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Multi Soil Layering Method for Wastewater Treatment: A Review

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Abstract

Liquid waste is the main source of contamination of water bodies, especially river water. This pollution causes decreased water quality in water bodies. One of the wastewater treatment treatments is the Multi Soil Layering (MSL) method. Some of the advantages of using the MSL method are that it is known to be cheap in terms of cost, easy to implement, does not require complicated maintenance so that it can be used continuously, and is also environmentally friendly. One of the constituent materials of the MSL reactor is andesol soil, gravel, and pearlite. MSL has two wastewater treatment zones, the aerobic zone, and the anaerobic zone. The article review aims to compare the efficiency of reducing the levels of pollutant parameters from aerobic and anaerobic processes in MSLmethod in wastewater.

Keywords: Aerobic, anaerobic, multi soil layering, wastewater treatment, MSL.

INTRODUCTION

The Multi Soil Layering (MSL) method is a wastewater treatment method that utilizes the ability of the soil as the main medium to reduce pollutant parameters and how to maximize the function of the soil, which is formed into a structure made in a construction consisting of a mixture of soil (organic) and rock composition. shaped like the arrangement of bricks. The composition of the soil mixture is usually made of selected soil, carbon, and others as well as for rock layers composed of additional materials such as rice husks, sawdust, zeolite, pearlite, gravel, and depending on the type of rock available (Latrach et al., 2016; Putra et al., 2019; Putra et al., 2018).

In principle, the MSL method has the main treatment zones, namely the aerobic and anaerobic zones. The aerobic zone usually consists of rock (zeolite, gravel, pearlite) while the anaerobic zone usually consists of a mixed layer of soil and activated carbon (charcoal) (Adindaet al., 2015; Akhyar et al., 2016; Latrach et al., 2014; Mutia et al., 2015).

Multi soil layering (MSL) is a method of treating wastewater that is effective and efficient, easy, and inexpensive without having to incur expensive costs (An et al., 2016; Latrach et al., 2014). Currently, the MSL method has been widely used as an alternative in wastewater treatment which has been proven to be effective in treating domestic wastewater and small industries (Hadrah et al., 2019; Sy et al., 2017; (Kasman et al., 2021).

One example of domestic wastewater that contain of several pollutant such as NO_3^-, treated with the MSL method is wastewater from the rest of household activities. The rest of household activities pollute the community environment through substances contained in wastewater which is very dangerous if not handled properly, in addition to household wastewater there is also wastewater from small home industries such as the laundry industry, industrial home batik, coconut industry, screen printing industry.

Similarly, industrial wastewater such as leather and weaving industry, containing some harmful pollutants that necessary to be treated. especially with adsorption method. Leather industry that hold some amount of coppers must be removed before spreading the undesirable effect to the environment (Maryudi et al., 2021).

From previous studies, the MSL method has succeeded in reducing levels of biological pollutant parameters such as BOD, COD, TSS, DO, pH, odor, and turbidity as well as heavy metal pollutant parameters such as Fe, Mn, and phosphate (Male, et al., 2020; Putri et al., 2019). In numerous of studies, domestic wastewater can reduce BOD around 68.67-87.63%, COD around 71.42-87.73%, and TSS around 69.11-77.12% The cooking oil industry, it can reduce BOD levels around 86-99%, COD around 71-96%, TSS around 77-88%, and pH around 6.95-7.24 (Sbahi et al., 2020).

The article review aims to compare the efficiency of reducing levels of pollutant parameters from aerobic and anaerobic processes in the MSL method in wastewater.

MULTI SOIL LAYERING

Multi Soil Layering (MSL) is a method used in the wastewater treatment process. The wastewater treatment process using this method is known to be inexpensive in terms of cost, easy to implement, does not require complicated maintenance so that it can be used continuously, and is also environmentally friendly. In addition, the materials used in the MSL reactor are widely available and easy to find in Indonesia because the materials used can be obtained in nature and the environment around coconut charcoal, zeolite, rice husks, sawdust, activated charcoal from various organic materials, and coatings. Anaerobic soil consists of andesol originating from the mountains, while pearlite and gravel are the aerobic layers (Fajri et al., 2018)

In wastewater treatment using the MSL method, the soil is used as the main medium to reduce pollutant parameters and enhance soil function through its structure (Haribowo et al., 2019; Lamzouri et al., 2016; Mutia et al., 2015; Song et al., 2018).

