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Treatment of Waste water Noodle Industry with a Multi-Soil-Layering (MSL) System.

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ABSTRACT

The study of treatment of wastewater noodle industry was investigated. The Multi Soil Layering (MSL) system was constructed in a 50 cm (L) x15 cm (W) x50 cm (H) of acrylic box. Volcanic soil was mixed with charcoal, sawdust and iron scraps at a ratio of 75:10:10:5, respectively, based on dry weight. The soil mixture was filled into the box as blocks forming a brick-like layer pattern. The spaces between the soil blocks were filled with zeolite (1-3 mm). This experiment was done using aeration and non aeration method, the wastewater was loaded periodically to the MSL system. The loading rate of wastewater varied from 10, 20, 40 and 80 mL min^{-1}. On the aeration and non aeration method have optimum condition on loading rate on10 ml/min, the removal efficiency of TSS, BOD, COD, Tartrazin were 97,41%, 96,87%, 98,51%, 76,86%, and 96,94%,96,49%, 98,26%, 82,18%, respectively.

Keywords: Multi Soil Layering (MSL); Sawdust; Zeolite; Wastewater Noodles Industry.

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INTRODUCTION

The noodles wastewater consist of liquid organic waste based of raw materials processed from agriculture, such as wheat flour (contains carbohydrates, protein, vitamins, and minerals), palm oil (contains fatty acids include lauric, palmitic, oleic) and tartrazin dyes, dissolved in wastewater. In dealing with the waste generated in industrial, waste treatment noodles that have been used in some noodles industrial are using landfill system which need large area and high operational costs.

Tartrazine is widely used as ingredient of foods, drinks and cosmetics colorant. Tartrazine is carcinogenic and cause allergic with molecular formula $C_{16}H_9N_4Na_3O_9S_2$ water soluble and mass of molecule is 534.4 g/mol. It is cheaper than betacarotene and therefore used as an alternative to beta carotene to achieve similar color. Tartrazine is also reputed to catalyze hyperactivity and other behavioral problems, asthma, migraine, thyroid cancer, etc. Because of its hazardous health effects, foods and drinks containing Tartrazine are avoided [15]. Tartrazine adsorption have been carried using hen feather [15], fly ash [17], sawdust [13], and biomass such as fungus [18] and algae [19].

Multi Soil Layering (MSL) is a one method can used for wastewater treatment system designed for enhances the inherent ability of the soil to purify wastewater [1]. This method is known to minimize of cost treatment, requiring only a small land, is ideal for urban areas in developing countries [2] it is simple in terms of operation and control, as well as environmentally friendly, because it uses natural materials and easily obtained, among which the topsoil from the mountains (Andisols), sawdust, coconut charcoal, and others as anaerobic layers, as well as gravel or other rocks as aerobic layers [3]. Compared with conventional tillage systems, the MSL system can withstand the load level higher hydraulic (HLR) and are less prone to clogging [4].

The MSL system in aerobic and anaerobic conditions are the main factors influencing the allowance pollutant parameters. The MSL consists of a mixture of soil layers that have a high absorption and arranged with brick patterns [1]. The MSL method is a method that utilizes the ability of soil to process wastewater [5]. The MSL method has been tested for the treatment of domestic wastewater in some countries, such as Japan [6, 7] and Thailand [8].

The MSL system has several advantages, among others, were able to reduce the value of BOD, COD, TSS and color, has a high ability to receive and absorb water that flowed into the system, 1000-4000 $Lm^{-2}d^{-1}$ whereas conventional soil 10-40 $Lm^{-2}d^{-1}$, can prevent clogging and does not need large area such as a pool treatment [2,8]. From previous studies [7], which has been carried out using the MSL system with material composition comprising a layer of a mixture of sandy clay (Sandy Clay) 75%, carbon 10%, rice bran 5%, iron powder 10%, reported can reduce the content of TSS, BOD, COD, Total nitrogen, Ammonium, Total phosphate from waste water septic tank 70% to 90%.

In this study investigated wastewater treatment noodles industrial by using a MSL system with a composition consisting of zeolite, volcanic soil from the foot of Mount Merapi of west Sumatera, Indonesian, coconut shell charcoal, sawdust, and the iron filings.

