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CAPABILITY OF MULTI SOIL LAYERING (MSL) METHOD IN DOMESTIC WASTEWATER TREATMENT

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ABSTRACT

H Nowadays, regarding the management of domestic wastewater in the environment, it is very necessary to minimize the occurrence of something that can damage the environment and living things. We solve the problem of how to apply the method in wastewater management, using a comprehensive review of the latest and past literature on the management of domestic wastewater by the multi soil layering method, in addition, there is an evaluation and summary of this article. The purpose of this study was to observe the effect of the Multi Soil Layering (MSL) and permeable layers (zeolite and gravel) method on the efficiency of reducing domestic waste pollutants. From the results of the pollutant parameters analyzed, it shows that the MSL reactor is very effective in reducing the content of pollutants in industrial wastewater to below the efficiency quality standard.

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1. INTRODUCTION

Domestic wastewater is wastewater that is generated from activities at home, starting from kitchen waste, toilets, sinks, and so on, which if directly disposed of without prior waste treatment, will cause pollution and will cause damage to the water ecosystem (Filliazati et al., 2013). The sewerage system is generally drained directly into the septic tank and the runoff water from the septic tank is infused into the ground or discharged into public drains. Non-toilet wastewater that comes from bathing, washing or discharging from the kitchen is usually channeled directly to a public channel. This type of household wastewater is categorized into two, namely black water and gray water. Black water

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itself usually comes from toilet waste, while gray water is produced from kitchen waste, bath soap and washing.

Water is very important in human life. Humans will continue their activities throughout their lives and are at risk of producing waste from activities that are carried out every day. This waste can be in the form of solid and liquid waste. Domestics produce waste almost daily and tend to be dumped into the environment for further processing. Waste is a material that is wasted or disposed of as a result of human activities that has no economic value. Currently domestic wastewater is one of the largest contributors to liquid waste in Indonesia and is also a source of problems from current clean water pollution. Every day, households produce garbage waste which is disposed of directly into the environment without being processed at all. The result of household waste every day is very large, which has a 3 dangerous impact on the surrounding environment. Domestic liquid waste the water that has been used and originates from households or settlements including from bathrooms, washing places, toilets, and cooking places.

In an effort to preserve the environment so that it is still beneficial for human life and other living things, it is necessary to control the discharge of liquid waste into the environment based on the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.68/MenlhkSetjen/2016 stipulated that the quality standard for domestic liquid waste is for the temperature parameter of 〖25〗^0C - 〖32〗^0C, for the pH parameter of 6-9, for the COD parameter of 100 mg/L and for the BOD parameter of 30 mg/L.

There are many alternatives for wastewater treatment that can be applied. Starting from the process of physics, chemistry and biology, but in general the process unit requires a high cost. One alternative to the low-cost wastewater treatment process is natural sewage treatment using soil.

Soil is a giant biological, physical and chemical system that has been used for recycling and treating waste since ancient times. The role of soil is not only as a medium for plant growth but also as a place to live disposal of waste from animals, humans and industry.

One way to achieve this is by utilizing technology that can reduce the levels of Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD). One of the technologies that can support this is the Multi Soil Layering (MSL) tool. Multi Soil Layering (MSL) is one method that has proven effective in the treatment of domestic wastewater, small industry and leachate (Salmariza et al, 2002; Kasman, 2004; Salmariza, 2011; Kasman et al, 2017). Multi Soil Layering (MSL) is a reactor that utilizes the ability of soil as the main ingredient by enhancing its function through soil structure to clean liquid waste so as not to pollute the environment. The construction of the Multi Soil Layering (MSL) reactor consists

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of a filter media in the form of a mixture of soil, zeolite and gravel which is arranged in layers to form a brick pattern.

The purpose of writing this article is to determine the design and model of MSL, the MSL reactor process by analyzing the efficiency of the Multi Soil Layering (MSL) method as a domestic wastewater treatment method, the feasibility and stability of the MSL reactor, and analyzing the advantages using MSL. Domestic wastewater, namely domestic wastewater, actually became a new source of water. If reused, wastewater treatment can reduce the level of environmental pollution due to hazardous domestic liquid waste, and liquids waste management can provide domestic benefits as a new source of clean water for the public.

2. METHODOLOGY RESEARCH

2.1 Material

The Multi Soil Layering (MSL) reactor that will be designed is made of acrylic with the dimension of 15 x 50 x 50 with the adding of inlet pipe ½ inch, outlet pipe ½ inch, and aeration pipe ½ inch. The base layer of MSL is a crushed stone with the diameter of 1-2 cm with the height of 5 cm that is arranged and covered by net plastic. The second layer is filled by zeolite with a height of 5 cm. On the third layer blocks mixed with soil are made with the parallel installed at a distance of 4 cm for each block. The next layer is filled with the zeolite with a height of 3 cm. The other layers are filled the same way until some blocks mixed with soil are made. Then these layers are covered by plastic tissue and 3 cm height zeolite is put above it.

