

## Adsorption of Ammonia in Wastewater Using Hyacinth (*Eichornia Crassipes*) Powder with The Assistance of Bio Balls

M. Ilham Nurdin<sup>a\*</sup>, Arifah Sukasri<sup>a</sup>, Jeanne Dewi Damayanti<sup>a</sup>

<sup>a</sup>Department of Chemical Engineering, Ujung Pandang State Polytechnic, Makassar, Indonesia 90245

\*Corresponding author: [milhamnurdin@poliupg.ac.id](mailto:milhamnurdin@poliupg.ac.id)

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**ABSTRACT.** Water pollution can be caused by the discharge of domestic wastewater containing contaminants. Ammonia is a water pollutant that has a bad impact because it can cause an unpleasant pungent odor and can inhibit or stop the growth of aquatic organisms because it interferes with oxygen binding, changes pH and affects enzymatic reactions and membrane stability in aquatic organisms. This research treats domestic wastewater contaminated with ammonia using adsorption using water hyacinth powder. To reduce ammonia contaminants in domestic wastewater. This study used a quantitative method which included the acclimatization stage, preliminary test, water hyacinth powder production, adsorption process, ammonia content analysis. The results showed that the use of water hyacinth powder in the most efficient adsorption process was 8 grams of water hyacinth powder and 60 bioballs in 10 liters of wastewater with a decrease in ammonia content of 93.47% for 24 hours. With the bioremediation process ratio, the ammonia content in wastewater can be reduced from 4.810 ppm to 0.314 ppm.

## 1. INTRODUCTION

Water pollution is one of the most serious environmental problems nowadays. Water is a source of human needs that must be maintained to maintain quality. The domestic sphere, in the form of housing and offices, plays a large role in the use of clean water. Water that is initially clean when used for domestic needs may become of poor quality due to use. Water used for domestic needs that are not treated first causes domestic activities to produce domestic wastewater. One of the contaminants in domestic wastewater is ammonia.

Domestic wastewater is wastewater originating from businesses and or residential activities, restaurants, offices, commerce, apartments and dormitories. Before being discharged into the environment, domestic wastewater must be treated in a treatment unit or Wastewater Treatment Plant (IPAL). Water samples were taken from the inlet and outlet of the Wastewater Treatment Plant (WWTP) using a biological method (anaerobic-aerobic biofilter) in the office area. The inlet sample was taken from the equalization tank and the outlet sample was taken from the end result of WWTP [1].

Adsorption is a phenomenon that describes the interaction between two different phases forming an interfacial layer by intermolecular transfer from a mass of liquid (liquid or gas) to a solid surface so, it is classified as a surface process. This layer is expressed by two types of physical interactions or chemical interactions. This process is usually reversible, and the reverse process is called desorption. In this review, we will explain the meaning and type of adsorption process defined. In addition to a brief explanation of the adsorption isotherm model majors, adsorption kinetics, and adsorption thermodynamics. There are various adsorption systems, liquid-gas or liquid-liquid. If the liquid material is the adsorbent, the interfacial layer is called a film, micelle, or emulsion. The other systems are solid-liquid or gas-solid; The adsorbent is a solid material, so the approved mechanism for the adsorption process is the interfacial layer model. There are various adsorption systems, liquid-gas or liquid-liquid. If the liquid material is the adsorbent, the interfacial layer is called a film, micelle, or emulsion. The other systems are solid-liquid or gas-solid; The adsorbent is a solid material, so a promising mechanism for the adsorption process is the membrane layer model. The interfacial layer describes the balance that exists between the adsorbent and bulk phases. The first region is the binding of the substrate to the sorbent surface and the second region is the surface layer of the sorbent. There are two principles for explaining the interface layer mechanism. Physical Adsorption: also called physisorption, the bond between substrate and adsorbent is weak Van der Waals forces,

there is no change in chemical structure for both substrate and adsorbent [2].

Chemical adsorption is also called chemisorption, the formation of a chemical bond between the substrate and the adsorbent, by rearranging the electron density between the adsorbent and the substrate, the nature of this bond is ionic bonding or covalent bonding. Both models explain the adsorption mechanism; based on experimental physical criteria the results of a suitable adsorption model are determined for a system. The physical criteria used to compare the two thermodynamic models or adsorption isotherm studies and kinetics or adsorption equilibrium studies. The interfacial layer describes the balance that exists between the adsorbent and bulk phases. The first region is the substrate binding surface of the sorbent and the second region is the surface layer of the sorbent. There are two principles to explain the mechanics of the interface layer [2].

