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Purifying Pollutant Indicators in Tofu Factory Wastewater Using a Multi Soil Layering System Aflizar1,a), Rini Mayyuliani2,b), Jamaluddin3,c),Amrizal3,d) 1Master's Program in Applied Food Security, Payakumbuh State Agricultural Polytechnic, Indonesia 26271 2Agricultural Water Nabagenebt Study Program,Payakumbuh State Agricultural Polytechnic, Indonesia 26271 3Technology Study Program Mechanization of Agriculture, Payakumbuh State Agricultural Polytechnic, Indonesia 26271 a) Corresponding author: aflizar_melafu@yahoo.com b)rinimayyuliani@gmail.com c)jamaluddin@gmail.com d)amrizalch@gmail.com Abstract.The MSL system used during this experiment was made in a field laboratory scale with dimensions (height 200 cm x width 50 cm x length 50 cm).

The main component of the MSL system consists of a mixed soil layer (SML) arranged in a triangular soil horizon pattern and surrounded by a Split Rock layer as a permeable layer (SSP).SML is made from local natural resources, namely sandy clay loam, sawdust from coconut stalks (Cocos nucifera) and iron pellets from lathe waste with a dry weight ratio of 8 : 1.9 : 0.1. The Tofu factory wastewater is channeled into the MSL system with a hydraulic loading rate (HLR) of 3166 L/m2/hour utilizing the force of gravity.Average removal efficiency of Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD5), Chemical Oxygen Demand (COD), Nitrate-Nitrogen (NO3- -N), Phosphorus (PO4- -P), Oils and grease , Electric Conductivity (EC), Total Dissolved Solid (TDS) and Salt (NaCl) were 67, 97, 97, 99, 77, 99, 78, 64 and 81%, respectively.The bad odor and color indicators of wastewater can also be efficiently removed with the MSL system.From this fact, the MSL system is efficient and capable of removing organic matter, phosphorus, nitrogen, oil and grease, odor and color.MSL system recommended for removing contaminants from Tofu Factory wastewater.

INTRODUCTION In urban and rural areas in Indonesia, liquid waste is discharged into rivers and waters without prior treatment, causing serious problems because the liquid waste contains high concentrations of nutrients, organic matter and pathogens[1-4]. In addition, the community's minimal environmental awareness and the absence of public wastewater treatment provided by the government or the private sector both in rural and urban areas are the driving factors for increasing disease by microorganisms and contamination of surface water and underground water.

To overcome environmental problems due to the disposal of this liquid waste, the only way is by processing the liquid waste itself to purify the pollutants contained therein[5]. The tofu industry is widely spread in urban and rural areas in Indonesia. Generally, the liquid waste generated poses a big problem because it is discharged directly into the environment without being processed, causing a low aesthetic odor and polluting the waters. In fact, in the field in rural and urban areas there is a tofu industry.

The rest of the production in the form of liquid waste has caused damage to the ecosystem and then the extinction of certain organisms and decreased water quality [1-4]. The current liquid waste purification technology is still very expensive and requires professional experts to operate it. To overcome this problem, so that wastewater purification technology in urban and rural areas can be adopted sustainably by the government and the community, the conditions must be cheap and simple to operate, such as The 5th International Conference on Agriculture and Life Science 2021 (ICALS 2021) AIP Conf. Proc.

2583, 060016-1–060016-9; https://doi.org/10.1063/5.0116427 Published by AIP Publishing. 978-0-7354-4216-0/$30.00

wetland lagoon technology and sand filters [6]. Although the sanitation performance of the above technology is good, it requires a large area of land and the price is still too expensive for developing countries[5]. Various methods have been tried to treat tofu liquid waste in Indonesia such as the method of adsorption of activated carbon oxidation, chemical oxidation method and digestion[7,8]. However, it is still expensive and difficult to operate when applying this method.

One of the simple, inexpensive and simple technologies in operation for wastewater treatment, the MSL system was introduced. It turned out to be successful in purifying liquid waste in Japan [9-15]. Furthermore, this MSL system, was also tested in China, in Thailand, in the United States, in Morocco to purify domestic wastewater [16-18, 5] and waste water from tofu factories in Indonesia [1].