MSL method formed to become a reactor consisting of a mixed layer of soil and rock layers arranged like bricks. The composite layer of soil consists of organic matter, carbon elements found in charcoal, and other additives such as iron filings. Commonly used mixed layers such as pearlite, gravel, and zeolite also depend on the type of rock contained in the composition of the bricks. Zeolite or perlite which contains silica group could support better performance during the adsorption process (Hanum et al, 2022; Rahayu, 2022; Rahayu et al., 2021). The effective use period for the MSL system for waste treatment is 12.8 years (Ihsan et al., 2013). (Nadhirah et al., 2021).

Based on the principle of the MSL method, there are two zones used in processing, namely the aerobic zone contained in the rock layer (perlite, gravel, and zeolite also depending on the type of rock present) and between the zeolite layer and soil mixture blocks. The function of the aerobic zone is to decompose organic matter, bind phosphate, oxidize ferrous ions to ferric ions, and nitrify. The mixed soil layer is in the anaerobic area. Using MSL, the wastewater treatment process consists of decomposition, filtration, fixation, nitrification, denitrification, absorption, and adsorption (Adindael al., 2015; Herman et al., 2017).

Numerous pieces of researches related to wastewater treatment using the MSL which uses many compositions from the reactor-making material and lots of samples have been tested. Some parameters investigated from all research parameters that are often sought are COD, BOD, TSS, pH, turbidity, odor, color, Ammonia, nitrate, nitrite, potassium phosphate and metals such as Mn, Pb, Hg, and Fe. Table 1 shows the composition of MSL.

Table 1. Multi Soil Layering (MSL) composition

No	Composition	Waste Type	Aerobic/anaerobic MSL conditions	Success	Ref
1	Coconutshell activated charcoal,perlite,gravel, rice husk, and Andasol soil. (With variations of HLR 5,10,20,40 ml/min)	Coconut industrial waste water	Aerobes and Anaerobes	BOD (35.68-20.13 and 13.53-33.01) COD (20.13-84.62 and 69.23-88.62) Turbidity (84.76-97.99 and 88.35-98.66) E.coli (99.25-99.92 and 25-99.92)	(Putra et al., 2018)
2	Coconut shell activated charcoal, perlite, gravel, rice husk, and Andasol soil.(With variations of HLR 5, 10, 20, 40 ml/min)	Coconut milk liquid waste	Aerobes and Anaerobes	Phosphate (99.28-99.80 and 99.82-99.87) Nitrite (68.06-76.39 and 67.36-74.31) Sulfate (96.97-97.48 and 86.56-97.30) Chloride (75.44- 85.51 and 82.99-88.66) Manganese (Mn) (79.44 - 94.39and49.77-80.61) Iron(Fe) (92.11-97.50 and 94.41-98.82)	(Putra et al., 2019)
3	Crushedstone, perlite, Andasol soil, gravel, banana peel charcoaland coconut shell charcoal (Variation HLR 500,700,900 l/m^2/day)	District peat water Tapung Kampar Regency	Anaerobic	Mn metal (36.65-55.83) Turbidity (63.86-61.45) pH (6.51-6.82)	(Adinda et al., 2015)
4	MSL A reactor (Andasol soil, zeolite and quartz sand) MSL B reactor (Andasol soil, isthmus and pumice stone)	Sasirangan industrial liquid waste		BOD (63.89%) COD (65.6%)	(Akhyar et al., 2016)
5	Gravel, pearlite, ground activated charcoal of Kalapa shell and activated charcoal of banana peel. Reactor 1 MSL : Anaerobic layer of coconut shell activated charcoal and soil Reactor 2 MSL : Anaerobic layer of activated charcoal banana peel and soil (Variation of HLR 500, 750, and 1000 L/m$^{2/}$day)	Palm oil effluent in anaerobic pond II (outlet) WWTP PT. Nusantara V Sei Pagar Plantation, Riau.	Anaerobic	TSS (coconut)= (79.77-88.76) Ammonia (coconut) = (39.85-56.52) TSS (banana) = (73.03-79.77)	(Mutia et al., 2015)
6	MSL1 reactor :Zeolite layer and gravel and gravel mixed with zeolite MSL2 reactor :(soil mixture layer (coconut shell activated charcoal and Andasol soil) + (Paddy straw activated	Waste in the WWTP in RT.04 RW.07 Tlogomas Village.		pH (4.25-5.77) TSS (58.42-71.05) TDS (18.05-31.84) DO (75.06-81.88) Turbidity (72.91-76.69) Electrical	(Megah et al., 2016)