MATERIALS AND METHODS

Materials of the MSL System

The primary materials of the MSL system includes soil mixture layers (SML) and permeable layers (PL). For the soil mixture layers consist of materials, such as charcoal, sawdust, and iron scraps, are added to the volcanic soil (10:10:5:75), and the mixture is packed into gunnysacks. The permeable layers used zeolite (1-3 cm).

Methods

Preparing MSL System

For stacking the SML blocks in a brick-like layer pattern. Manner within the 50 cm (L) × 15 cm (W) × 50 cm (H) box made with acrylic, the SML blocks were prepared in two sizes. The blocks in the Block A group were 9 cm (L) × 15 cm (W) × 4 cm (H) in size, and those in the Block B group were 5 cm (L) × 15 cm (W) × 4 cm (H) in

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size. An SML followed by a PL was repeatedly stacked in the acrylic box to form the MSL system. First, a 5-cm-thick gravel arranged at the base of the box and then covered with plastic net then 5-cm-thick PL layer was paved followed by a 4-cm-thick SML layer. The horizontal intervals between the SML blocks were 2.5 cm, and this interval was filled with the PL material. Next, a 4-cm-thick PL followed by a 4-cm-thick SML were repeatedly packed onto the base layer. Finally, a 5-cm-thick PL was packed at the top of the box to complete assembling the MSL system.

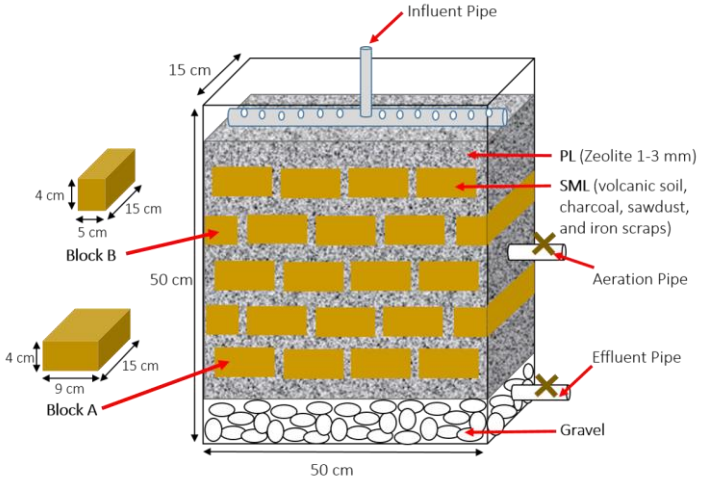

Figure 1: Design of MSL system

Treatment of the Sample

The wastewater of noodles industry was used to analysis of the quality wastewater parameters of pH, BOD, COD, TSS and Tartrazin. In order to predict the ability of the MSL system with performed analysis after wastewater treatment of noodles industry. With loading rates were observed, 10, 20, 40, and 80 mL min^{-1}.

Monitoring Water Quality

The wastewater accumulated in the wastewater box then flowing through into the MSL system and tested for water quality. Some parameters such as pH, BOD (Winkler method), COD (Iodometric method), TSS (Gravimetric method), and Tartrazin (Spectrophotometric method)[12].

RESULTS AND DISCUSSION

pH Analysis

pH plays an important role in the wastewater treatment process, the pH scale measures the concentration of hydrogen (H^+) and hydroxide (OH^-) ions. Noodles industrial wastewater is containing organic compounds so that the organic acids in waste can make the pH became lower (pH 4,23). Noodles wastewater have been processed using MSL system obtained pH 8.25 at a loading rate of 10 mL min^{-1}.

In Figure 2, shows that the loading rate play an important role in changing the pH value of noodles industrial wastewater, where the slower of loading rate, the pH of the wastewater to be much improved from 4.23 to 8.25. If the loading rate slower the contact time of waste water will longer on the process denitrification by *Nitrobacter* bacteria released hydroxyl ions which will raise the pH value [2].

According to Zein R. et al, The pH of the effluent combination system of grease trap and MSL on the aeration slightly lower than non-aeration process due to nitrification posibility is greater than denitrification [9]. Nitrification is the process of oxidation organic compounds containing N (org-N) into NH_3-N, NH_3-N is then oxidized into NO_2-N and NO_3-N by aerobic bacteria. This process release of H^+ ions that caused the pH of the effluent being lower than non-aeration process. While in the non-aeration process, pH of the effluent becomes greater than the effluent aeration, due to in the denitrification process NO_2-N and NO_3-N were reduced into N_2 gas by releasing OH^- ions [21].