Natural soils or conventional soil systems for treating wastewater have disadvantages because they are easily clogged and the flow rate is low. Therefore, this MSL system corrects the weaknesses of the conventional soil system. Through intelligent innovation, MSL treats liquid waste by increasing the flow rate of processed liquid waste and overcoming blockages in the system.

The Smart innovation by improving the existing structure in the MSL system so as to increase the ability of the soil to filter and absorb contaminants in wastewater. So that the MSL system is not easily clogged and is able to treat wastewater with a high flow rate and is also able to reduce nutrients and organic matter in the wastewater [11]. The MSL system has the advantage that it is rarely clogged and the area required for installation is small.

High flow rate (HLR), simple maintenance and 20 years effective service life in treating domestic wastewater [19]. Therefore, this MSL system is enough to be a solution to treat industrial tofu wastewater in rural and urban areas in Indonesia. MSL systems can be made from locally available materials in rural and urban areas such as soil, iron pellets, sawdust [2-4].

According to [12] the MSL system has an aerobic layer and an anaerobic layer where the aerobic permeable layer is based on zeolite or split rock. As for the mixed soil layer which is anaerobic, it can be arranged based on a brick pattern or imitate a soil horizon pattern. Wastewater that enters the MSL system is then purified by means of filtration, reabsorption and biodegradation [9-10].

Based on the problems that have been described, this study aims to assess the performance of the MSL system in purifying physicochemical pollutants contained in tofu factory wastewater. Therefore, in this study, an MSL system with a height of 2 (two) meters was made with raw materials derived from local natural resources, namely soil, sawdust and split rock to purify pollutants and contaminants in the waste water of the tofu factory.

MATERIAL AND METHODS Description of experimental in the field and laboratory The structure of the MSL field-laboratory system used in this study is presented in Figure 1.In the installation of the MSL system for experiments, holes are made on sloped land (200 cm high, 50 cm wide, 50 cm long). The MSL system consists of 2 main components, namely a mixed soil layer (SML) and a permeable layer (PL) made of split stone (with a diameter of 3-4 cm) and palm fiber (Geotextile).

The mixed soil layer is made from local soil of sandy loam (Inceptisol) mixed with sawdust from coconut trees (Cocos nucifera), waste iron pellets from lathe with comparison (8 : 1,9 : 0,1) each on a dry weight basis (Figure 2 a,b,c,d)

/ FIGURE 1.Design of Structure of the Multi Soil Layering (MSL) system The mixed soil layer is arranged in a soil horizon pattern in the form of a triangular arrangement surrounded by a layer of gravel and fibers or geotextiles.

The basic physical and chemical properties of the soil used are sandy clay loam (ordo Inceptisol), blackish brown with a pH of 5, C-organic 6.37% and Total Kjedahl Nitrogen 4.8 g/kg [2-4]. Sawdust from coconut trees (1- 2 mm in size), iron pellets from lathe are cut into 2 cm in size (Figure 2 d, e). Waste water from the remaining processing of soybeans into tofu that smells bad is taken from the Tofu Factory in Purwajaya

Village, close to the Politeknik Pertanian Negeri Payakumbuh (Figure 2 f,g). wastewater is taken twice a week and discharged into the MSL system at a Hydraulic Loading rate (HLR) 792 L/ 0.25 m2/hour or 3168 L/m2/hour or 76 M3/m2/day.

The waste water tank is installed above the MSL system and by gravity, Tofu wastewater is discharged or discharged into the MSL system. Aeration or natural inflow of air from pipes placed above the MSL system which aims to create aerobic and anaerobic conditions in the MSL system (Figure 1). FIGURE 2.Materials for the MSL system and Tofu Factory Wastewater Sources: (a) Local soil, (b) sawdust, (c) iron lathe, (d) split stone, (e) Geotextile fibers, (f) Tofu Factory and (g) disposal of tofu factory wastewater.