	charcoal and Andasol soil) + (sawdust and Andasol soil) (Coconut shell and Andasol soil layers are more efficient)			Conductivity (16.49-31.77)	
7	Crushed stone, gravel/zeolite, soil mixture, and plastic nets (with variations of hrl 500,750, and 1000 l/m^2/day) (more efficient eg with the addition of zeolite is better than without zeolite)	Laundry Liquid Waste		COD (74-87) BOD (75-88) TSS (73-88) Total phosphate (20-78) pH (6.73) MBA (85-95)	(Hadrah et al., 2019)
8	Reactor 1 MSL : gravel and charcoal, mixed layer of andisol soil, and crushed stone. Reactor 2 MSL : Sawdust and gravel, mixed layer of andisol and crushed stone.	Domestic wastewater from cafeteria and kitchen at Kasetsart University, Bangkok	Anaerobic	Oils and Fats (27,778-89,474)	(Sy et al., 2017)
9	A mixture of andosol soil, zeolite rock, gravel, rice husk, coconut shell charcoal, and sawdust. (most effective with sawdust in lowering heavy metal indicators)	Dug well water and river or ditch water in Teluk Nilap Village, Kubu Babussalam, Rokan Hilir		pH (50) COD (31.16) BOD (73.16) Metal Hg (70.75) Metal Pb (26.74) Metal Fe (46.94)	(Putri et al., 2019)
10	Reactor MSL 1: a layer of gravel mixed with activated charcoal with soil MSL 2 reactor: layer of gravel and sawdust with soil,	Rice Field Liquid Waste	Anaerobic	Potassium (19,443-100)	(Ihsan et al., 2013)
11	Andesole soil and charcoal	Hotel Liquid Waste	Anaerobic	COD (55-90)	(Elystia, et al., 2012)
12	Andisol soil, bagasse activated charcoal powder and fine bagasse powder	Tofu industrial liquid waste	Aerobic	TSS (86.86) BOD (78.87) COD (89.75)	(Dessy et al., 2019)
13	Ijuk, iron, sawdust, activated charcoal that has been sifted with a size of 50 mesh and volcanic soil (variation of HLR 250, 500, 1000 l/m^2/day)	Polluted water in Mount Nago Irrigation area of Pasar Baru, Cupak Tangah Village, Pauh IX District, Padang.	Anaerobic	pH (8) COD (97.21)-99.59) BOD (98.84-99.73) PO_4^- (>0.03 ppm) NH_4^+ (<0.2 ppm)	(Herman et al., 2017)
14	Zeolite, gravel sand, porous	Synthetic		COD (98.29)	(Hong et

	plate and outlet pipe, soil, charcoal and iron powder.	waste in rural China		TP (100) NH_4^+ (76.60)	al., 2019)
15	Mixture of soil, crushed stone and zolite	Leachate Liquid Waste		COD (96.771%) Ammonia (99.966%) Fe (99.279%) Color (96.53%) pH 7.00	(Lamzouri et al., 2016)
16	Gravel, zeolite, a mixture of soil and coconut shell charcoal	Ethanol Industrial Liquid Waste		COD (80.85) BOD (94.68) TSS (83.99)	(Irmanto et al., 2013)
17	Crushed stone, river pebbles, mixed soil and gravel	Leachate Liquid Waste		COD (53.457) Ammonia (98,325) Fe (88.5) pH 7.00	(Kasman et al., 2021)
18	Sand, gravel, humus soil, coconut charcoal. (innovation with sand with HLR 0.3 ; 0.6 ; 0.9 and 1.2 L/m^2/hour)	Liquid waste (WWTP) the last pool of the CPO industry		COD (89.06-97.47) BOD (88.61-98.37) pH (6.72-7.36) Oil and Fat Content (88.27 -95.48)	(Sidebang et al., 2017)
19	Volcanic soil, rice husk, coconut shell activated charcoal, zeolite, iron powder. (variation of water rate (HLR) 10, 20, 40, 80 mL/m^2/min)	The sample came from the well water of a resident in Jati, Padang.	Aerobes and Anaerobes	Turbidity (54.65 and 44.04) Mn (66.44 and 47.26) Nitrite (58.74 and 49.74) Nitrates (58.34 and 45.57) pH (77 and 73) Odor (no smell	(Song et al., 2020)
20	Sawdust, andisol soil, coarse gravel and fine gravel, and fine charcoal from coconut shells.	Cooking Oil Industry Liquid Waste		BOD (98) COD (96) TSS (88)	(Swesty et al., 2019)
21	Silica sand, coconut husk, activated carbon, ginger coral, water hyacinth, fine zeolite, soil, coarse zeolite, gravel, and dacron	Batik liquid waste in Binangun Village, Banyumas District, Banyumas Regency.		pH (7.94) Chromium (29.41) Turbidity (low) Odor (low)	(Wibowo et al., 2019)

