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Domestic Wastewater Treatment using Constructed Wetland as a Development Strategy of Sustainable Residential

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Abstract. Sustainable residential development is a residential area with more attention to ecological aspects of environmental. In the developing countries including Indonesia, the high environmental pollution resulting from domestic. Therefore we need a domestic wastewater treatment is inexpensive and easy to operate and even expected to provide benefits to society. A type of wastewater treatment that meet these qualifications are constructed wetland. Effluent of the constructed wetland treatment potential for aquaculture. On the other hand, Indonesia has many kinds of aquatic plants that have been shown to reduce various types of pollutants.This study aims to test the effectiveness of constructed wetland using Cyperus papyrus to treat domestic wastewater from flats. This study is an experimental study, in which the effectiveness of constructed wetland is known to measure the characteristics of influent and effluen. These results indicate that the constructed wetland using Cyperus papyrus plant has a high effectiveness for treating domestic waste water flats. The result shows, Papyrus plant reactor shown to neutralize the pH by 8.4 to 7.0,. reduction of BOD values can reach 93.17%, reduction of TSS parameter 96.49% and NH_3-N values can be reduced 99.13%.

Keywords: Constructed wetland, Sustainable development, Domestic wastewater, Residential, Wastewater treatment plant

1. Introduction

The house is a basic need of human beings other than food and clothing. The need for adequate housing is a key issue difficult to solve for developing countries like Indonesia. This is caused by the large population of Indonesia, more than 200 million people while the majority of the economic level below the poverty line. Even Indonesia is estimated that the population will reach 260 million by 2020, with the current growth rate. Development of the city - major cities in Indonesia that holds more than 43% of Indonesia is driven by rapid urbanization (Fakhrizal, 2004). The rate of urbanization will create tremendous demand for affordable housing for all communities in large cities has become a serious problem because the practice of land speculation and the limitations of government subsidies for home - a modest home and very simple. The government has tried to overcome these problems with the construction of flats.

Sustainable residential development is defined as sustained efforts for social, economic, and environmental quality so that in implementing a sustainable residential is important to consider the environmental settlements. One of the efforts made to achieve environmentally sustainable residential plan is a residential area with more attention to ecological aspects of environmental aspects in planning for housing. In the developing countries including Indonesia, the high environmental pollution resulting from domestic is because some things, among others: limited land for housing so that no space to build a wastewater treatment unit, which generally require large tracts of land; low economic problems that plagued the cost limitations and conditions of inadequate sanitation facilities and people's habits are less supportive of clean and healthy.

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Constraints on development that led to the WWTP (Waste Water Treatment Plant) to the domestic problems of its own. In order to improve the quality of the environment and minimize pollution originating from domestic (housing/residential), needed environmental service programs, which one of them is the selection and application of new technologies urban domestic wastewater treatment is 'simple and apropriate' to the community that is: simple, easy and cheap and affordable in the system operation and maintenance. One of the appropriate technology that can treat domestic wastewater is the Wetland Technology for Domestic Waste Water Treatment (Sim, 2003).

This study aims to test the effectiveness of constructed wetland using Cyperus papyrus to treat domestic wastewater from flats. If through this study proved that the constructed wetland treating wastewater effectively for domestic then this technology could potentially be used also to treat domestic waste water in residential complexes. In addition to continued use of aquaculture provide the possibility for public participation in the wastewater so that slowly the awareness in protecting the environment will increase. The results of this study is expected to be a consideration in developing the government's development policy in the future flats.

2. Materials and Methods

The species used in this study is a plant with characteristics as follows: root fibers, can survive in moist soil and tend to have high enough power evapotranspiration. Ability to live in wet soil conditions tended / stagnant water is a basic requirement of the plant species used as crops require artificial wetlands system used must be embedded in the media is continuously fed wastewater so that the condition will always be wet planting medium. Rooted plant fibers are intended to be a lot of plants to absorb water containing organic matter is high enough so that the decomposition of wastes will be easily absorbed by plants. High evaporation power meant that the treated waste water will be absorbed and then evaporated into the air in the form of pure water (H_2O). Based on a literature review of the types of plants that have the characteristics mentioned above is Cyperus Papyrus. The use of these plants are also easy to get motivated, where the plants are native to Indonesia and many grew up in East Java. Plant prices are affordable by the community. Plants are usually grown on vacant lands and gardens. Besides these plants are also widely sold in market interest rates or traders in East Java.