Description of experimental in the field and laboratory At almost the same time raw and foul smelling tofu factory wastewater and tofu factory wastewater have been treated the system is collected about 1 time a month for testing of chemical and physical pollutant parameters collected by plastic bottles on the influent and effluent from the MSL system. 1000 ml of water samples were taken at each sample point and stored in the refrigerator at 4oC.

For testing physical parameters such as Color and Odor, organoleptic methods were used using 40 respondents. The Analysis of suspended solids (TSS) with gravimetric filtration method. In the analysis of wastewater chemical parameters such as pH, Electric Conductivity (EC), Total Dissolved Solid (TDS) and salt (NaCl) were measured using a multipara meter probe with the Mi 170 Bench meter. Biochemical

Oxygen Demand was measured in 5 test days (BOD_5) using the Warburg method.

Chemical Oxygen Demand (COD) was analyzed by the dichromate reflux method [20].The concentration of phosphates (PO_4-P) was measured by the molybdate method and ascorbic acid was measured by the Genesys 10s UV-VIS spectrophotometry. The concentration of Nitrate Nitrogen (NO_3-N) was analyzed by concentrated sulfuric acid method and measured by Spectrophotometer Genesys 10s UV-VIS with a wavelength of 432 nm. Oil and grease (Grease and oil) were analyzed by gravimetric method using hexane solvent and separating funnel.

Surfer 9 software from Golden Software was used to analyze the data and map the vertical distribution of COD and patterns of wastewater movement in the MSL system. RESULTS AND DISCUSSION Physico-chemical performance of MSL system in purifying Tofu Wastewater Pollutants Table 1. shows that the concentration of all physico-chemical pollutant parameters can be reduced by the MSL system.

Wastewater from the tofu factory changes from very smelly to odorless. The tofu factory waste water changes from a whitish brown color to a slightly clear one. The removal efficiency of Total Suspended Solids (TSS) is 62%. The average organic matter removal efficiency (BOD_5) is 97% and COD is 97% respectively. The occurrence of removal of organic matter in wastewater by the MSL system due to it is absorbed by the mixed porous soil layer.

The MSL system presence of microorganisms to degrade organic matter in the mixed soil layer by changing the organic matter in the wastewater into H_2O and CO_2[9-12]. The average removal efficiency of NO_3-N and PO_4-P were 99.9% and 67%, respectively (Table 1). Regarding the removal of N and P, the results also showed that the MSL system was very effective in removing NO_3^- -N and PO_4^- - P in Tofu Wastewater.

The facts from Table 1 also show that the MSL system was able to treat organic matter, color, odor and nutrients during the experiment without clogging the MSL system with a wastewater flow rate (HLR) of 792 L/ 0.25 m^2/hour. The average nutrient transfer by the MSL system for TSS, BOD_5, COD, NO_3^- -N and PO_4^- -P were 62%, 97%, 97%, 99.9%, 67%, respectively.

The physicochemical content of treated water by the MSL system for TSS, pH, BOD_5, COD NO_3^- -N and PO_4^- -P, oil and grease (grease and oil) has met the quality limits for the disposal of tofu factory wastewater as recommended by Laws in Indonesia (Table 1). TABLE 1.Mean level concentration of waste water Tofu factory and Treated water by MSL system (mean + standard deviation), removal percentage and admissible limit for Tofu factory waste water reject.

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Parameter Polutant _Tofu factory Waste water _MSL system RP (%) Treated water _Absolute removal rate _Admissible limit for wastewater

RP: Removal Percentage * Admissible limit for Tofu wastewater release by Indonesia government 2014 Notes: TSS, Total suspended solids; BOD_5, biological oxygen demand measured in a 5-day test; COD, chemical oxygen demand; NO_3^{-}–N, nitrate; PO_4^{-}–P, orthophosphates; EC, electric conductivity; TDS, total dissolved solid; NaCl, salts

It was proven in this study that the content of organic matter, nutrients, odor and color in tofu factory wastewater can be removed by the MSL system very efficiently.

Why organic matter, nutrients, odor and color can be removed from wastewater because organic matter in tofu wastewater is consumed by microorganisms as a source of carbon (C) is important for microorganisms. Meanwhile, the Odor and Color parameters are absorbed or absorbed or removed by the carbon present in the mixed soil layer. Carbon comes from local soil and Sawdust.