Table 1 shows that it can be seen that the percentage value for almost all parameters is close to perfect. For example, the COD results of 99.59% in the Mount Nago irrigation water sample in the Pasar Baru area, Cupak Tengah Village, Pauh IX District, Padang.

The composition of the MSL reactor is palm fiber, iron, sawdust, activated charcoal that has been sifted with a size of 50 mesh, and volcanic soil with variations in HLR or flow rate of 250,500,1000 l/m2/day with anaerobic process conditions (Hadrah et al., 2019).

The BOD result was 98.8% in the Mount Nago irrigation water sample in the Pasar Baru area, Cupak Tengah Village, Pauh IX District, Padang. The composition of the MSL reactor is palm fiber, iron, sawdust, activated charcoal that has been sifted with a size of 50 mesh and volcanic soil and with variations in HLR or flow rate of 250,500,1000 l/m^2/day with anaerobic process conditions (Hadrah et al., 2019).

The TSS results were 79.77% with banana peel activated carbon and 88.76% with coconut shell activated carbon in the sample of palm oil liquid waste in the anaerobic pond II (outlet) of wastewater treatment plant PT. Nusantara V Sei Pagar Plantation, Riau. With the composition of gravel, pearlite, soil activated charcoal of Kalapa shell and activated charcoal of banana peel, in this research there are two innovations, namely by making two reactors with activated carbon of banana peel and activated carbon of coconut shell where the reactor with the composition of activated charcoal of coconut shell is more effective, with HLR 500, 750, and 1000 l/m^2/day under anaerobic conditions (Megah et al., 2016). The yield of Fe metal is 99% and 99, 27% in samples of coconut milk liquid waste and Leachate liquid waste with reactor compositions Coconut shell activated charcoal, pearlite, gravel, rice husks, and Andasol soil and a mixture of soil, crushed stone and zeolite with an anaerobic process (Komala et al., 2012; Mutia, et al., 2015).

Manganese yield was 94.39% in coconut milk liquid waste samples with reactor compositions of Coconut shell activated charcoal, pearlite, gravel, rice husks, and Andasol soil and with variations in HLR or flow rates of 5, 10, 20, 40, ml/m^2/minute with aerobic processes (Mutia et al., 2015). It can be seen that the MSL method can be used to treat industrial, household, and other wastewater. With many reactor composition innovations that are easy to find around us.

The parameters that have been tested, each shows the level of success. Some samples that have been tested show MSL conditions, some are aerobic, and some are anaerobic, some have two states at once. However, in MSL conditions, this dramatically affects the success rate. In addition to aerobic and anaerobic process conditions, variations in the Hydraulic Loading Rate (HLR) are also very influential on the success of the Multi Soil Layering method. There is still very little explanation of this condition in aerobic conditions because the aerobic process is less efficient for use in wastewater at high pollutant levels above 3000 mg/L.

AEROBIC

Aerobic is a biological waste treatment that uses oxygen as a processing process. In the anaerobic process, the wastewater treatment process is carried out biologically; in the process, micro-organisms or bacteria are used to decompose certain pollutant compounds in a biological reactor (Fajri et al., 2018; Harimu et al., 2020). Conditions are created to adjust the growth of micro-organisms or bacteria to be used. Based on the oxygen present in the heterotrophic bacteria environment, heterotrophic bacteria are therefore divided into two types, namely: Firstly, Absolute aerobic bacteria: i.e. bacteria that, if there is no oxygen in the environment, can not live. Secondly, Aerobic, facultative bacteria: bacteria that can grow even without oxygen, but if there is oxygen in their environment, they will show faster growth. Factors that can affect the wastewater treatment process using aerobic such as hydrocarbon, oxygen, the composition of microorganisms, pH, temperature, and nutrients (Dewi, 2022; Fajri et al., 2021).

