

Efficiency of constructed wetland using vetiver plant (*Vetiveria* sp) to reduced BOD and COD Concentration in greywater

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**Efficiency of constructed wetland using vetiver plant
(*Vetiveria sp*) to reduced BOD and COD Concentration in
greywater**

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Abstract. Constructed wetland is engineered, man-made ecosystems as a wastewater treatment unit to reduce water pollution by using plants. The purpose of this study to know the efficiency of Sub-Surface Flow constructed wetland with *Vetiveria sp.* in domestic wastewater treatment and to reveal the effect of aeration and detention time to reducing BOD concentrations in domestic wastewater. The research has been conducted in a constructed wetland located in Srengseng Sawah Village of continuing aerated reactor and without aeration as a control reactor. Detention time (days) 2 and 3 were setup, then the sample was taken for BOD concentration. The results indicated that constructed wetland with aeration and detention time 4 days had a higher performance to remove BOD up to 90% than without aeration and less than 4 days' process. These results fulfil the requirement of the quality standards of the Decree of DKI Jakarta Governor No. 122 of 2005 and Decree of the Minister of Environment No. 112 of 2003.

1. Introduction

Population growth will increase domestic activities and domestic wastewater, which will cause environmental pollution later. Naturally, the environment has the ability to degrade pollutants, if the pollution load can still be tolerated. The increase in the volume of untreated wastewater will certainly cause problems in the environment if not-balanced with an increase in the capacity and quality of the receiving water body [1].

This domestic wastewater resulted by daily waste from human activities such as residential activities, restaurants, offices, commercial centers, apartments, and dormitories. Around (60-70) % of the water used by urban people will be wasted into wastewater which will be discharged directly into water bodies without prior treatment which causes this wastewater to be a major contributor to water pollution [2,3]. In addition, wastewater is discharged directly into water bodies due to the limited Wastewater Treatment Plant (WWTP) in Indonesia due to various problems such as the number of costs that will be used to treat the wastewater and the difficulty in operating it so that WWTP becomes ineffective [4].

Therefore, waste treatment is needed which applies low-cost processing, easy operation by producing water quality that achieves existing environmental quality standards. The choice of waste treatment must also be based on the characteristics of the waste where domestic waste contains high organic matter so that to reduce it can use biological treatment. Based on these considerations, alternatives in wastewater treatment especially biological processing to minimize wastewater can use a constructed wetland system [5].



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Constructed wetlands can effectively eliminate suspended solids, organic pollutants, and nutrients from wastewater [3]. Constructed wetland systems can save energy, cheaper development, and operational costs, and can form new ecosystems, and provide aesthetic value somewhere [6]. The constructed wetland system has two types, namely the type of flow above the surface (Free Water Surface Flow) and subsurface flow (Sub-Surface Flow) [7]. However, because the Constructed wetland system in a conventional way requires large land, frequent blockages, slow mass transfer, and poor root penetration into layered soil columns, new technology is needed to overcome this problem.

There is a new approach in constructed wetland systems in increasing efficiency in wastewater treatment by combining the benefits of phytoremediation and attached growth systems based on engineering procedures (bio-rack technique) [8]. Using this bio-rack technique provides better conditions for plant root growth, efficient oxygen diffusion, the increased surface area for microbial growth in this system.

2. Materials and method

2.1. Location

The study was conducted in RW 8 Srengseng Sawah Village, Jagakarsa District, South Jakarta. The area of Srengseng Sawah Village is 674.70 Ha with a population of more or less 51,565 people spread in 19 districts with a population density of 6,954 people/ km² [9].