Physical adsorption is also called physisorption, the bond between the substrate and the adsorbent is a weak Van der Waals force, there is no change in the chemical structure of either the substrate or the sorbent. Chemical Adsorption: also called chemisorption, the formation of a chemical bond between the substrate and the adsorbent, by rearranging the electron density between the adsorbent and the substrate, the nature of this bond is ionic bonding or covalent bonding. Both mechanism models explain adsorption; based on one physical criterion results a suitable adsorption experimental model is determined for a system. The physical criteria used to compare the two models are thermodynamic or adsorption isotherms and kinetics or adsorption equilibrium studies. The interfacial layer describes the balance that exists between the adsorbent and bulk phases. The first region is the substrate binding surface of the sorbent and the second region is the surface layer of the sorbent. There are two principles to explain the mechanics of the interface layer [2].

Palilingan 2019 uses a combination of adsorbents as a filtration medium to reduce phosphate and ammonia levels in laundry wastewater. Based on this study, there was a significant difference in ammonia levels between the control sample and the treated sample or filtered sample, where the percentage reduction in ammonia levels before and after the filtration treatment was 63.6% from 11 mg/L to 4 mg/L. This shows that the existence of a filtration process can reduce the level of ammonia in the laundry wastewater sample. This result is reinforced by the results of statistical analysis through the mean difference test (t test) which shows that there is a significant difference in the mean ammonia levels in the control and treatment samples as seen from the probability value of  $p(0.0025) < 0.05$ . This value indicates that the presence of filtration treatment using filtration media in the form of a combination of adsorbents has a significant effect on reducing ammonia levels in laundry wastewater samples. [3].

Izmah 2023 reduces organic matter (ammonia) in wastewater using chicken feather waste as an alternative adsorbent. Based on the results of these studies, the efficiency obtained for the mass of adsorbent 1 gram was 86.78%, 2 grams was 37.26%, and 3 grams was 52.50%. The results of the calculation of the adsorption capacity obtained results on the mass of adsorbent 1 gram of 31.97 mg/gram, 2 grams of 6.86 mg/gram, and 3 grams of 6.45 mg/gram. The optimum mass of adsorbent in the ammonia adsorption process is 1 gram with an efficiency of 86.78% and a capacity of 31.97 mg/gram. Based on the results of research on the reduction of organic matter (ammonia) in wastewater using chicken feather adsorbents, it can be concluded that the best adsorption efficiency and capacity is using a mass of 1 gram of adsorbent with an efficiency level of 86.78% and an adsorption capacity of 31.97 mg/gram [4].

This research treats domestic wastewater contaminated with ammonia by means of adsorption using water hyacinth powder. It is hoped that water hyacinth powder can reduce ammonia contaminants in domestic wastewater so that the problem of ammonia in wastewater can be overcome so as not to pollute water bodies and the environment in general. Water hyacinth was chosen as an adsorbent because based on previous research, water hyacinth has the ability to absorb both anionic and cationic contaminants. According to Shofiyan and Gusrizal, the adsorbent prepared from water hyacinth contains functional groups such as carboxyl (COOH) and hydroxyl (-OH) which can function as adsorption active sites [5].

## 2. MATERIALS AND METHODS

### 2.1. Tool

The tools used in this study were Orion Aquamate 8000 UV-VIS spectrophotometer, grinder, 60 mesh sieve, bioball, phyto-biofilm container in the form of a plastic bucket, analytical balance, oven, measuring flask,

measuring cup, aquadest bottle, volumetric pipette, burette, beaker.

## 2.2 Materials

The materials used in this study were domestic wastewater, water hyacinth, Nessler reagent solution, distilled water, ordinary filter paper, and Whatman filter paper no. 40.

## 2.3. object Study

The object of this study was the Ammonia content in 8 samples of domestic wastewater treatment.

## 2.4. Work Steps

### 2.4.1. Acclimatization

Acclimatization was carried out on water hyacinth plants taken from Lake Tanjung Bunga, Maccini Sombala, Makassar and then cleaned of dirt and soil on the roots, then acclimatized for one week. Acclimatization is done by planting water hyacinths in clean water for one week.