Based on the report of [21-22] and [11] that in the MSL system, pollutants in wastewater can be physically-chemically absorbed by soil particles (SML: mixed soil layer) and split rock surface (PL: permeable layer). . Furthermore, it is broken down by microorganisms found in the mixed soil layer. In the book[23] says that in 1 tablespoon or 10 grams of natural soil contains 11 billion microorganisms.

In MSL the system uses local soil as the main raw material, as well as being a source of microorganisms that play a role as a bioreactor that works to purify pollutants contained in the waste water of the tofu factory. Although the characteristics of the tofu factory wastewater, with HLR or flow rate, the composition and dimensions of the MSL system are different from those made in Japan, China, the United States, Morocco. However the efficiency of organic matter removal is similar to that reported by other studies.

in Indonesia,[1] found that the removal efficiency of BOD5 was 95% and that of COD was 99%, respectively. Color removal or decolorization is somewhat similar to that of [21-22], ranging from 52 to 67%. Odor removal efficiency, EC, TDS, NaCl in the MSL system which is also very efficient, it turns out that this team has just reported and has not been reported by other researchers. The NO3-N removal efficiency was very high (99%) in this study compared to that observed by [11] of 75% and [5] which is 71%.

This is related to the MSL height of the system in this experiment which is higher so that perfect absorption occurs because of the height of 200 cm while in other studies it is < 100 cm. This phenomenon can be explained by the research of [19] that the high NO3-N removal efficiency may be due to the high capability of the soil and local materials used to compose the MSL system. Where can absorb NH4-N.

In addition, it is able to maintain the coexistence of aerobic and anaerobic conditions in the MSL system in carrying out the chemical process of alternating nitrification and denitrification. This can happen because this MSL system uses local soil, local sawdust, local geotextiles, local split stone. Where it is possible to create optimal conditions and can explain the high efficiency performance in NO3-N removal.

The percentage of PO4-P removal was quite high (67%) in the MSL system in this study. Because according to [17] and (14,15) the absorption and or rusting of iron into Fe+ in the mixed soil layer in the MSL system and results in binding PO4- ions. Similar results to those obtained by [11] on domestic wastewater treated with MSL systems found the percent removal of PO4- -P between 44% and 88%, respectively.

Where the HLR flow rate is 7.9 – 76 L/m2/day. Absolute removal by the MSL system in this study was quite high in purifying tofu factory wastewater because the HLR was high, namely 792 L/ 0.25 m2/hour or 3168 L/m2/hour or 76 M3/m2/day (Table 1). (9,10) reported that for domestic wastewater treated with MSL systems in Japan with an HLR of 7.9

- 76 L/m2/hour, the absolute removal rate ranged from 0.54 to 6.25 TSS g/m2/hour, 0.2 63 - 5, 29 BOD5 g/m2/Hour, 0.83 - 9.13 COD g/m2/Hour. This Absolute pollutant removal rate increases with increasing HLR from 21 - 83 L/m2/hour but the pollutant removal efficiency is relatively low because the residence time of effluent in the MSL system is shorter[21-22]reported that with a low HLR in MSL this system is more efficient than other natural systems such as artificial wetlands because it requires more land.

Therefore, the MSL system is a better choice in purifying tofu factory wastewater for solving wastewater problems in urban and rural areas in Indonesia. Figure 2 shows in detail the vertical distribution of COD in each layer of the MSL system as high as 200 cm and also in detail shows the movement of tofu factory wastewater from top to bottom in the MSL system.

High COD removal occurred gradually at 6 levels of mixed soil layer and 6 levels of permeable layer of split rock and local palm fiber. At a depth of 120 cm from the height of the MSL system. It turns out that the COD concentration is in accordance with the quality standards recommended by the Indonesian government.

The process of decreasing the COD concentration of the tofu factory wastewater continues to a depth of 200 cm from the MSL system. In the 12 layers of MSL system in this study, the process of absorption and degradation of COD occurred in a linear model. COD removal begins at the first mixed soil layer. Linearly and gradually the COD concentration continued to decrease until 97% was removed.