2.2 Method

The technical method applied in the preparation of this paper is qualitative. This method is an exploratory approach to understand the central phenomenon being studied (Raco, 2018). Sources of data obtained from various scientific articles obtained from Google Scholar. The reason for searching for articles on Google Scholar is that the number of articles displayed on this application's search engine is very large, making it easier for authors to choose articles that are relevant to the topics discussed in this paper. The scientific articles that have been selected are then analyzed and explained descriptively. This method is a very interesting strategy with the assumption of a review to discuss exhaustively the subjective information they need to track down the connection between designs in a peculiarity and disclose the degree to which a peculiarity happens through the eyes of analysts (J. Fereday & E. Muir-Cochrane, 2006). The reason for using this method is to measure objective facts and based on existing cases (Somantri, 2005). This study emphasizes descriptive explanations that take the

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results of previous studies related to the objectives of this study. This method is very appropriate to use to explain to avoid exposure to the impact of the Covid-19 pandemic on family resilience.

3. RESULTS AND DISCUSSION

It can be seen from the survey results that to manage domestic wastewater, it is necessary to assess the possibility of damage and the consequences of environmental damage by controlling businesses or activities that can minimize environmental pollution. Therefore, we have outlined the treatment of domestic wastewater with a multi soil layering method. One alternative that can be applied to manage domestic liquid waste is to use the Multi Soil Layering (MSL) method. Multi Soil Layering (MSL) is one of the most widely used and proven effective methods for managing domestic waste. Multi Soil Layering (MSL) material is composed of a mixture of soil and rock that has been designed and intended to manage liquid waste disposal so that it does not harm the environment. The advantage that can be obtained from the use of this technology can be seen from the materials which are used in the MSL reactor installation which is very abundant in Indonesia, so it is very recommended to be implemented because besides being easy to get, it is also very much more effective, efficient, and inexpensive.

3.1 Domestic Wastewater Characteristics

Domestic wastewater is waste water that comes from the daily activities of human beings related to the use of water (PermenLHK/68, 2016). Fluid waste, both homogeneous and nonhomogeneous, has a few qualities as indicated by the source, the attributes of fluid waste can be ordered into physical, substance and organic qualities (Metcalf & Eddy, 2003). The qualities of this wastewater shift enormously, so it relies upon the wellspring of the wastewater. With respect to the time variable and testing strategy also impact on the attributes of wastewater (Said, 2000).

Table 1. Wastewater Source

Bell (1977)	**Kusnoputranto (1986)**
Domestic Wastewater, waste that comes from households, offices, trade centers, hospitals and contains various ingredients, including: dirt, urine, and water used for washing containing	Domestic Wastewater, waste water originating from settlements generally have composition consisting of (stool and urine), kitchen and bathroom washing water, mostly organic matter.

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detergents, bacteria and viruses.	
Industrial Wastewater, this wastewater contains a lot of solvents, minerals, heavy metals, dyes, nitrogen, sulfide, phosphate, and other substances which are toxic.	Municipal Wastewater, waste water in general comes from urban areas, trade, schools, places of worship and other public places (such as hotels, restaurants and others).
A lot of wastewater from agriculture contains animal waste, herbicides and pesticides.	Industrial Wastewater, Wastewater originating from various types of industries as a result of the process production is generally more difficult to process and has different variations broad enough.

Domestic waste, apart from damaging the environment, is the most dangerous where pathogenic microorganisms are present in human feces, because it can transmit various diseases. So to prevent and overcome the problem of water pollution in the water body, a standard for wastewater quality is made. Waste water quality standard is a measure of the limit or level of pollutant elements and or the number of elements pollutant whose presence is tolerable in the wastewater to be disposed of or released into water sources from a business and or activity. Efforts that what the government does to contain the rate of pollution load is to enacting the latest regulations on domestic wastewater quality standards, namely Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.68/Menlhk/Setjen/Kum.1/8/2016 Tahun 2016 concerning Wastewater Quality Standards Domestic.