### 2.4.2. Preliminary Test

The preliminary test is carried out by examining samples of domestic liquid waste. Measurement of initial ammonia levels in domestic wastewater was carried out using the spectrophotometer method. The results of this measurement are used as the basis for determining the object of research which is a parameter that is not by quality standards. Examination of ammonia levels in samples of domestic liquid waste was carried out at the Waste Management Laboratory, Department of Chemical Engineering, Ujung Pandang State Polytechnic, Makassar using an Orion Aquamate 8000 UV-VIS Spectrophotometer.

### 2.4.3. Making Water hyacinth Powder

The acclimatized water hyacinth is then made into water hyacinth powder which is carried out in the following stages:

- a. Drying by drying in the sun
- b. Oven drying to remove maximum moisture content
- c. Smoothing using a grinder or grinder
- d. Sieving using a 60 mesh sieve to obtain a uniform size of water hyacinth powder
- e. Weighing water hyacinth for 7 kinds of water hyacinth mass variations of 1g, 2g, 3g, 4g, 6g, 8g and 10g.

### 2.4.4. Adsorption Process

The adsorption process using water hyacinth powder with the help of bioballs was carried out with 8 sample treatments

- a. Treatment 1 (1 g water hyacinth powder, bioball in 10 liters of wastewater)
- b. Treatment 2 (2 g of water hyacinth powder, bioball in 10 liters of wastewater)
- c. Treatment 3 (3 g of water hyacinth powder, bioball in 10 liters of wastewater)
- d. Treatment 4 (4 g of water hyacinth powder, bioball in 10 liters of wastewater)
- e. Treatment 5 (6 g water hyacinth powder, bioball in 10 liters of wastewater)
- f. Treatment 6 (8 g of water hyacinth powder, bioball in 10 liters of wastewater)
- g. Treatment 7 (10 g water hyacinth powder, bioball in 10 liters of wastewater)
- h. Treatment 8 (10 liters of wastewater) as a control

The eight treatments were carried out for 3 days with sampling in contact time of 1 hour, 6 hours, 12 hours, 1 day, 2 days and 3 days to measure the Ammonia content.

### 2.4.5. Analysis of Ammonia content

Ammonia content analysis was carried out spectrophotometrically. Ammonia research parameters were carried out using the Nessler method using spectrophotometric analysis with the following procedure:

- a. Pipette 50 ml of each sample into a 250 ml Erlenmeyer, each sample was carried out in duplicate
- b. Added 1 ml of Nessler's solution into each Erlenmeyer which already contains the sample
- c. Set aside for  $\pm 10$  minutes
- d. Inserted into the cuvette on the spectrophotometer, the ammonia level of the sample was measured in duplicate

on the DR 2000/2010 spectrophotometer at a wavelength of 425 nm

e. Record the results

Ammonia standard refers PP 82 2001 to regarding water quality standards, the allowable ammonia content in water is 0.5 mg/L [6].

### 3. RESULTS AND DISCUSSION

#### 3.1. Acclimatization

Acclimatization is carried out by planting water hyacinth in clean water for one week so that the water hyacinth can adjust its growth to the new environment and reduce the ammonia that has been absorbed by the water hyacinth in the previous environment. This can make the absorption capacity of certain substances greater so that the absorption of ammonia in a new environment can run more optimally.

#### 3.2. Preliminary Test

The measurement results of the ammonia content in the preliminary test are used to determine the research object to be compared with water quality standards. The ammonia standard refers to PP 82 2001 regarding water quality standards, the allowable ammonia content in water is 0.5 mg/L [6].

Preliminary test samples are samples of domestic wastewater taken in the Jongaya canal at several sampling points. The samples are put together and then homogenized so that the substance content in the wastewater is evenly distributed. Ammonia analysis on samples of Jongaya Canal Wastewater was carried out at the Chemical Laboratory and Instrument Laboratory of the Department of Chemical Engineering, Ujung Pandang State Polytechnic using the Orion Aquamate 8000 UV-VIS Spectrophotometer. Ammonia levels in the samples were measured using a UV-Vis spectrophotometer using the Nessler method of ammonia analysis. The results of the analysis of ammonia levels in the Jongaya Canal wastewater were 5.06 mg/l. This value exceeds the standard for water quality (the allowable content of ammonia in water is a maximum of 0.5 mg/L). Based on this, domestic wastewater in the Jongaya Canal should be treated first so that the ammonia content meets water quality standards before being distributed to water bodies. This is done so that the wastewater that is disposed of does not damage the aquatic ecosystem and does not pollute the environment.

