COMPARISON OF ABILITY PO_4 AND NH_3 DECREASE IN HOSPITAL WASTEWATER USING PHYTOREMEDIATION BATCH WITH EICHHORNIA CRASSIPES AND AZOLLA PINATA

AM Lelie Novia W[1,*], Wahyu Wilopo[2], Agus Prasetya[3]

[1]Master in Systems Engineering, Universitas Gadjah Mada, Indonesia
[2]Department of Geological Engineering, Universitas Gadjah Mada, Indonesia
[3]Department of Chemical Engineering, Universitas Gadjah Mada, Indonesia
*Correspondence: lelienovia@gmail.com

Abstract

Hospital operations have the potential to produce waste, especially wastewater, which can cause environmental pollution. Therefore it is necessary to control the disposal of liquid waste that is discharged into the environment. It is required to reduce the pollution of wastewater management is excellent and appropriate legislation. Research methodology starts from the data observed laboratory test results for samples of hospital wastewater. From these data, it is known that the levels of phosphate and ammonia still do not meet quality standards following the Decree of the Minister of Environment No. 58 of 1995 regarding effluent standards for hospitals. Further research is limited only focused on decreased levels of phosphate and ammonia in hospital wastewater.

Data research includes a phosphate concentration of outlets as a pilot study. The subsequent wastewater will be divided into seven-bath, three-bath containing wastewater and water hyacinth plants with a density different in each basin ie density of 60 mg/cm², 90 mg/cm², and 120 mg/cm², three baths containing hospital wastewater and Azolla plant density of each tub 60 mg/cm², 90 mg/cm², 120 mg/cm², and the control tanks containing wastewater without a given crop. Based on the results obtained, phosphate levels can meet the fastest quality standards for four days on a tub of hospital wastewater and water hyacinth with a density of 120 mg/cm2 and all of a tub of wastewater hospitals and Azolla. For ammonia takes the fastest four days, this happens in a tub filled with water hospital waste, and water hyacinth with a density of 120 mg/cm² and the entire tub of wastewater hospitals and Azolla.

History:

Received: March 21, 2017
Accepted: October 30, 2020
First published online:
December 25, 2020

Keywords:

Hospital Wastewater
Phytoremediation
Water Hyacinth
Azolla Pinata

1. Introduction

The hospital is one type of health service with its activities in operation for 24 hours. One of the remaining processes is the liquid waste generated that negatively impacts society and the environment (Sun et al., 2008) (Nurhayati et al., 2014). One of the adverse effects of debris on the community is an infectious disease spread through water (waterborne disease) (Li et al., 2009). It is necessary to process hospital waste not pollute the environment when discarded (Haberl et al., 1995).

Currently, the Panti Rapih hospital already has WWTP. But from the early studies found that the levels of phosphate and ammonia do not meet quality standards. The initial data is carried out studies using phytoremediation methods. A system where specific crops cooperate with the microorganism in a medium (water) can transform contaminants (pollutants) into less harmful or even economically useful materials (Alamsyah, 2007). Concealment of this study plants used is water hyacinth and Azolla with a density of 60 mg/cm², 90 m/ cm², and 120 mg/cm².

This study aims to determine the effect of plant species, density, and residence time in the lower levels of phosphate and ammonia in hospital wastewater to meet the quality standards.

2. Methodology

The wastewater used in this study is a waste outlet WWTP hospital (Lakshmi et al., 2015). The materials used are hospital wastewater, water hyacinth, Azolla, and chemicals for testing and phosphate levels are phenolphthalein (PP), H_2SO_4, distilled water (Masi et al., 2000). The solution amoniummolibdat, a solution of $SnCl_2$, chemicals for assay ammonia of phenols, nitroprusside, oxidizing solution. The tools used in this study include: Container, Scoop samplers, Scales. The sample bottle, Paper sticker, 50 ml Erlenmeyer, Pipette measuring 10 ml, Pipette measuring 5 ml, and UV-VIS Spectrophotometer

The initial measurement of hospital wastewater is done by taking samples at the outlet WWTP Hospital tested in Balai Laboratorium Kesehatan Yogyakarta. While waiting for the laboratory results, do stabilization plant is plant entered the water-containing liquid waste hospital, left in place for one week (Imron et al., 2019). After one week seen whether the plant is still alive or not, when the plants live can continue to the next process; when the plant dies, it must be replaced with other types of crops (Faezipour & Ferreira, 2013).