3.2 Design and Model MSL

We take the example of the MSL reactor design which is made of acrylic with square dimensions equipped with inlet pipes, outlet pipes and aeration pipes. The bottom layer of the MSL reactor is made of crushed stone arranged and covered with a plastic net. The second layer, filled with gravel/zeolite with a certain height. In the third layer, mixed blocks of soil are made which are installed parallel to each other at a distance. Then the next layer is filled with gravel/zeolite. The other layers are filled in the same way to form several layers of soil mixture blocks, then covered with a plastic net and on top of the plastic net covered with a layer of gravel/zeolite with a predetermined height.

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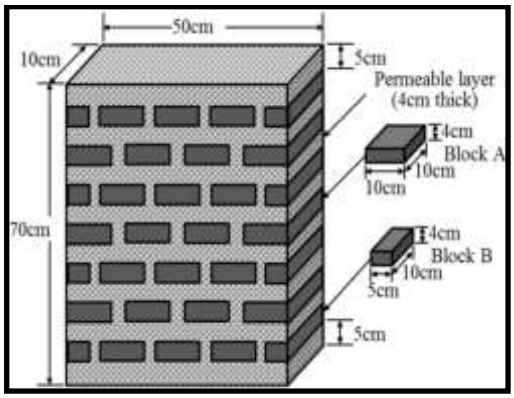

Fig 1 MSL Reactor

This system consists of several components, as follows:

a. Soil Mixture Block (SMB)

Soil is the principle part of SMB (Soil Mixture Block) its physical, compound and natural qualities have a significant impact on the viability of the channel in this framework. This is on the grounds that soil combination is the fundamental mechanism for microorganisms develop and recreate. Soil blend in this framework set in a crate the size of a block comprises natural soil, mud and sawdust with 2:1:1 proportion enveloped by a net slam organization. With size 10 cm x 4 cm x 3 cm.

b. Gravel

The gravel is a penetrable layer to forestall blockage and the base for the help on this framework. This gravel has a measurement of 2 cm – 3 cm. In this apparatus rock the base is organized with a course of action statute of 10 cm and the best 8 cm.

c. Pottery Fractions (Clay)

Pottery Fractions (Clay), is a sort of fine material that is as chips and is shaped from sedimentary stone, soil made out of aluminum silicate gatherings can be framed adrift and ashore with the arrangement cycle can be allogeneic soil or authigenic earth. In this framework. This stoneware shard can ingest particles from an answer and deliver the particle when the conditions are changed. In this ceramic layer there is a distance of 10 cm on each of the SMB (Soil Mixture Block) layers.

d. Aerator

The aerator in this framework is helpful in the air circulation process as a provider air so the oxygen content in the water increments and becomes typically utilized by microorganisms to decrease the toxin load. Air circulation likewise lessens smells brought about by movement disintegration. In

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this framework, the air circulation process is associated through a hose clear layer that lies between the first and second layers to the aerator.

e. Microorganisms

In this system, there are also microorganisms that are useful for the waste degradation process.

3.3 Wastewater Treatment Using MSL

The Multi Soil Layering (MSL) system is a liquid waste treatment technique, both domestic and non-domestic. This system uses soil as a filter, with its physical, chemical and biological characteristics. The MSL (Multi Soil Layering) method can treat high waste loads and can be used as an advanced wastewater treatment. The process of improving water quality in the MSL (Multi Soil Layering) system can occur physically, chemically and biologically. Physical processes include sedimentation and filtration. While the chemical processes include precipitation (redox), and substrate adsorption. Biological processes include microbial decomposition and mineralization of organic materials, transformation of nutrients by microbes (nitrification/denitrification) (Luanmanee, 2002).

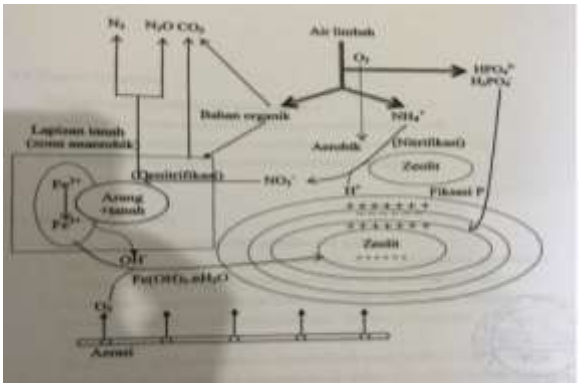

Fig 2 Mechanism in MSL (Multi Soil Layering) System

Pre-treatment wastewater containing organic matter, ammonia and phosphate contaminants is channeled into the MSL (Multi Soil Layering) system by gravity. Aerobic conditions occur in layers of broken pottery and anaerobic conditions occur in layers of mixed soil blocks that have been saturated with wastewater. The regulation of this condition can be done by adjusting the amount of oxygen that is fed into the MSL (Multi Soil Layering) by adjusting the size (small) or the length of time for filling the MSL (Multi Soil Layering). Aerobic conditions in the pottery layer increase the nitrification process (ammonia is converted into nitrite), the decomposition of organic matter by producing CO_2 gas and iron oxide (II) to iron (III), and the absorption of phosphorus. In the anaerobic zone, a denitrification process occurs, where nitrate is converted into nitrogen oxides and nitrogen gas (Wakatsuki