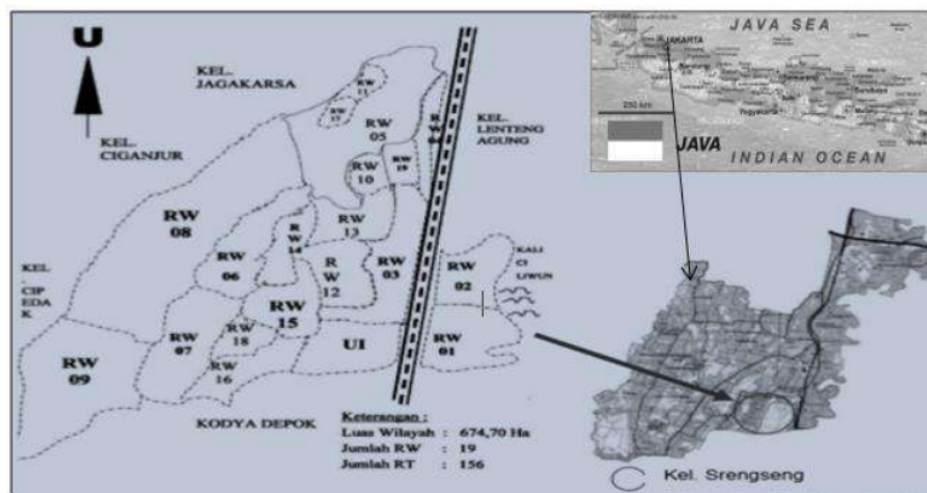


Figure 1. Location of constructed wetland.

2.2. Domestic wastewater

The wastewater used is greywater from settlements in Srengseng Sawah, South Jakarta. Greywater was directly discharged through residential sewers and before flowing into the river.

2.3. The constructed wetland

This research was conducted in a Constructed Wetland located in Srengseng Sawah Village, Jakarta. This Constructed Wetland construction measures 300cm x 200cm x 130cm. The constructed wetland system has two types, namely the type of flow above the surface (Free Water Surface Flow) and subsurface flow (Sub-Surface Flow) [10]. However, because the constructed wetland system in a conventional way requires large land, frequent blockages, slow mass transfer, and poor root penetration into layered soil columns, new technology is needed to overcome this problem. [11].

2.4. Media and plant

Media consisting of gravel, sand, topsoil mixed with compost, sand, and mud. The plant used *Vetiveria* sp. that is able to absorption pollutants as nutrients needed [12].

2.5. Data analysis

Calculation of effectiveness of pollutant removal in constructed wetlands using formulas:

$$Efficiency (\%) = \frac{C_o - C_t}{C_o} \times 100\%$$

where :

Co: Value of domestic wastewater parameters before treatment

Ct: Value of parameters for domestic wastewater after treatment

2.6. Quality standard

The wastewater used in this study was greywater that quality is not complying with the quality standard requirements to disposed of into the environment. The characteristics of wastewater before processing show in table 1.

Table 1. Characteristics of residential wastewater RW 8 Srengseng Sawah.

No.	Parameter	Unit	Quality of wastewater	Quality Standard*
1.	pH	-	6,9 – 7,2	-
2.	SS	mg/l	23,00 – 50,33	50
3.	BOD	mg/l	151,85 – 286,04	50
4.	COD	mg/l	210,07 – 320,70	80
5.	Detergent	mg/l	4,09 – 11,92	2
6.	T-N	mg/l	12,38 – 25,87	-
7.	T-P	mg/l	0,96 – 3,89	-

*Quality Standards: Gov. Reg .of DKI Jakarta No. 122/2005

3. Results and discussion

In figure 2 show that the highest COD concentration is 342 mg/l and the lowest is 67 mg/L. The highest level occurs on day 4 with temperature of around 35 °C while the lowest concentration occurs on day 4 with temperature 30 °C. The ability to decrease COD content increases after the 12th day due to the efficiency of removal of wastewater content depending on concentration and the length of time of detention in constructed wetland.