In this study uses water hyacinth plants and Azolla that settling for a week in a tub of water hospital waste was still alive. It can proceed to the next process is to divide the plant into six-bath consisting of 3 tubs for water hyacinth plants, and three tubs for plants Azolla (A.A.Deshmukh et al., 2011). Arranged so that in each tub of plants with different densities. Great density in each tub is 60 mg/cm2, 90 mg/ m2, 120 mg/cm2. Prepared one bath again as utility holes are basin which contains only hospital wastewater. The treatment of plant density variations can be seen in Table 1.

Table 1. Plant density variation

No	code	Density
1.	EG1	120 mg/cm²
2.	EG2	90 mg/cm²
3.	EG3	60 mg/cm²

Table 1. Continued

No	code	Density
4.	AZ1	120 mg/cm^2
5.	AZ2	90 mg/cm^2
6.	AZ3	60 mg/cm^2
7.	control	without plant

Flow chart of the research described in Figure 1.

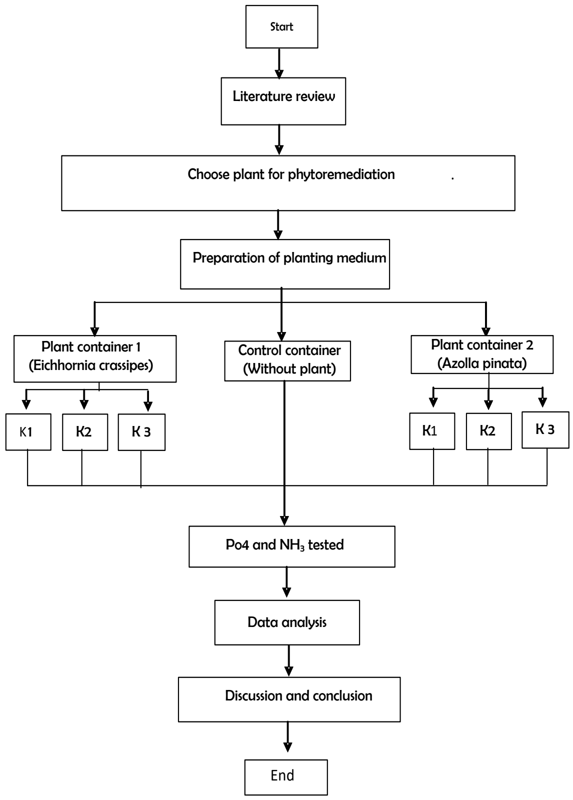

Figure 1. Flowchart of research

3. Result & Discussion

Sampling was done every two days for two weeks. Parameters tested were PO_4 and NH_3; test results are compared with KEPMEN LH 58 on effluent standards for hospital operations. The laboratory results and NH_3 PO_4 levels in this study can be seen in Figure 2 and Figure 3.

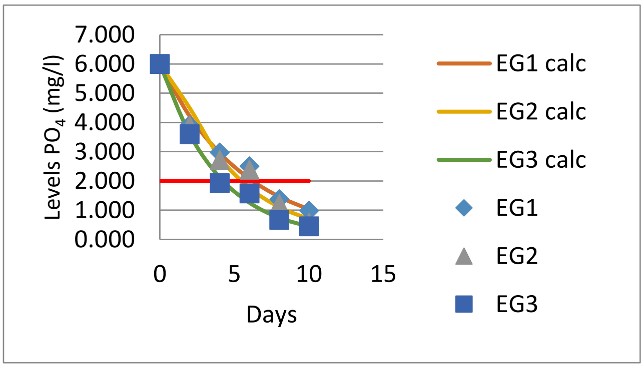

Figure 2. PO_4 decrease in hospital wastewater using water hyacinth plants with a density of 60 mg/cm^2, 90 mg/cm^2, and 120 mg/cm^2: Comparison of the data with the calculation of the model