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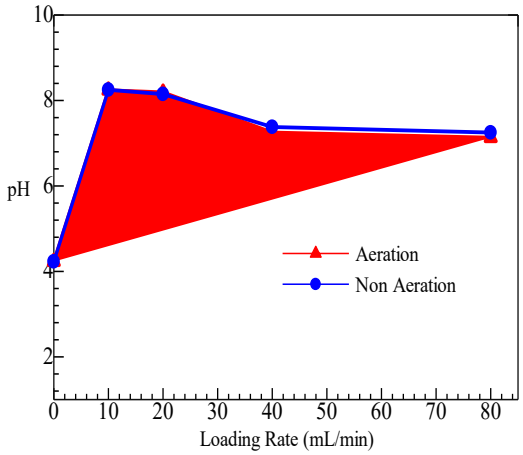

Figure 2: pH analysis of noodle wastewater

Effect Loading Rate on Removal Efficiency of TSS

Figure 3 shows the effect of loading rate on the removal efficiency of TSS. Based on the loading rate that used the smaller of loading rate, the turbidity value will be smaller, it can be stated that the loading rate is small causing contact between the wastewater and material in the MSL will be longer so that the purification process will be more optimal.

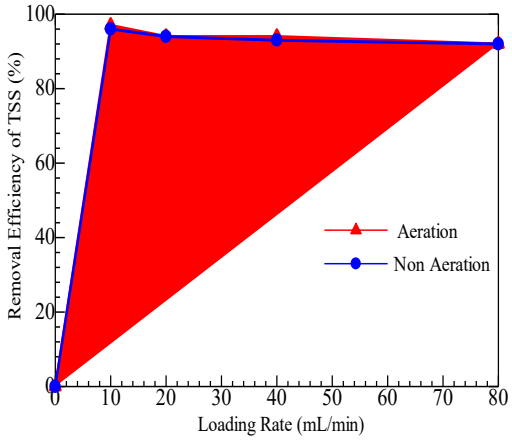

Figure 3: Removal efficiency of TSS

Based on Figure 3, it is known that removal efficiency of TSS increases with decreasing loading rate, with the maximum removal efficiency is 97.41% on aerated and 96.94% on non-aerated conditions performed with a loading rate of 10 mL min^{-1}. TSS impairment caused by the filtration process in the system played by volcanic soil and zeolite used. Besides the influence of the molecular size of the volcanic soil and the pores of the zeolite used resulting in ion exchange and absorption of the content of suspended substances in the waste [3].

Effect Loading Rate on Removal Efficiency of BOD

Biochemical Oxygen Demand (BOD) is one of the important chemical parameter that determines quality of water. The high content of BOD in wastewater will decreasing water quality. The results of analysis of BOD noodle wastewater can be seen in Figure 4.

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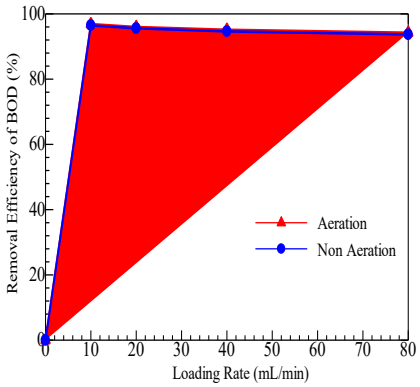

Figure 4: Removal efficiency of BOD

Figure 4 shows the removal efficiency of BOD maximum obtained on loading rate 10 mL min^{-1} is 96.8% for aeration and 96.49% non aeration condition.

According to Chen et.al the BOD removal efficiency after treatment with MSL system is 87.5 to 92.6%, increasing of BOD in the MSL system occurs caused of absorption and decomposition process that occurs in nature soil [3].

Soil has large pores and large surface area. Several microorganisms and serves as a provider of pore space for the accumulation of microorganisms on the MSL system. The organic material is a carbon source for microorganisms, the high concentration of BOD in the wastewater can improving the work of microbes so that microorganisms can easily form biofilms both in the soil layer and zeolite. With the biofilm microbes help absorption, thus simplifying the decomposition of organic material in the waste [2].