The research was carried out of the room, as it requires sunlight and availability of sufficient oxygen. Plants acclimatized for 14 days in advance. The reactor used in this study as much as 3 (three) units each measuring 3 x 1 x 0.6 m. What distinguishes one another reactor is the distance between the plants 16 stem/m^2, 12 stem/m^2 and 8 stem/m^2. Wastewater in constructed wetland for 4,5,6,7, 8 days. Flow rate was regulated 300,360,450 l/day for later measured parameter reduction of pH, BOD (Biological oxygen Demand), TSS (Total Suspended Solid), ammonium (NH_3-N). These parameters are commonly used to assess the quality of wastewater. As a benchmark to measure the success of this system, the reactor performance results will be compared with conventional wastewater treatment systems in flats at this time.

Variation of the treatment in this study aims to determine the optimal conditions of the constructed wetland reactor conditions will be varied so that it will know the difference in performance of each reactor is based on the variation condition with the following variations:

Table 1. Research variation

VARIATION	REACTOR-A	REACTOR-B	REACTOR-C
Type of plants	*Cyperus Papyrus*	*Cyperus Papyrus*	*Cyperus Papyrus*
Detention time (days)	4, 5, 6,7,8	4, 5, 6,7,8	4, 5, 6,7,8
Influen flow (litre/day)	450,360,300	450,360,300	450,360,300
Initial density (stem/m^2)	16	12	8
Dimension (length x width x height)	(3x1x0,6)m	(3x1x0,6)m	(3x1x0,6)m
Observation parameter	pH,BOD, TSS, NH_3-N	pH,BOD, TSS, NH_3-N	pH,BOD, TSS, NH_3-N

Reactor to be used in this system of artificial marshes to the outer layers of impermeable plastic sheeting. Reactor shape is a square with sides sloped to prevent the "dead zone" or dead zones at the bottom corner of the reactor. The size of the sides of the reactor at the top is 4x1 meters, while the reactor is 0.6 meters deep. Sketch of the reactor can be seen in Figure 1. the following:

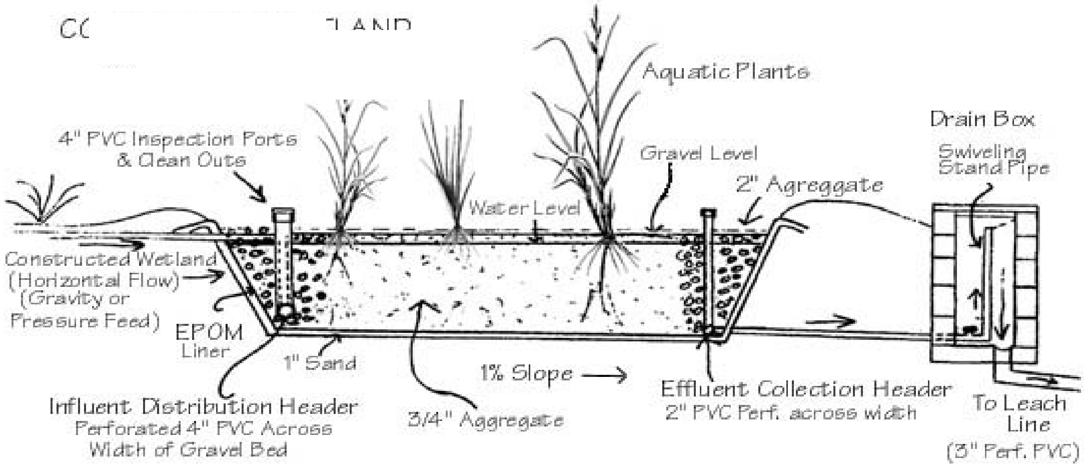

Fig. 1: Elongated pieces of artificial marsh reactor

3. Results and Discussion

The process of acclimatization is the process of adjustment to the experimental plant of the new environmental conditions, namely the reactor. The process of acclimatization in this study performed a total of two stages, namely 1 and acclimatization acclimatization 2. Conditioned on the acclimatization of a Plant to adjust to the new planting medium is gravel and garden soil. Water used for watering the plants is used to clean water is not wastewater. Observations during the study showed that at 2 weeks of the beginning of planting, the papyrus Plant looks dry on the vine. This condition indicates that papyrus plant more difficult to adapt to the new environment. After two weeks of planting, papyrus blossomed again beginning to look as well. This process lasted for 2 weeks until the end of the first month.