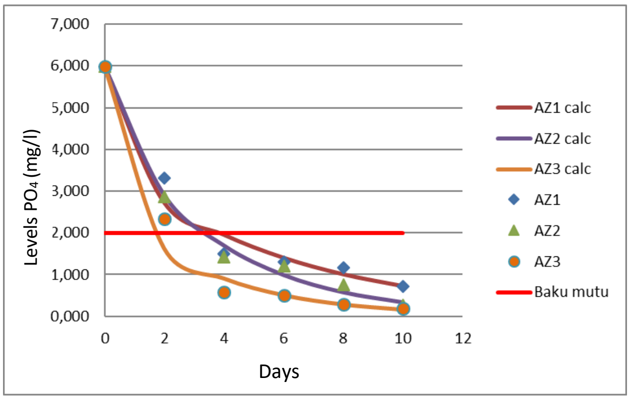

Figure 3. PO_4 decrease in hospital wastewater using Azolla plant with a density of 60 mg/cm^2, 90 mg/cm^2, and 120 mg/cm^2: Comparison of the data with the calculation of the model

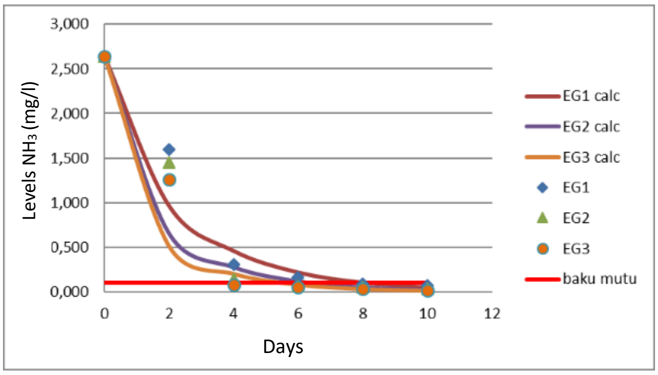

Figure 4. NH_3 decrease in hospital wastewater using water hyacinth plants with a density of 60 mg/cm^2, 90 mg/cm^2, and 120 mg/cm^2: Comparison of the data with the calculation of the model

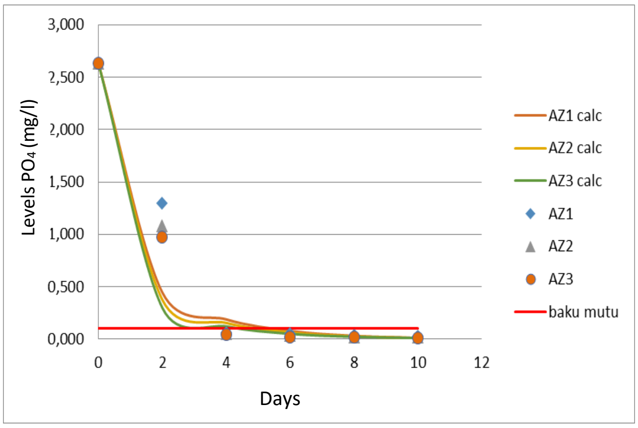

Figure 5. NH_3 decrease in hospital wastewater using Azolla plant with a density of 60 mg/cm^2, 90 mg/cm^2, and 120 mg/cm^2: Comparison of the data with the calculation of the model

After getting the data and NH_3 PO_4 levels decrease in hospital wastewater containing water hyacinth plants and subsequently obtained Azolla decrease speed coefficient (k) uses research data and formulas $C_o/C_i = \exp^{(-kPO_4 \cdot t)}$. The coefficient of reduced rates of PO_4 and NH_3 in hospital wastewater can be seen in Table 2 and Table 3.