#### 3.3. Making Water hyacinth Powder

Water hyacinths can be used for the environmental restoration process. Based on research Nuridin (2020), ammonia levels in domestic wastewater can decrease from 4.0847 ppm to 0.2957 ppm (meeting water quality standards based on PP No. 82 of 2001: maximum ammonia content of 0.5 ppm) using the most efficient phytobiofilm technology. efficiently (92.76%) by contacting 5 water hyacinth stems (32.50g) and 200 bioballs into 10 liters of domestic wastewater for 24 hours [7].

Water hyacinth is made into water hyacinth powder to expand the adsorption contact surface of wastewater. Drying by drying in the sun aims to remove the water content in water hyacinth. Oven drying to remove maximum moisture content. Smooth using a grinder to get water hyacinth powder in a smaller size. Sieving using a 60 mesh sieve to obtain a uniform size of water hyacinth powder. Weighing of water hyacinth to obtain 7 kinds of water hyacinth mass variations of 1g, 2g, 3g, 4g, 6g, 8g, and 10g as a variable which will be seen for its effectiveness and efficiency in adsorbing ammonia.

#### 3.4. Adsorption Process

The adsorption process using water hyacinth powder with the help of bioballs was carried out with 8 treatments

- a. Treatment 1 (1 g water hyacinth powder, bioball in 10 liters of wastewater)
- b. Treatment 2 (2 g of water hyacinth powder, bioball in 10 liters of wastewater)
- c. Treatment 3 (3 g of water hyacinth powder, bioball in 10 liters of wastewater)
- d. Treatment 4 (4 g of water hyacinth powder, bioball in 10 liters of wastewater)
- e. Treatment 5 (6 g water hyacinth powder, bioball in 10 liters of wastewater)
- f. Treatment 6 (8 g of water hyacinth powder, bioball in 10 liters of wastewater)
- g. Treatment 7 (10 g water hyacinth powder, bioball in 10 liters of wastewater)
- h. Treatment 8 (10 liters of wastewater) as a control

The eight treatments were carried out for 3 days with sampling in contact time of 1 hour, 6 hours, 12 hours, 1 day, 2 days and 3 days to measure the Ammonia content. The 7 kinds of water hyacinth mass variations are

variables that will be seen for their effectiveness and efficiency in adsorbing ammonia. Bioballs play a role in helping the process of absorbing or reducing ammonia because based on research Nurdin (2022), bioballs are effective in reducing ammonia in domestic wastewater with efficient treatment using a ratio of 60 bioballs in 10 liters of waste water with a decrease in ammonia content of 92.74% for 72 hours. O'clock. [8].