Aerobic bacteria used in wastewater treatment processes contain organic pollutants and other chemical compounds such as sulfides and ammonia. In this process, these compounds will be decomposed first to produce neutral and more environmentally friendly compounds. The aerobic decomposition process can be seen as follows:

Organic Decomposition Reaction:

$$\text{Organic Pollutant Compound} \xrightarrow[\text{Heterotropic}]{\text{Oxygen } (O_2)} CO_2 + H_2O + NH_4 + \text{Biomas} \quad (1)$$

Nitrification Reaction:

$$NH_4^+ + 1.5\ O_2\ NO_2 \rightarrow + NO_2^- + 2\ H^+ + H_2O \quad (2)$$

$$NO_2^- + 0.5\ O_2 \rightarrow NO_3^- \quad (3)$$

Sulfur Oxidation Reaction:

$$S^{2-} + {}^1/_2\ O_2 + 2\ H^+ \rightarrow S^0 + H2O \quad (4)$$

$$2\ S + 3\ O_2 + 2\ H_2 \rightarrow 2\ H2SO4 \quad (5)$$

Based on these chemical reactions, it can be seen that oxygen is very influential because oxygen is needed to decompose pollutants, and the amount of oxygen required is proportional to the amount of organic, sulfide and ammonia present in wastewater (Hartaja, 2015). There are advantages in the aerobic process: the reaction is faster than the anaerobic process, and organic pollutants can be degraded to deficient concentrations.

Not only has its advantages, the wastewater treatment process carried out aerobically also has several disadvantages (Kasman et al., 2021). It takes much energy to supply oxygen to a wastewater treatment reactor, and the operating costs are high. During the process, the mud will appear so that it requires further handling and requires a relatively expensive cost. On the other hand, it process is less efficient when used in wastewater with high levels of pollutants or waste above 3000 mg/L.

Treating wastewater using an aerobic method, it can reduce the level of danger from the water with the success rate of each and the type of each waste with variations in the HLR in each process. The following is a table of the success rate of the aerobic process:

Table 2. The success rate of aerobic methods in wastewater treatment

No	Waste Type	Waste Content	Level of success (%)	Ref
1	Coconut milk industry liquid waste	BOD	35.68 - 20.13	(Putra et al. 2018)
		COD	20.13 - 84.62	
		Turbidity	84.76 - 97.99	
		E. coli	99.25 - 99.92	
2	Coconut industry liquid waste	Phosphate	99.28 - 99.80	(Putra et al., 2019)
		Nitrite	68.06 - 76.39	
		Sulfate	96.97 - 97.48	
		Chloride	75.44 - 85.51	
		Manganese (Mn)	79.44 - 94.39	
		Iron (Fe)	92.11 - 97.50	
3	Tofu industrial liquid waste	TSS	86.86	(Dessy et al., 2019)
		BOD	78.87	
		COD	89.75	
4	The sample came from the well water of a resident in Jati, Padang.	Turbidity	54.63	(Wibowo et al., 2019)
		Mn	66.44	
		Nitrite	58.74	
		Nitrate	58.34	
		pH	77	
		Smell	No smell	

Table 2 shows that the highest BOD value is 78.7 in the aerobic process, which tests samples of tofu industrial waste. Factors that influence this process are HLR or water rate and reactor composition. At the highest COD value of 89.75, this parameter is also shown in the tofu industrial waste test. Factors influencing this process are variations in Hydraulic Loading Rate (HLR) or water rate and reactor composition.

ANAEROBIC

Anaerobic is a process that does not involve free oxygen as an oxidant. Anaerobic processing is carried out using microorganisms. In wastewater treatment, the use of microorganisms has a relatively high content of organic matter, so it is very potential if developed. Microorganisms can directly use wastewater as nutrients for growth. Anaerobic microorganisms are sensitive to oxygen because they can inhibit growth (Hartaja, 2015; Koottatep et al., 2021). Methane gas is obtained from an anaerobic process undergoing various stages.

The anaerobic process produces single carbon compounds because almost all organic polymers can be decomposed into single carbon compounds. The construction of methane gas comes from acetic acid, H_2, and CO_2. In addition, it can result from the conversion of formic acid and methanol (Hartaja, 2015).