Table 2. Value coefficient pace of decline PO_4 (kPO_4) the wastewater containing the water hyacinth plant

Density EG	EG1	EG2	EG3
kPO_4	0,176	0,233	0,262

Table 3. Value coefficient pace of decline PO_4 (kPO_4) the wastewater containing Azolla

Density AZ	AZ1	AZ2	AZ3
kPO_4	0,166	0,268	0,292

Table 4. Value coefficient pace of decline NH_3 (kNH_3) the wastewater containing the water hyacinth plant

Density EG	EG1	EG2	EG3
kNH_3	0,369	0,427	0,461

Table 5. Value coefficient pace of decline NH_3 (kNH_3) the wastewater containing Azolla

Density AZ	Az1	AZ2	AZ3
kNH_3	0,424	0,443	0,456

Once the known k value of each parameter and the treatment is performed, statistical tests to determine the relationship between the value of k with the density and type of plant. The jam statistical test was also conducted to determine the formula k value of each parameter.

The statistical test result is an excellent relationship between the variables value kPO_4, and the correlation coefficient calculates the density is 0,921—the level of significance of the correlation coefficient between the value kPO_4 and a density of 0.005. The relationship between the value kPO_4 and plant species on the correlation coefficient is 0,355.

The relationship between the variables kNH_3 and density values calculated by the correlation coefficient was 0.830. The level of significance of the correlation coefficient between the value kPO_4 and density of 0.021. The relationship between the value kNH_3 and plant species by Table 2 the correlation coefficient was 0.239.

From Figure 2, in the form of scattering can be seen that the levels of PO_4 research results met the standard on day 4 for wastewater with a water hyacinth plant density of 120 mg/cm^2. Wastewater with water hyacinth plant density of 60 mg/cm^2 and 90 mg/cm^2 PO_4 levels is below the 8th day's quality standard. From Figure 3, in the form of scattering can be seen that the levels of PO_4 research results meet the quality standards on the 4^{th} day of wastewater to the plant Azolla in the third-density

From Figure 4, in the form of scattering can be seen that the levels of NH_3 research results meet the quality standards on the 8^{th} day of wastewater with water hyacinth plants at a density of 60 mg/cm^2, for wastewater with water hyacinth plants at a density of 90 mg/cm^2 are below the quality standard on day 6, while the density of 120 mg/cm^2 is below the quality standard on the 4^{th} day. From Figure 5, in the form of scattering can be seen that the levels of NH_3 research results meet the quality standards on the 4^{th} day of wastewater to the plant Azolla in the third-density

The relationship value between the variables kPO_4 and density values calculated by the correlation coefficient was 0.921. This shows a very close relationship (approaching 1) between the value kPO_4 density. Towards a positive relationship (no negative sign in number 0.921), the greater the density will create a greater value kPO_4. Vice versa, the smaller the density, the smaller the value kPO_4. The level of significance of the correlation coefficient between the value kPO_4 and thickness of 0.005. Therefore, the probability is far below 0.05, the correlation between the density kPO_4 and very real.

The relationship between the value $kPO_4$and the type of plant is 0.355. This shows that there is no significant difference between kPO_4 and plant species. The relationship value between the variables kNH_3 and density values calculated by the correlation coefficient was 0.830. This shows a very close relationship (approaching 1) between the value kNH_3 density. Towards a positive relationship (no negative sign in number 0.830), the greater the density will create a greater value k_{NH3}. Vice versa, the smaller the density, the smaller the value kNH_3.

The level of significance of the correlation coefficient between the value $kPO_4$and density of 0.021. Therefore, the probability is far below 0.05, the correlation between the density kNH_3 and very real. The relationship between the value kNH_3 and the type of plant is 0.239. This shows that there is no significant difference between kNH_3 and plant species.