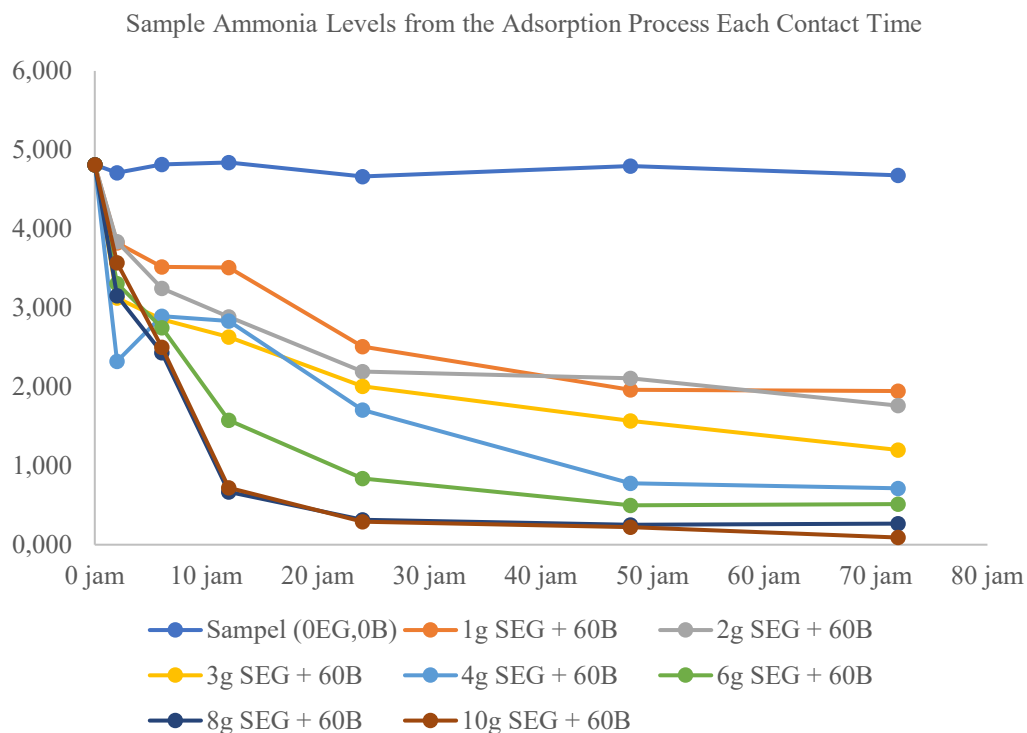
### 3.5. Analysis Content Ammonia

Domestic wastewater samples were analyzed using the Nessler method of spectrophotometric analysis. The results of the analysis of the eight treatments can be seen in table 1

**Table 1 . Ammonia Content (ppm) Sample Each Contact Time (hours)**

Treatment	0 hours	2 hours	6 hours	12 hours	24 hours	48 hours	72 hours
Sample (0EG,0B)	4,810	4,710	4,818	4,841	4,664	4,794	4,679
1gSEG+60B	4,810	3,824	3,517	3,509	2,508	1962	1946
2gSEG+60B	4,810	3,840	3,247	2,885	2,192	2.108	1,761
3g SEG+ 60B	4,810	3.124	2,855	2,631	2008	1,569	1,199
4g SEG+ 60B	4,810	2,323	2,893	2,831	1,707	0.776	0.714
6gSEG+60B	4,810	3,309	2,747	1,577	0.838	0.499	0.514
8gSEG+60B	4,810	3.155	2,431	0.668	0.314	0.253	0.268
10gSEG+60B	4,810	3,570	2,500	0.722	0.291	0.222	0.091

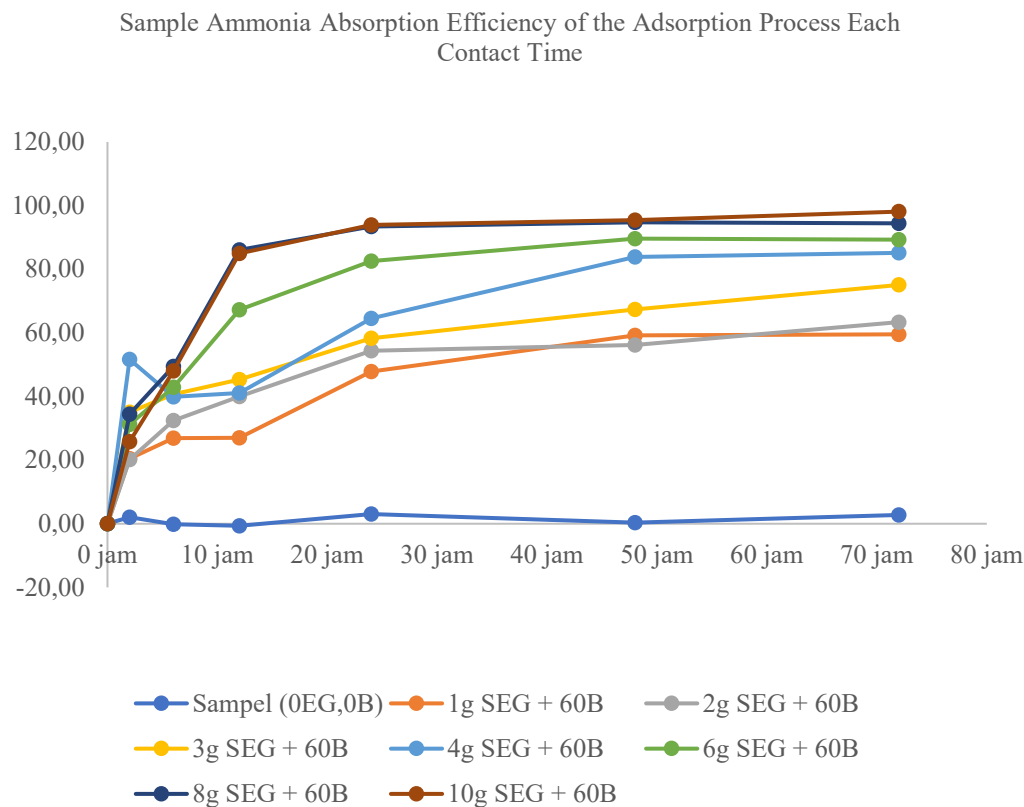
The rate of absorption of ammonia or the rate of reduction in ammonia levels in domestic wastewater can be seen through the graph in Figure 1.



