substances (MBAS) in waste water in bamboo wetland system as presented in Table 2.

Table 2. Decrease Efficiency Detergent Concentration (%) By Conditions Operations In Bamboo Wetland System.

No.	Experiment factor	High level	Low level	Effect
1	Bamboo plant (A)	69.81	72.13	-2.32
2	Initial detergent concentration (B)	75.52	66.41	9.11
3	Interaction A and B	71.42	70.51	0.91
4	Soil organic matter (C)	69.99	71.94	-1.95
5	Interaction A and C	73.07	68.12	5.70
6	Interaction B and C	73.82	68.12	5.70
7	Type of soil (D)	71.11	70.82	0.29
8	Aerob-anaerob condition (E)	72.31	69.63	2.68
9	Interaction C and D	71.56	70.37	1.19
10	Interaction D and E	74.09	67.84	6.25
11	Planting medium thickness (F)	68.93	73.01	-4.08
12	Interaction E and F	76.92	65.01	11.92
13	Porosity (G)	69.55	72.38	-2.83
14	Retantion time (H)	75.14	66.80	8.34
15	Interaction G and H	73.89	68.04	5.85

Source: *Data Processed (2014).*

From the data in Table 2, note the high level of operational conditions and the low level of the eight factors of the experimental variable conditions, there are four main factors that are positive, it means giving real effect. When sorted by the highest value of each is the initial detergent concentration, retention time, aerobic-anaerobic condition, and type of soil. While 4 other factors is negative, each of which is soil organic matter, the number of bamboo plants, porosity, and thickness of the medium. The calculation result of the interaction of factors gives an indication of the condition of relevance of each factor was observed.

Benefits of bamboo plants in wetland systems, among others: 1). Prevent global warming, bamboo absorbs carbon dioxide and releases 30% more oxygen into the atmosphere compared to trees in general. 2). Preventing erosion, because the root system of bamboo will continue to grow even after harvesting. New shoots will appear and bamboo roots are still able to maintain the stability of the soil and retain nutrients that exist. 3). Bamboo as a material that is strong, can replace the use of wood for any application. 4). Traditional medicinal materials, bamboo contains natural bio-agent known as bamboo kun which acts as an anti-bacterial, China bamboo is one of the traditional medicine to eliminate the infection. 5). Bamboo can eliminate odor; bamboo charcoal can also be used to filter out harmful chemicals in the water. 6). Bamboo fiber can maintain its body temperature. Cloth from bamboo fiber will cool the body temperature of the person wearing it while it is hot and makes people warm when the air is cold. 7). Bamboo shoots as a source of healthy food, bamboo shoots have become a source of food,

particularly in Asia. Bamboo shoots are foods that are low fat, low calorie and low cholesterol. Bamboo shoots are also a source of fiber and potassium are very good. One serving provides 10% bamboo shoots nutrition of the recommended daily intake of nutrients. Additionally If the bamboo forests could be laid out properly, can also be used as an attractive tourist spot like Sagano bamboo forest in Japan, which is one of the most beautiful natural environment in Japan (Anonymous, 2012).

5. THE PROSPECTS OF BAMBOO WETLAND SYSTEM DEVELOPMENT

The cost required to construct an wetland system may be cheaper 50-90% of the cost required to build a conventional waste water treatment systems. Likewise, the cost of the necessary investment is much cheaper because the system bogs artificial does not require high-tech equipment, does not require the input electrical energy, and chemicals (coagulants, flocculants, fertilizers), and does not require personnel trained operator (Puspita *et al*. 2005).

In Indonesia the cost of construction, operation and maintenance of swamp artificial it may be cheaper given the cheap labor costs and the relatively low price of the land, because the swamp artificial need not be built in a strategic area that is targeted by investors, but in the marginal as swamp naturally dormant regarded as vacant land.

Plants are most often used in artificial wetlands in Europe and the United States are marsh plants such as *cattail* and *Bulrush*, water grass species *Phragmites australis, Juncus effuses, Typha latifolia, Schoeplectus locustri, Azolla microphylla* and *Eichornia crassipes* (water hyacinth). All water plants used are classified weeds relatively no economic value even cause problems for the environment (Khiatuddin, 2003).

The success of bamboo Substituting wood for industrial raw materials wood-based raw materials can be seen from some of the products on the market such as chopsticks (chopstick), toothpicks (toothstick), particleboard, playbamboo and handles lighters. Land to be planted with bamboo can be on dry land or wetlands. Spacing is recommended for industrial bamboo is 8 x 8 meters, so it takes 156 seedlings per hectare. The potential receipt of bamboo cultivation is the result of sales bamboo poles were newly acquired in year 7 (Sutiyono, 2012).

In terms of production, bamboo is far superior compared to other wood plants in general. To obtain quality raw material, bamboo can be harvested within a period of 3-5 years, compared with the timber takes 10-50 years. One bamboo planted cuttings can produce 200 stems of bamboo in a period of 5 years, while in the same period only one tree reaches maturity. Given the high productivity, bamboo can provide abundant raw materials Yag for humans. In Costa Rica, 1000 new homes built every year only 60 hectares of bamboo (Khiatuddin, 2003).

Since 1700 years ago China relies heavily on material aged 3-5 years bamboo as raw material for the paper industry. Moreover, in India also uses bamboo as raw material for paper mills (Fatriasari and Hermiati, 2008).

6. CONCLUSION

From the research first stage and the second stage can be concluded that:

1. The system is able to process the bamboo wetland system, pollutant load of up to 12 g detergent / liter of water with a dwell time of 30 days. Interaction and primary treatment of various initial concentrations of detergents and retention time had a significant effect on the quality of wastewater. COD reduction efficiency of 80.11%.

2. Factors operational conditions affecting bamboo wetland system to optimize the management of waste water is beginning detergent concentration, retention time, aerobic conditions, and the red-yellow podzolic soil.

3. Development of bamboo wetland system, wetland system construction design made of bamboo as a shallow pool so that the ecosystem aerobic conditions. Wastewater flow set according to the existing contour. On the embankment pond or riverbank wastewater planted with bamboo. The system can be designed as; domestic waste water treatment park in residential, industrial and agricultural, preventing abrasion, erosion and sedimentation along the river, blocking the intrusion of sea water, flood control, reclamation of mined land, water catchment areas, and recreation areas and conservation of wetlands.

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