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Managing laundry wastewater

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Abstract. Laundry services are emerging in every corner of Bali, particularly at suburban area, from cities to villages. These services help the community to ease their burden. However, the burden for the environment is increase. The wastewater from the laundries should be controlled, which should be handled natural ways. One way of reducing the dangerous chemical from the laundry wastewater can be done by Vertical-Sub-surface Flow Constructed Wetland system, using volcanic rocks as substrate of plant grow and the plant as filters. This study aimed to investigate the effectiveness of volcanic rock and Canna plants as a filter for the laundry wastewater. The volcanic rock as substrate for the plant grows was place in layers in a drum and the laundry wastewater was flowed. The parameter of wastewater laundry, such as TDS, BOD, COD and total phosphate were measured before and after treatment. The treatment was run for 6 weeks. The result shows that this system is effective that overall can reduce the parameter measured for 53.86%.

Keywords: laundry, wastewater, volcanic rock, environment management

1. Introduction

Laundry services are currently increasing in developing countries, such as in Indonesia. Bali as a small famous of tourist destination island, laundry services is very promising. Laundry services are emerging in every corner of Bali, offered by various industries, in small to large scale, such as laundry for handling household services to hotels and hospitals services. The increase in number of laundry services, especially small and medium scale in Bali has not yet been recorded, but it does reach urban and rural areas. This service industry is potential along the increasing activities of the community. The increasing number of laundry services industries results in increasing the volume of wastewater produced.

Wastewater from laundry activities has a harmful impact on the environment and human health. A study conducted by Esmiralda et al. [1] showed that high concentrations of surfactant and Chemical



Oxygen Demand (COD) of laundry wastewater decreased the LC50, which means that the wastewater is increasingly toxic, so increase the risk of the environment and the biota from the wastewater pollution. The most active ingredient of laundry detergents is surfactants [2]. Phosphate contents in laundry wastewater leads to eutrophication in water bodies. Kohler [3] found that the phosphorus content in sodium tripolyphosphate of laundry wastewater leads to an increase in the growth of water hyacinth, algae and cyanobacteria. Therefore, it reduces the oxygen content in the water, accelerating the eutrophication process. Direct usage of laundry wastewater or eutrophic waters can increase the risk of human health, that they use the wastewater for directly watering the vegetable garden. The risk is caused by toxins produced by cyanobacteria that grow in the water [4].

The impact of laundry wastewater can be minimized by controlling water pollution or increase the quality of wastewater through wastewater treatment plants. Constructed wetland is a type of wastewater treatment that can be applied in the household or laundry services. The constructed wetland has many advantages such as easy to maintenance, 15 years of continuous installation, and flexible installation location [5], but required a reasonable large area to implement. The constructed wetland has been found to reduce more than 50% of Biochemical Oxygen Demand (BOD), COD and phosphorus content in wastewater treated. [6] Vertical-Subsurface Flow Constructed Wetland is a type of water treatment that requires small land use for its operation but can significantly reduce the ammonia, nitrate, and phosphorus content in wastewater [7]. This study proposed to treat the wastewater by implementing the vertical-subsurface flow of constructed wetland using the volcanic rock as filter substrate, which has not been studied in this type of water treatment for laundry wastewater. Volcanic rock has been found as a good substrate used in vertical-subsurface flow constructed wetland and horizontal-subsurface flow constructed wetland compared to other rock types [5].

2. Method

The Vertical-Subsurface Flow Constructed Wetland system used three 200 liters of iron drums with a 0.88m high and 0.57m in diameter. Kintamani volcanic rock was arranged from the bottom to the top in three layers. The layers arrange from the bottom to the top with the height of 15 cm, 20 cm and 25 cm respectively. The size of the rocks was around 10-15 cm, 3-5 cm, 6-10 cm from the bottom to the top layers. PVC pipe, 0.5 cm diameter, was implemented as a wastewater way with the flow rate system of 240 ml/min. The first and third drums were planted with cattail plants (*Thypha* sp.) and *Canna* sp. in the second drum. There were 3 plants in each drum, with the distance among plants was 25 cm, and the distance between plants and drum edge was 19 cm. All drums were filled with laundry wastewater, which the water depth from the plant surface was 10cm. The treatment was run for 6 weeks. Treated wastewater samples were collected each week and analyzed for Total Dissolved Solid (TDS), Total Suspended Solid (TSS), pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and total Phosphate, then the results was compared to the Indonesian National Standard (SNI) SNI 6989, 59-2008.

3. Result

The results of this study found that, in general, the wastewater content based on the variable measured has decreased substantially at week1 up to week 6, compared to before treatments (Table 1). The total dissolved solid (TDS) was decreased gradually from 856 mgL⁻¹ before treatment to 728.04 mgL⁻¹ at week 6, as that of total suspended solid (TSS) from 60 mgL⁻¹ before treatments to 22.80 mgL⁻¹ on week6. The pH was quite high before treatment but stable throughout the treatments. The biological oxygen demand (BOD) was high in the first week of treatment and decreased almost 2/3 on the sixth weeks. Similar trend was performed in Chemical Oxygen Demand (COD), which was high in week 1 (926.75 mgL⁻¹) and decreased significantly in week6 (113.04 mgL⁻¹). The total P was not detected in week1, but it decreased to 3.10 in week6 from 5.65 in week 2. In only a week of treatment (week 1), all variables measured were lower than that of quality standard required by Indonesian National Standard (SNI), except the COD.