**Figure 1 . Graph of Ammonia Levels in the Adsorption Process**

Based on Table 1 and Figure 1, it can be seen that the eight treatments resulted in a rapid decrease in ammonia levels up to 12 hours of contact time but did not meet the water quality standard of at least 0.5 mg/l. Ammonia levels then gradually decreased at a contact time of 24 to 72 hours of contact time. At a contact time of 0-12 hours, ammonia levels for all treatments did not meet water quality standards. However, at 24 hours of contact time,

ammonia levels were obtained that met water quality standards for variations in the use of 8 grams of water hyacinth powder and 60 bioballs in 10 liters of wastewater and the use of 10 grams of water hyacinth powder and 60 bioballs in 10 liters of wastewater. Treatment with a variation of 6 grams of water hyacinth powder and 60 bioballs in 10 liters of wastewater was able to absorb ammonia levels to obtain ammonia levels of 0.499 ppm at 48 hours of contact time and increased slightly to 0.514 ppm. The efficiency of ammonia absorption or the efficiency of reducing ammonia levels in wastewater can be illustrated graphically in Figure 2.



**Figure 2.** Sample Ammonia Absorption Efficiency of the Adsorption Process Each Contact Time

Based on the research results, the treatment that uses the least amount of water hyacinth powder but can absorb ammonia to inspect or according to water quality standards is a variation of using 6 grams of water hyacinth powder and 60 bioballs in 10 liters of waste water capable of absorbing ammonia levels to obtain ammonia levels of 0.499 ppm at 48 hours of contact time and rose slightly to 0.514 ppm. Because the results of the ammonia content obtained in this treatment were very close to the maximum number of water quality standards and the results of the ammonia content for the next contact time increased, the treatment was not considered effective as a ratio capable of absorbing ammonia in wastewater to meet the quality standard. This is because the treatment using this ratio is considered to be maximal in absorbing ammonia so that it is no longer able to absorb further ammonia until it drops to conforming to water quality standards. Compared with other treatment data at 24-hour contact time, ammonia levels met water quality standards for variations in the use of 8 grams of water hyacinth powder and 60 bioballs in 10 liters of waste water and the use of 10 grams of water hyacinth powder and 60 bioballs in 10 liters of wastewater. Therefore it can be concluded that the efficient absorption of ammonia is by using 8 grams of water hyacinth powder and 60 bioballs in 10 liters of wastewater with a decrease in ammonia content of 93.47% for 24 hours. With the bioremediation process ratio, the ammonia content in wastewater can be reduced from 4.810 ppm to 0.314 ppm.

This study shows that the absorption value of ammonia by water hyacinth powder is greater than the 2019 Palilingan study which used a combination of adsorbents as a filtration medium in reducing phosphate and ammonia levels in laundry wastewater. Based on this study, there was a significant difference in ammonia levels between the control sample and the treated sample or filtered sample, where the percentage reduction in ammonia levels before and after the filtration treatment was 63.6% from 11 mg/L to 4 mg/L [3]. This study also showed that the absorption value of ammonia by water hyacinth powder was greater than that of this study. Izmah 2023