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et.al.1993). During the processing of the MSL (Multi Soil Layering) system, gases such as CO_2, CH_4, and N2O are produced. CO_2 emissions from the decomposition of organic matter generally increase with the increase in air temperature. Nitrogen gas and N_2O are released as dissolved gases in treated water thereby reducing the nitrogen removal efficiency of the MSL (Multi Soil Layering) system.

3.4 MSL Reactor Feasibility and Stability

The feasibility and work stability test of this reactor usually uses direct observation to get accurate data results. Usually these observations include physical and chemical conditions. These physical conditions may include color, odor and state of the water outlet, while chemical conditions only include analysis of the concentration of COD. This observation was carried out on the water coming out of the outlet pipe reservoir. The waste water is drained from the waste water tank and the outlet is taken for a certain period of time and then the physical and chemical conditions are observed.

From several existing studies previously, the MSL method can reduce BOD and COD of the Uya river in the Oki islands, Japan to 90% (Wakatsuki et.al.2001). The MSL method can also lower BOD of 98.8% and COD of 93.6% for treatment of domestic waste from cafeterias and Kasetsart University toilets, Thailand (Luanmanee et al, 2000). Effective MSL system used to treat waste for 12.8 year. However, it might be shorter or longer depending on the quality of the effluent, content and type of organic material, temperature and management of the system (Wakatsuki et.al., 1993).

3.5 Mechanism of Decreasing Efficiency by MSL Reactor

The efficiency in question is comparing the initial waste content and waste after processing using the MSL method. Efficiency reduction of wastewater parameters can calculated by (Mutia, 2015):

$$Kadar\ (\%) = \frac{n_{awal} - n_{akhir}}{n_{awal}} \times 100\% \quad (1)$$

The mechanism for purification of edible oil industrial wastewater in the MSL reactor is as follows. The process of decomposition of organic material is found in the aerobic and anaerobic zones. The adsorption process occurs on the surface of the mixed soil layer in the aerobic zone and rock layer, while the absorption process occurs in the anaerobic zone in the mixed soil layer. Wastewater organic matter is adsorbed in the top layer of a mixture of soil and charcoal and the surface of the rock layer will then be decomposed by aerobic microorganisms attached there. Meanwhile, what is absorbed into the soil mixture layer will be decomposed by anaerobic microorganisms that live in the soil mixture anaerobically. Filtration of suspended and dissolved substances including oil/fat occurs when liquid

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waste enters the MSL system layer (block mixture of soil and rock). Wakatsuki et.al., (1993) stated that the liquid waste organic material was adsorbed in the top layer of a mixture of soil and charcoal and the surface of the zeolite. Microorganisms in the soil and in the biofilm formed on the zeolite decompose the absorbed and adsorbed organic material. Meanwhile, filtration occurs when liquid waste enters the MSL system layer (block mixed with soil and zeolite).

From the mechanism that occurs in the MSL reactor, it can be seen that there is a decrease in all pollutant parameters, BOD, COD TSS and fatty oil. The results of laboratory analysis showed that the highest reduction efficiency was at BOD, namely 86-99% followed by COD 71-96% then TSS 77-88% and the lowest was oil/fat, namely 60-80%. Meanwhile, the pH increased from 6.37-6.95 to 6.99 7.24. From the efficiency of decreasing the parameters that occur, it can be concluded that the MSL reactor is very effectively used to treat edible oil industrial wastewater. In addition to the high reduction efficiency, all values and concentrations of pollutant parameters at the outlet can also meet the quality standards.

4. CONCLUSION

Hereby we may conclude that The waste disposal program's main goal is to change the way hazardous waste is handled when it is being stored, delivered, and disposed of in an environmentally sound manner. A need to address possible hazards to human health and the environment motivates the focus on hazardous waste management. Toxic waste management requires more than just dropping it on the ground. As part of the manufacturing process, industries are being urged to produce less hazardous waste. Because it is impossible to totally prevent hazardous waste, the only option is to reduce, recycle, and treat it. As a result, actions should be done to maximize use of modern technologies while minimizing environmental impact. The importance of waste minimization, recycling, and medication cannot be overstated.

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