/ FIGURE 3.Vertical Distribution of Chemical Oxygen Demand (COD) in MSL system during purification of wastewater Tofu factory This occurs in the 6th mixed soil layer.

A somewhat similar result was reported by [14-15] that in the MSL system, COD removal occurred in the first mixed soil layer and continued in the 6th layer until the COD was reduced to 90%. It was found in the experimental MSL system as high as 73 cm with an HLR flow rate of 42 L/m2/hour. The MSL system in this study has a flow rate (HLR) of 1800 times greater but has almost the same ability because it is 2.7

times higher and is made from Indonesian local raw materials. CONCLUSIONS It turned out that the MSL system in removing pollutants in the liquid waste of the tofu factory which was tested in this experiment showed its performance and high adaptability and was efficient in handling wastewater pollutant parameters, namely odor, color, organic matter and nutrients.

This MSL system is recommended to be applied in purifying pollutants in wastewater from tofu factories which are widely spread in rural and urban areas in Indonesia. MSL system can be made from local soil and local natural resources native to Indonesia, which is widely available in rural areas. MSL system is effective and efficient with smart innovations that are simple and also cheap and have fewer operational and maintenance constraints.

ACKNOWLEDGMENTS We thank to the Mendikbud Ristek and Politeknik Pertanian Negeri Payakumbuh or financial support and technical assistance for this research.
REFERENCES Rahmiana Zein,RefildaSuhaili, HericNovrian, SyukryaNingsih, LidyaNovita, NenengSwesty, Mukhlis, and HilfiPardi. 2017. Multi Soil Layering (MSL) System for Treatment of Tofu Industry Wastewater. Research Journal of Pharmaceutical, Biological and Chemical Sciences. RJPBCS 8(6). 675-682.

https://www.researchgate.net/publication/328980681 Aflizardan Tim. 2018. Pengenalan IPAL STBM (InstalasiPengolahan Air Limbahsistim Tanah BerlapisMelafu) danFaktaunikdibalik IPAL IndustriMilikSwastadan Negara. Politeknik Pertanian Negeri Payakumbuh. Aflizar. 2013.

MengatasiPencemaranPerairanDenganIpalStbm (Sistim Tanah BerlapisMelafu) UntukMengolahLimbahCair Home Industri Dan Domestik Dan Air Sungai Tercemar. Politeknik Pertanian Negeri Payakumbuh. DOI: 10.13140/RG.2.2.35549.92649. Aflizar, Muzakir, Edi Syafri. 2014. Poster thn 1 Ristek. Rekayasa IPAL STBM (Sistim Tanah BerlapisMelafu) berbasisTempurungSawitdan material LokaluntukmenetralisirPolutandalamLimbahcair PKS DOI: 10.13140/RG.2.1.3835.7362 Lahbib LATRACH1, Tsugiyuki MASUNAGA, Naaila OUAZZANI1, Abdessamad HEJJAJ1, Mustapha MAHI and Laila MANDI. 2014.

Removal of bacterial indicators and pathogens from domestic wastewater by the multi-soil-layering (MSL) system. Soil Science and Plant Nutrition (2014), 1–10. http://dx.doi.org/10.1080/00380768.2014.974480 Bdour AN, Hamdi MR, Tarawneh Z

2009: Perspectives on sustainable wastewater treatment technologies and reuse options in the urban areas of the Mediterranean region. Desalination, 237, 162–174. doi:10.1016/j.desal.2007.12.030 Starr K, Gabarrell X, Villalba G, Peiro LT, and Lombardi L. Biomass and Bioenergy 2014; 62: 2043-2049.