Research Results reduced organic matter (ammonia) in wastewater using chicken feather waste as an alternative adsorbent. Based on the results of these studies, the efficiency obtained for the mass of adsorbent 1 gram was 86.78%, 2 grams was 37.26%, and 3 grams was 52.50%. The results of the calculation of the adsorption capacity obtained results on the mass of adsorbent 1 gram of 31.97 mg/gram, 2 grams of 6.86 mg/gram, and 3 grams of 6.45 mg/gram. The optimum mass of adsorbent in the ammonia adsorption process is 1 gram with an efficiency of 86.78% and a capacity of 31.97 mg/gram. Based on the results of research on the reduction of organic matter (ammonia) in wastewater using chicken feather adsorbents, it can be concluded that the best adsorption efficiency and capacity is using a mass of 1 gram of adsorbent with an efficiency level of 86.78% and an adsorption capacity of 31.97 mg/gram [4].

#### 4. CONCLUSION

The most efficient use of water hyacinth powder in the adsorption process is 8 grams of water hyacinth powder and 60 bioballs in 10 liters of wastewater with a decrease in ammonia content of 93.47% for 24 hours. With the bioremediation process ratio, the ammonia content in wastewater can be reduced from 4.810 ppm to 0.314 ppm.

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#### REFERENCES

- [1] S. Sulistia and A. Cahaya Septisya, "Analisis Kualitas Air Limbah Domestik Perkantoran," *JRL Institut Pertanian Bogor*, vol. 12, no. 1, pp. 41–57, 2019, Accessed: May 11, 2023. [Online]. Available: <https://ejurnal.bppt.go.id/index.php/JRL/article/view/3658/3057>
- [2] M. Alaqarbeh, "Adsorption Phenomena: Definition, Mechanisms, and Adsorption Types: Short Review," *RHAZES: Green and Applied Chemistry*, vol. 13, no. 1, pp. 43–51, 2021, Accessed: Jun. 04, 2023. [Online]. Available: <https://revues.imist.ma/index.php/RHAZES/article/view/28283/14731>
- [3] S. Palilingan, M. Pungus, and F. Tumimomor, "Penggunaan kombinasi adsorben sebagai media filtrasi dalam menurunkan kadar fosfat dan amonia air limbah laundry," *Fullerene Journ. Of Chem*, vol. 4, no. 2, pp. 48–53, 2019, Accessed: Jun. 04, 2023. [Online]. Available: <https://www.indochembull.com/index.php/fullerene/article/view/59/54>
- [4] A. Izmah, D. Suprayogi, and S. Nengse, "Reduksi bahan organik (amonia) pada air limbah menggunakan limbah bulu ayam sebagai alternatif adsorben," *Jurnal Pengelolaan Lingkungan Berkelanjutan (Journal of Environmental Sustainability Management)*, vol. 7, no. 7, pp. 46–53, Apr. 2023, doi: 10.36813/jplb.7.1.46-53.
- [5] A. Shofiyani and Gusrizal, "Pengaruh pH dan Penentuan Kapasitas Adsorpsi Logam Berat Pada Biomassa Eceng Gondok (*Eichornia crassipes*)," *Jurusan Kimia, Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Tanjung Pura*, 2006.
- [6] PP 82 Tahun 2001, *Peraturan Pemerintah Republik Indonesia Nomor 82 Tahun 2001 Pengelolaan Kualitas Air Dan Pengendalian Pencemaran Air Presiden Republik Indonesia*. Indonesia, 2001.
- [7] M. I. Nurdin, A. Sukasri, and J. D. Damayanti, "Efisiensi Penggunaan Eceng Gondok (*Eichornia Crassipes*) Denganmedia Biofilter Bio-Ball Pada Teknologi Fito-Biofilm Dalam Penurunan Kadar Amonia Pada Limbah Cair Domestik," in *Prosiding 4 th Seminar Nasional Penelitian & Pengabdian Kepada Masyarakat 2020*, 2020, pp. 93–97. [Online]. Available: <http://snp2m.poliupg.ac.id/2020>
- [8] M. I. Nurdin, M. Yasser, Sukasri Arifah, and J. D. Damayanti, "Efisiensi Penggunaan Bioball Dalam Proses Adsorpsi Amonia Pada Air Limbah," in *Prosiding 6 th Seminar Nasional Penelitian & Pengabdian Kepada Masyarakat 2022*, 2022, pp. 174–178. [Online]. Available: <http://snp2m.poliupg.ac.id/2022/>