$CH_3COOH \rightarrow CH_4 + CO_2$ Acetic Acid

$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$

$HCOOH \rightarrow 0.25\ CH_4 + 0.75\ CO_2 + 0.5\ H_2O$
Formic Acid

$CH_3OH \rightarrow 0.75\ CH_4 + 0.25\ CO_2 + 0.5\ H_2O$
Methanol

The anaerobic process has several advantages including:

- Energy saving, because the decomposition process of organic pollutants by microbes is carried out without using air, so energy is not needed to supply air as occurs in aerobic

processes (Hartaja, 2015).
- Produce biogas (methane gas). The final breakdown of pollutant products, methane gas, which can be used as gas fuel, can be used for power generators and also in steam generator boilers (Hartaja, 2015).
- It can treat waste with high concentrations such as BOD up to 80,000 mg/l (Hartaja, 2015).

In addition to advantages, the anaerobic wastewater treatment process has several disadvantages including
- Slow pollutant decomposition reaction (Komala et al., 2012).
- Sensitive if exposed to air, temperature, and load fluctuations (Komala et al., 2012).
- If treating low concentration waste is less effective, such as BOD below 3,000 mg/l (Komala et al., 2012).
- The development of biomass to be used it takes a long time in start-up (Komala et al., 2012).

In the anaerobic process, it is known that the pollutant reaction rate is fundamentally influenced by the number of bacteria. In addition, the degradation process will take place quickly if given the addition of nutrients such as nitrogen and phosphate compounds. The anaerobic process will be disrupted if there are chemicals such as cyanide compounds, sulfur, and heavy metals. The following is a table of the success rate of the anaerobic process.

Table 3. The success rate of anaerobic methods in wastewater treatment

No	Waste Type	Waste Content	Level of success	Ref.
1	Peat Water Treatment	pH	6.51-6.82	(Adinda et al., 2015)
		Mn . metal	36,6555,83	
		Turbidity	63.86-61.45	
2	Coconut industry liquid waste	Phosphate	99.82-99.87	(Putra et al., 2019)
		Nitrite	67.36-74.31	
		Sulfate	86.56-97.30	
		Chloride	82.99-88.66	
		Manganese (Mn)	49.77-80.61	
		Iron (Fe)	94.41-98.82	
3	Coconut milk industry liquid waste	BOD	13.53-33.01	(Mutia et al., 2015)
		COD	69.23-88.62	
		Turbidity	88.35-98.66	
		E. coli	25-99.92	
4	Palm Oil Liquid Waste	TSS (coconut)	79.77 – 88.76	(Mutia et al., 2015)
		TSS (banana)	73.03-79.77	
		Ammonia (coconut)	39.85 – 56.52	
5	Domestic wastewater from cafeteria and kitchen at Kasetsart University, Bangkok	Oils and Fats	27,778-89,474	(Sy et al., 2017)
6	Rice Field Liquid Waste	Potassium	19,433 -100	(Ihsan et al., 2013)
7	Hotel Liquid Waste	COD	55-90	(Elystia et al., 2012)
8	Polluted water in Mount Nago Irrigation area of Pasar Baru, Cupak Tangah Village, Pauh IX District, Padang.	pH	8	(Herman et al., 2017)
		COD	97.21)-99.59	
		BOD	98.84-99.73	
		PO_4^-	(>0.03 ppm	
		NH_4^+	<0.2ppm	
9	The sample came from the well water of a resident in Jati, Padang.	Turbidity	44.04	(Song et al., 2020)
		Mn	47.26	
		Nitrite	49.74	
		Nitrate	45.57	
		pH	73	
		Smell	No smell	

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Based on Table 3, the anaerobic MSL conditions have been tested with several different samples and waste content which includes potassium, TSS (coconut), TSS (banana), ammonia, BOD, COD, turbidity, E. coli, phosphate, nitrite, sulfate, chloride, manganese (Mn), iron (Fe), turbidity, Mn, nitrate, pH, odor, odorless, oil and fat, PO_4^-, NH_4^+ and metal Mn (Latupeirissa, et al., 2014; Nurhadini and Silalahi, 2017; Raksajati et al., 2020; Rustiah et al., 2018).

CONCLUSION

Comparing aerobes and anaerobes in handling domestic waste using the MSL process, it turns out that using anaerobes is superior to aerobics. Aerobic processes are less efficient for use in wastewater at high pollutant levels above 3000 mg/L. At the same time, using this can reduce organic waste with high levels of up to 80,000 mg/L. In using anaerobes, there are several advantages, namely saving energy and producing biogas. Besides being profitable, the anaerobic process also has a weakness. The reaction in reducing pollutants tends to be slower, sensitive to air, temperature fluctuations in the load, and less effective in treating waste with low levels below 3000mg/L.

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