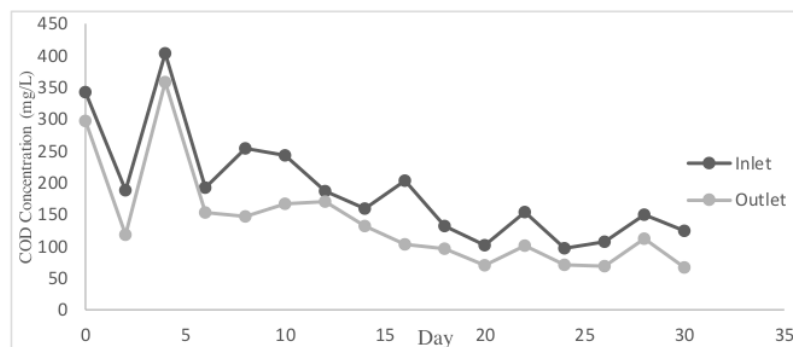


Figure 2. COD concentration in inlet and outlet.

The hydraulic permeability and productivity level of the media greatly influences the detention time of wastewater, sufficient detention time will provide an opportunity for contact between microorganisms and wastewater [5]. Organic material contained in wastewater will be overhauled by microorganisms into compounds simpler and will be used by plants as nutrients, while the root system of aquatic plants will produce oxygen which can be used as a source of energy/catalyst for a series of metabolic processes for microorganism life [13].

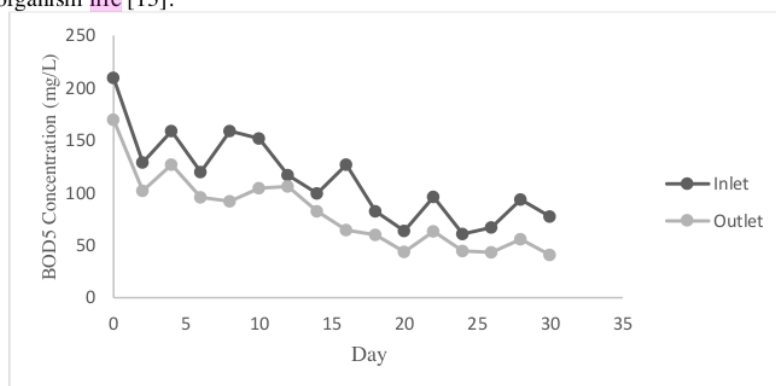


Figure 3. BOD₅ concentration in Inlet and outlet.

Figure 3 show that the highest BOD₅ level occurred on the 8th day while the lowest concentration occurred on day 30. The effect of retention time also played a role in the process of decreasing waste content. A decrease in the concentration of organic matter in the wetland system occurs because of the mechanism of microorganism and plant activity, through the oxidation process of aerobic bacteria that grow around the plant's rhizosphere [14]. The mechanism of biological decline occurs due to microbiological activity at the root [15].

Plant roots increase the density and microbial activity provided by the root surface for microbial growth [16]. One factor is the availability of oxygen for biological processes. If oxygen in the roots is sufficient, the microorganisms that play a role in decomposing the waste are also getting bigger [17]. When wastewater passes through soil particles at a certain detention time, it gives the chance of settling solid particles. With this deposition process, it will reduce the oxygen demand for subsequent biological treatment. The more and in the root tissue in the soil, the wider the rhizosphere zone is created, so that the swamp's ability to support microorganisms is increasing [18].

Decreasing the BOD content in Constructed wetland processes requires considerable availability which will pass through the side-lines of the soil to be sent to plant roots for microorganisms to decompose the waste content. Soil air occupies part of the macropores between the secondary aggregates of the soil [19]. The soil air is very important for the respiration of plant roots and the activities of living bodies in the soil. Especially living bodies in aerobic soil desperately need oxygen to support their activities to decompose organic matter. In general, the effectiveness of wastewater treatment with a Constructed wetland system equipped with plant growth proved to be quite high.

4. Conclusion

Based on the results analysis of domestic wastewater treatment with constructed wetlands by *Vetiveria* sp. plant has a good performance in domestic wastewater treatment in Constructed Wetland system. The COD removal of 91.8% with 20 cm plant distance plant and a retention time of 2 days and the BOD₅ removal is 91.6%.

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