Table 1. The weekly measurement of wastewater contents from week1 to week 6, and the quality standard of wastewater based Indonesian National Standard.

Variabels	Quality Standar	Before Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week6
TDS (mgL ⁻¹)	2000	856	793.03	783.08	770.89	734.47	722.8	728.04
TSS (mgL ⁻¹)	60	48.65	34.65	32.80	24.80	24.30	22.10	22.80
pH	6-9	8.6	7.8	7.8	7.8	7.8	7.8	7.8
BOD (mgL ⁻¹)	60	182.78	122.31	182.78	178.45	133.81	46.80	43.30
COD (mgL ⁻¹)	150	346.84	926.75	326.40	285.60	273.09	116.3	113.04
Total P	5	7.3	0	5.65	4.85	5.22	3.65	3.10

4. Discussion

The high concentration of BOD, COD and total phosphate in the wetland system before treatment indicates that the laundry wastewater was polluted. The laundry products were made of surfactants and builders that contribute to the high concentration of BOD, COD, and total phosphate. The surfactant that usually used in laundry products are Alkyl Benzene Sulfonate, Linear Alkyl Benzene Sulfonate, and Alpha Olein Sulfonate, Texapon (Sodium Lauryl Ether Sulphate), and Nonylphenol, and as for the builders, the laundry products contains of Sodium Tripolyphosphate [8], [9]. The organic compounds that are used in laundry products have an effect to increase the BOD, COD, and total phosphate concentration in the wetland water system.

The result shows that the wetland system built to purify laundry wastewater is promising, that the system can reduce the content of all parameters measured. The effectiveness of the system built was more than 50% (Table 1). This means that 50% of the pollutant contains in laundry wastewater was reduced. The water pH decreases after the first week of treatments, but steady at 7.8 until the end of the treatment (Table 1). The water pH was still higher compared to the standard. Purifications of wastewater depend on carbonic acid, which the biochemical and physical processes occur during purification affect carbon dioxide and bicarbonate concentrations [10].

A steady decline on TDS and TSS occur up to week 4, but it increased slightly in week 5. The wetland system built can effectively reduce the solid compound in the water system up to week 4, but not in week 5. Reduction of water in the system due to evaporation may influence the solids particle content, which in this study has not been measured. Dissolved solids may difficult to separate by the wetland system. The content of dissolved solids in laundry wastewater composed mostly of sodium based laundry products in detergents and water-soluble whitening, so it requires a special process to separate them. In this study, the reduction of TDS in wastewater relies solely on sedimentation and filtration processes. The pore sizes of the filter systems affect the effectiveness of solid filtering system in the wetland. Larger pore sizes do not filter or retain small sized solid particles in the system [11], [12]. The effectiveness of wetland system was more than 50% on filtering TSS in the last two weeks of treatments. However, the system will be more effective in reducing TSS if the pore of the rocks were smaller, therefore filter the TDS [12].

The high value of BOD and COD in laundry water is caused by the use of different types of detergent with different surfactant content in it [8]. During the washing process, the type of detergent used is adjusted to the type of stain present in the laundry. Therefore, the laundry industry uses more than one type of detergents in each washing process. The content of surfactants which are complex organic compounds in wastewater will increase the oxygen demand for microorganisms to decompose these organic matters, result in increasing the BOD and COD in the water. As the number laundry services increase, so the laundry products and the chemical content in the laundry products used. At the earlier

time, the laundry used only conventional detergents consisting of three common types of surfactants, ie. Alkyl Benzene Sulfonate, Linear Alkyl Benzene Sulfonate, and Alpha Olefin Sulfonate, either separately or in combination. Recently, laundry product contain of Texapon (Sodium Lauryl Ether Sulphate) and Nonylphenol as surfactant [13], [8].

Another thing that affects the performance of BOD, COD, especially Total Phosphate that is still below 65% is the performance of plants, rock filters and microorganisms in the system. Large rock size causes the disruption of plant growth due to lack of nutrient available in the system for growing shoots. This causes the number of microorganisms in the system less than the number that should be. The filter size and the number of pores in the filter are in accordance with optimal condition during the system's operate within 6 weeks of the study. Large filter sizes causes less organic material to be broken down into suitable sizes and to be degraded by microorganisms that are found less in the system as well as oxidizing chemicals in the system. The reduction of Total Phosphate concentration that is less than 65% is caused by less optimal degradation and adsorption by microorganisms, plants, and the rock filters. The small number of microorganisms leads to the phosphate degradation process, especially the phosphate type which has a slow complex arrangement. Therefore, there is only small amount of phosphate that can be adsorbed. The number of plants was not increase significantly and less pores to filter the phosphate, so only a small portion of the phosphate in the water was absorbed [14].

5. Conclusion

The vertical sub-surface flow constructed wetland system was able reduce the pollutant content of laundry wastewater, which was indicated by the decreasing of TDS, TSS, BOD, COD and total phosphate concentration in the water system. The system was effective to reduce more than a half of the amount of pollutant concentration in laundry wastewater.

6. References

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