In the second month, Plant watered with waste water from a mixture of gray water effluent septictank with (the water that comes from bathroom floor and laundry). This process is called the second stage of acclimatization. Acclimatization implemented the second phase is planned for 1 month, but because of the observation for 2 weeks showed no change in Plant acclimatization process is stopped and then continued with the process running. This is because the Plant is completely adaptable to the changing characteristics of watering had no effect on plant life. Sprinkling of water characteristics with organic matter content is high enough it will become fertilizer for plants. The results of the performance of the reactor with the plant Papyrus in decreased these parameters can be shown in the following table:

Table 2: Provision for pollutant materials in the reactor with Papyrus at a density of 16 stem/m2

Parameter	REACTOR A					
	Detention Time (day)					
	0	4	5	6	7	8
pH	8.40	7.00	7.00	7.00	7.00	7.00
BOD (%)	0.00	86.22	91.38	93.11	93.15	93.17
TSS (%)	0.00	83.74	90.97	96.39	96.45	96.49
NH_3-N (%)	0.00	98.19	98.92	99.10	99.11	99.13

Table 3: Provision for pollutant materials in the reactor with Papyrus at a density of 12 stem/m2

Parameter	REACTOR 2B					
	Detention Time (day)					
	0	4	5	6	7	8
pH	8.40	7.10	7.10	7.00	7.00	7.00
BOD (%)	0.00	84.49	85.87	87.94	88.00	88.05
TSS (%)	0.00	80.13	89.16	92.77	93.87	93.87
NH_3-N (%)	0.00	97.65	98.37	98.55	98.56	98.58

Table 4: Provision for pollutant materials in the reactor with Papyrus at a density of 8 stem/m2

Parameter	REACTOR 2C					
	Detention time (day)					
	0	4	5	6	7	8
pH	8.40	7.40	7.30	7.30	7.00	7.00
BOD (%)	0.00	80.01	82.77	86.22	86.23	86.28
TSS (%)	0.00	76.52	82.00	89.16	89.18	89.19
NH_3-N (%)	0.00	95.30	96.57	96.93	98.06	98.06

Based on the data in Table 2. up with 4 can be graphed as follows:

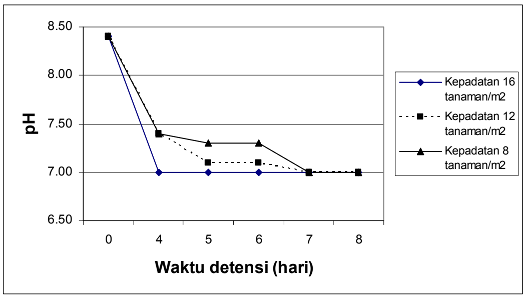

Fig. 2: PH in the reactor parameters with Papyrus Plant

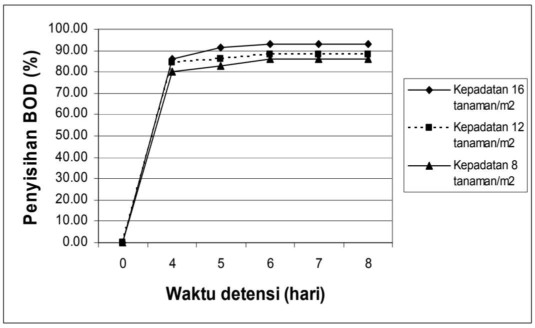

Fig. 3: Provision for BOD measurements in the reactor with Papyrus Plant

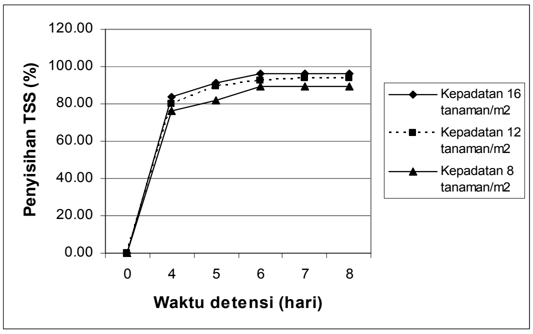

Fig. 4: Provision for TSS measurements in the reactor with Papyrus Plant

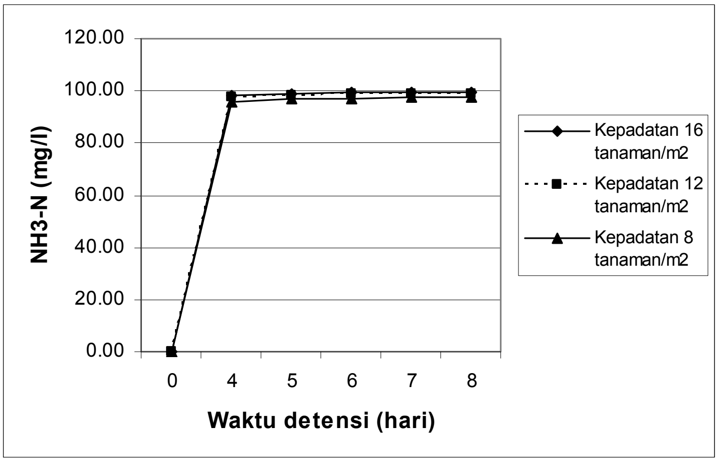

Fig. 5: Provision for TSS measurements in the reactor with Papyrus Plant

Papyrus plant reactor shown to neutralize the pH of the wastewater, as shown by Fig. 2. When the initial pH value is lowered by 8.4 to 7.0 in the reactor to achieve a density of 16 stem/m^2. BOD parameter values can also be derived by this reactor. Initial BOD value of 325 mg / l can be reduced to 22.4 mg / l in the reactor at a density of 16 stem/m^2 BOD reduction can reach 93.17% this is shown in Fig. 3. The trend / trend BOD reduction is proportional to the density of the larger plants. Fig. 4. showed a decrease in TSS parameter may reach 96.49%. Parameters of the initial TSS of 310 mg / l can be derived by Papyrus reactor to be 11.2 mg / l or approximately 89.19% at density 16 stem/m^2. TSS greater proportional decrease with the addition of Plant density. Parameter values NH_3-N beginning at 55 mg / l can be reduced to a 2.8 mg / l or by 99.13%, as shown in Fig. 5. NH-$_3$N decrease proportional to the density Plant. When compared with the Quality Standards set by the Minister of Environment The decision Number. 112 / 2003 then all the parameters that it meets the quality standard.

The wastewater is deposited first to know into Imhoff cones to reduce sediment in the waste water out. In this case the input waste and approximately 1 hour after its sediments should be less than 1 ml / I. During processing, organic substances present in wastewater and undergo a process of oxidation of organic or inorganic compounds in the form of ions such as NO3-, NH4 + and so can be absorbed by Papyrus. Roots absorb nutrients that come in with the water flow. Accumulation of nutrients in the form of ions in plant roots through the help of membrane transport ligand in the roots, and will form a complex ion transport will continue to form the xylem and leaf cells, after arriving at the leaf will pass plasmalema, cytoplasm and vacuole, where the ions will accumulate in vacuoles are not going to relate to the physiological processes of plant cells (Salisbury and Ross, 1995).

In Papyrus occur on several processes, namely: (1) Phytoacumulation (phytoextraction) is a process in which Papyrus interesting substance that accumulates contaminants from media around the roots of plants, this process is also called hyperacumulation, (2) Rhizofiltration (rhizo = root) is the adsorption or deposition of substances in waste water out by the roots to attach to the roots of Papyrus, (3) Phytostabilization the attachment of a particular contaminant substances in the roots of Papyrus may not be absorbed into the plant stem. These substances are closely attached (stable) at the root so it will not get carried away by the flow of water in the media, (4) Rhyzodegradetion rhezosphere enhenced also called biodegradation, or plented-assisted bioremidiation degradation, namely the decomposition of the substances in the liquid waste out by microbial activity who were around the roots of plants, (5) Phytodegradation (phyto transformation) which is a process undertaken to describe the Papyrus contaminant substances that have a chain of complex molecules into harmless materials with the composition of simpler molecules that can be useful for plant growth itself . This process can take place in the leaves, stems, roots or outside around the roots with the help of enzymes released by the plant itself. Some plants release an enzyme that speeds up a chemical degradation process, (6) Phytovolatization the process interesting and transpiration by plants contaminant substances in a form that has a solution does not decompose as a hazardous material and then vapour into the atmosphere.

The treatment efficiencies of constructed wetlands containing Cyperus papyrus L. (papyrus) and Miscanthidium violaceum (K. Schum.) Robyns (synonymous with Miscanthus violaceum (K. Schum) Pilg.) were investigated in a tropical climate (Kampala, Uganda). Papyrus showed higher ammonium-nitrogen and total reactive phosphorus (TRP) removal (75.3% and 83.2%) than Miscanthidium (61.5% and 48.4%) and unplanted controls (27.9% ammonium-nitrogen).

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