Effect Loading Rate on Removal Efficiency of COD

COD is an important chemical parameters in water as an indication of water pollution by organic substances that naturally can be oxidized through microbiological processes and can result in a lack of oxygen dissolved in the water. Based on the Figure 5 the efficiency of COD highest loading rate of 10 mL min^{-1} in both processes, both aeration and non aeration, with a value that is equal to 98.51% and 98.26%. From the results obtained it appears that the efficiency of MSL effective and highly efficient in the decrease of COD in wastewater. A high percentage of decline in COD values are also caused by the influence of volcanic soil containing microbes, in this MSL material used is sawdust. According to Chen, et al [3], which uses sawdust in a mixture of soil can play a role in the decline in COD because it can be used as adsorbents, absorption caused by the content of cellulose in sawdust.

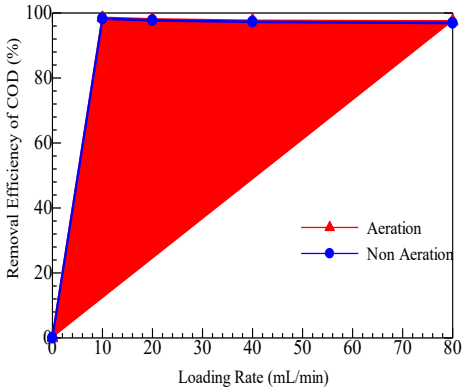

Figure 5: Removal efficiency of COD

According to Sato, et al [5] obtained the percentage of COD has decreased 80.6% and 74.3% aeration system non aeration system. Differences due to material mix and the size of the MSL system used. Percentage difference COD reduction is due to the use of a given aeration system could increase the activity of microorganisms in the system of work in the process decomposition organic compounds contained in the waste, this process takes place in a layer of soil in the MSL system.

Effect Loading Rate on Removal Efficiency of Tartrazin

Water pollution due to discharge of color effluents from textile dye manufacturing and textile dyeing mills are one of the major environmental concerns. Tartrazine, a yellow menace, is widely being used in foodstuffs, cosmetics, medicines and textile. Because of their complex molecular structures and large sizes most of the dyes are considered non-oxidizable by conventional physical and biological treatments [16]. Tartrazin dye was used for noodle coloring in noodle industry, it showed of noodle wastewater that color is yellow.

Figure 6 shows MSL system capable to remove the tartrazine dye in noodles wastewater with an efficiency is 76.86% and 82.14% in the conditions of aeration and non aeration at a loading rate of 10 mL min^{-1}. There are differences between the percentage of efficiency with aeration and non aeration which shows that the decrease parameter tartrazine dye better in non-aeration conditions. Waste initial noodle industry in acidic conditions of pH 4.23, resulting in the degradation of dye tartrazine by microorganisms still in acidic conditions.

According to Zein R.et al.[12] states that the maximum absorption of tartrazine dye using seeds of *Annonamuricata* L as 23,6310mg g^{-1} at pH 2, contact time 120 min, stirring rate 100 rpm, initial concentration 600mg $L^{-1}$and adsorbent dosage 0,1 g. Besides Sushmita, et al [13] and Mohammed A. Kassem [14] stated that the absorption of tartrazine by sawdust and charcoal has a capacity of maximum absorption at pH 3.

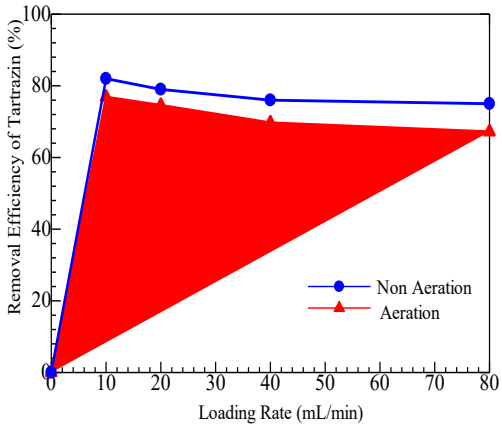

Figure 6: Removal efficiency of tartrazin

CONCLUSION

The MSL system has ability for removal of TSS,BOD,COD and Tartrazin dyes of noodle waste water industry on aeration and non aeration conditions and loading rate 10 mL min^{-1} Removal efficiency for TSS,BOD,COD and tartrazin were 97,41%, 96,87%, 98,51%, 76,86%, on aeration condition and 96,94%,96,49%, 98,26%, and 82,18%, on non aeration condition respectively.

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