4. Conclusion

Water Hyacinth and Azolla pinata can reduce to below PO_4 and NH_3 until complying the standard with quality. There is no significant difference between the water hyacinth and Azolla in lowering PO_4 and NH_3. The plant density affects the decreased levels of PO_4 and NH_3; the more influential the plants density, the reduced levels of PO_4 and NH_3 are also getting more significant. The thickness of the plants most rapidly degrade contaminants in this study is 120 mg/cm^2. The residence time effect on PO_4 and NH_3 levels decreases.

The longer the dwell time, PO_4 and NH_3 levels will decrease. The residence time of the fastest in reducing contaminants in this study was four days. The coefficient of reduced rates of phosphate in water hyacinth with a density of 60 mg/cm^2, 90 mg/cm^2, 120 mg/cm^2 is 0.176/day, 0.233/day, 0.262/day, for Azolla plant amounted to 0.166/day, 0.268/day, 0.292/day. The coefficient of velocity drop in ammonia in water hyacinth density of 60 mg/cm^2, 90 mg/cm^2, 120 mg/cm^2 each of 0.369/day, 0,427/day, 0.461/day, to plant Azolla 0.424/day, 0.443/day, 0.456/day.

With the development of plants in the phytoremediation method so quickly that the plants produce in large quantities, it is necessary to conduct further research on plants' growth and the need to think about where to throw the plant. Environmental conditions significantly affect the effectiveness of decreased levels of pollutants in the methods of phytoremediation; subsequent studies can include environmental conditions such as temperature, sunlight, and humidity

References

A.A.Deshmukh, A. A. D., Bandela, N. N., J.R.Chavan, J. R. C., & Nalawade, D. P. (2011). Studies on Potential Use of Water Hyacinth, Pistia and Azolla for Municipal Waste Water Treatment. *Indian Journal of Applied Research*, *3*, 226–228.

Alamsyah, B. (2007). *Pengelolaan Limbah di Rumah Sakit Pupuk Kaltim Bontang Untuk Memenuhi Baku Mutu Lingkungan*. Universitas Diponegoro.

Faezipour, M., & Ferreira, S. (2013). Developing a systems thinking perspective of hospital water sustainability. *2013 IEEE International Systems Conference (SysCon)*, 109–113.

Haberl, R., Perfler, R., & Mayer, H. (1995). Constructed Wetlands in Europe. *Water Science and Technology*, *32*(3), 305–315.

Imron, I., Dermiyati, D., Sriyani, N., Yuwono, S. B., & Suroso, E. (2019). Fitoremediasi dengan Kombinasi Gulma Air untuk Memperbaiki Kualitas Air Limbah Domestik. *Jurnal Ilmu Lingkungan*, *17*(1), 51.

Lakshmi, Refonaa, J., & Vivek, J. (2015). Tracking of bio medical waste using global positioning system. *2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2015]*, 1–5.

Li, Z., Li, M., Li, Y., & Prospere, A. (2009). Experimental Study on Treatmental Efficiency of Wastewater from Small Hospital by Vertical Flow Constructed Wetland. *2009 International Conference on Management and Service Science*, 1–4.

Masi, F., Bendoricchio, G., Conte, G., Garuti, G., Innocenti, A., Franco, D., Pietrelli, L., Pineschi, G., Pucci, B., & Romagnolli, F. (2000). Constructed wetlands for wastewater treatment in Italy: State-of-the-art and obtained results. *Conference Proceedings of the IWA 7th International Conference on Wetland Systems for Water Pollution Control, Orlando (USA)*, 979–985.

Nurhayati, E., Hidayat, M., & Saraswati, S. P. (2014). Analysis of phosphate in liquid waste hospital. *ASEAN Journal of Systems Engineering*, *2*(2), 52–54.

Sun, Y., Gu, P., & Wang, K. (2008). Trihalomethane Occurrence in Chlorinated Hospital Wastewater. *2008 2nd International Conference on Bioinformatics and Biomedical Engineering*, 3540–3544.