Kim MS, Lee DY, and Kim DH. Int. J. of Hydrogen energy 2011; 36: 8712-8719. Masunaga T, Sato K, Mori J, Shirahama M, KudoH,Wakatsuki T 2007a: Characteristics of wastewater treatmentusing a multi-soil-layering system in relation to wastewater contamination levels and hydraulic loading rates. Soil Sci. Plant Nutr., 53, 215–223. doi:10.1111/j.1747-0765.2007.00128.x

Masunaga T, Sato K, Senga Y, Seike Y, Inaishi T, Kudo H, Wakatsuki T 2007b: Characteristics of CO2, CH4 and N2O emissions from a multi-soil-layering system during wastewater treatment. Soil Sci. Plant Nutr., 53, 173–180. doi:10.1111/j.1747-0765.2007.00118.x Masunaga T, Sato K, Wakatsuki T 2001: Application of multisoil- layering method in wastewater treatment. APEC virtual centre for environmental technology exchange.

Masunaga T, Sato K, Zennami T, Fujii S, Wakatsuki T 2003: Direct treatment of polluted river water by the multi-soillayering method. J. Water Environ. Technol., 1, 97–104. doi:10.2965/jwet.2003.97. Sato K, Iwashima N, Wakatsuki T, Masunaga T 2011: Quantitative evaluation of treatment processes and mechanisms of organic matter, phosphorus, and nitrogen removal in a multi-soil-layering system. Soil Sci. Plant Nutr., 57, 475–486. doi:10.1080/00380768. 2011.590944

Sato K, Masunaga T, Wakatsuki T 2005a: Characterization of treatment processes and mechanisms of COD, phosphorus and nitrogen removal in a multi-soil-layering system.

Soil Sci. Plant Nutr., 51, 213–221. doi:10.1111/j.1747- 0765.2005.tb00025.x Sato K, Masunaga T, Wakatsuki T 2005b: Water movement characteristics in a multi-soillayering system. Soil Sci. Plant Nutr., 51, 75–82. doi:10.1111/j.1747-0765.2005.tb00009.x Attanandana T, Saitthiti B, Thongpae S, Kritapirom S, Luanmanee S, Wakatsuki T 2000: Multi-media- layering system for food service wastewater treatment. Ecol. Eng.,

15, 133–138. doi:10.1016/S0925-8574(99)00041-5 Luanmanee S, Boonsook P, Attanandana T, Saitthiti B, Panichajakul C, Wakatsuki T 2002: Effect of intermittent aeration regulation of a multi-soil-layering system on domestic wastewater treatment in Thailand. Ecol. Eng., 18, 415–428. doi:10.1016/S0925-8574(01)00103-3 Luo W, Yang C, He H, Zeng G, Yan S, Cheng Y 2014: Novel two-stage vertical flow biofilter system for efficient treatment of decentralized domestic wastewater. Ecol.

Eng., 64, 415–423. doi:10.1016/j.ecoleng.2014.01.011 Chen Xin , An Cheng Luo, Kuniaki Sato, Toshiyuki Wakatsuki &Tsugiyuki Masunaga. 2008. An introduction of a multi-soil-layering system: a novel green technology for wastewater treatment in rural areas. Water and Environment Journal. Print ISSN 1747-6585. doi:10.1111/j.1747-6593.2008.00143.x APHA 1992: American Public Health Association. Standard Methods for Analysis of Waste and Waste Water.

APHA,Pub, Washington, DC. CHEN Xin, Kuniaki SATO, Toshiyuki WAKATSUKI and Tsugiyuki MASUNAGA. 2007. Comparative study of soils and other adsorbents for decolorizing sewage and livestock wastewater. Soil Science and Plant Nutrition (2007) 53, 189–197. doi: 10.1111/j.1747-0765.2007.00124.x CHEN Xin ,Kuniaki SATO, Toshiyuki WAKATSUKI and Tsugiyuki MASUNAGA. 2007b.

Effect of aeration and material composition in soil mixture block on the removal of colored substances and chemical oxygen demand in livestock wastewater using multi-soil-layering systems. Soil Science and Plant Nutrition (2007) 53, 509–516 doi: 10.1111/j.1747-0765.2007.00156.x Brady, R and Weil, NC. 2007. Nature and Properties of Soils, The, 15th Edition. Pearson . https://www.pearson.com/us/higher-education/program/Weil-Nature-and-Properties-of-Soils-The-15th- Edition/PGM219427.html

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