JGG-Jurnal *Green Growth* dan Manajemen Lingkungan Vol. 13 No. 2 July 2024
p-ISSN: 2303-2332; e-ISSN: 2597-8020 DOI : doi.org/10.21009/jgg.132.06

Evaluating The Effectiveness of Wastewater Treatment In the Reusable Packaging Industry: A Case Study of ALNER'S WWTP In Indonesia

Bintang Ekananda[1*], Anif Farida[1], Rian Sumendar[1]

[1] *Environmental Management Graduate Program Muhammadiyah Sorong of University*
Jalan Pendidikan No. 27 Kelurahan Klabulu Distrik Malaimsimsa, Kota Sorong, Papua Barat Daya
email: bintang@alner.id, aniffarida@um-sorong.ac.id

Received
29 July 2024

Revised
30 July 2024

Accepted
31 July 2024

**Correspondence*
Bintang Ekananda
Email: bintang@alner.id

Abstrak

Penggunaan kemasan plastik sekali pakai yang meluas telah menjadi masalah lingkungan yang signifikan, terutama di negara-negara Selatan. Studi ini meneliti pendekatan inovatif dari perusahaan rintisan Alner, yang menggunakan kombinasi pengolahan elektrokimia dan teknologi Moving Bed Biofilm Reactor (MBBR) di instalasi pengolahan air limbah (IPAL) untuk mengelola air limbah yang dihasilkan dari pembersihan kemasan yang dapat digunakan kembali. Sampel air limbah dikumpulkan sebelum dan sesudah pengolahan, dan dianalisis untuk parameter utama seperti Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD5), Total Padatan Tersuspensi (TSS), minyak dan lemak, amonia, surfaktan, dan fosfat. Hasilnya menunjukkan penurunan yang signifikan pada semua polutan yang diukur, dengan COD berkurang 99,58% dan BOD5 berkurang 99,56%. Nilai-nilai pasca pengolahan untuk semua parameter masih berada dalam batas peraturan yang ditetapkan oleh Peraturan Menteri Lingkungan Hidup dan Kehutanan No. P.68/MenLHK/Setjen/Kum.1/8/2016. Studi ini menggarisbawahi potensi model penggunaan ulang dalam mengurangi sampah plastik sekali pakai dan menyoroti pentingnya pengolahan air limbah yang efektif dalam menjaga kelestarian lingkungan. Pendekatan Alner memberikan solusi yang terukur dan ramah lingkungan, menetapkan tolok ukur untuk inisiatif serupa di industri, dan mendukung kelayakan dan keberlanjutan pengintegrasian teknologi pengolahan air limbah yang canggih di sektor pengemasan yang dapat digunakan kembali, yang menawarkan solusi komprehensif untuk polusi plastik.

Kata kunci: *pengolahan air limbah, kemasan yang dapat digunakan kembali, pengolahan elektrokimia, reaktor biofilm tempat tidur bergerak*

Abstract

The widespread use of single-use plastic packaging has become a significant environmental issue, particularly in the Global South. This study examines the innovative approach of the startup Alner, which employs a combination of electrochemical treatment and Moving Bed Biofilm Reactor (MBBR) technology in its wastewater treatment plant (WWTP) to manage wastewater generated from the cleaning of reusable packaging. Wastewater samples were collected before and after treatment, and analysed for key parameters such as Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD5), Total Suspended Solids (TSS), oil and grease, ammonia, surfactants, and phosphates. The results demonstrated a significant reduction in all measured pollutants, with COD reduced by 99.58% and BOD5 by 99.56%. Post-treatment values for all parameters were well within the regulatory limits set by the Ministry of Environment and Forestry Regulation No. P68/MenLHK/Setjen/Kum.1/8/2016. This study underscores the

p-ISSN: 2303-2332; e-ISSN: 2597-8020 DOI : doi.org/10.21009/jgg.132.06

potential of reuse models in reducing single-use plastic waste and highlights the importance of effective wastewater treatment in maintaining environmental sustainability. Alner's approach provides a scalable and environmentally friendly solution, setting a benchmark for similar initiatives in the industry, and supports the feasibility and sustainability of integrating advanced wastewater treatment technologies in the reusable packaging sector, offering a comprehensive solution to plastic pollution.

Keywords: wastewater treatment, reusable packaging, electrochemical treatment, moving bed biofilm reactor (mbbr)

INTRODUCTION

The widespread use of single-use plastic packaging has emerged as a major environmental issue, particularly in the Global South. This trend, which began in the early 2000s, was driven by the idea of serving the "Bottom of the Pyramid" (BoP). Multinational companies introduced small, affordable sachets to make products accessible to low-income populations(Syahrial et al., 2023). While economically beneficial, this practice has led to severe environmental impacts (Bor, 2020).

Countries like Indonesia, ranked second as the largest contributor to ocean plastic waste, are significantly affected (Parlindungan Sigalingging, 2020). With approximately 81% of waste mismanaged, single-use sachets are often improperly disposed of, eventually ending up in rivers and oceans (Jambeck et al., 2015). The environmental damage is exacerbated by the low-quality, multi-layered plastics used in these sachets, which are not economically recyclable (Poggenpohl, 2018)(Evita et al., 2023).

To address the plastic pollution crisis, a shift to reusable packaging is essential. Reuse models offer several environmental benefits over single-use packaging, such as reducing the overall volume of waste generated and being designed for greater sustainability throughout their lifecycle (EMF, 2019). However, for reuse systems to be effective, they must achieve high return rates for packaging and ensure that containers can be recycled at the end of their use.

Innovative reuse models, such as those implemented by Alner in Greater Jakarta, demonstrate the potential for scalable solutions. These models provide high-quality, affordable products through vending machines, reducing reliance on single-use packaging.

However, the cleaning process for reusable packaging can also pose challenges, particularly regarding wastewater generation(Mohamad Moklis et al., 2020). This paper examines the efforts of the startup Alner in treating wastewater from the cleaning process of their reusable packaging products. Alner's approach highlights the broader potential

p-ISSN: 2303-2332; e-ISSN: 2597-8020 DOI : doi.org/10.21009/jgg.132.06

of reuse as a holistic and environmentally friendly solution. By integrating effective wastewater treatment, Alner shows that reuse models can be both feasible and sustainable, offering a comprehensive solution to plastic pollution.

METHODS

This study employs an empirical research approach to evaluate the effectiveness of Alner's wastewater treatment plant (WWTP) in treating wastewater generated from the cleaning process of reusable packaging. The research involves the collection and analysis of wastewater samples before and after treatment, comparing the results with the Indonesian regulatory standards outlined in the Ministry of Environment and Forestry Regulation (PerMenLHK) No. P68/MenLHK/Setjen/Kum.1/8/2016 concerning domestic wastewater quality standards.

Sample Collection

The objective of sample collection is to assess the quality of wastewater before and after treatment at Alner's WWTP and determine compliance with Indonesian regulations. Sampling points include:

- **Pre-Treatment:** Samples are taken directly from the wastewater holding tank generated by the reusable packaging cleaning process.
- **Post-Treatment:** Samples are taken after the wastewater has been treated at Alner's WWTP.

Figure 1. Wastewater Sample (1L) from Alner's **WWTP**

Figure 2. Treated Wastewater Sample (5L) from Alner's WWTP

The types of packaging involved include PET, PP, and HDPE plastics used for various products such as detergents, shampoos, dishwashing liquids, body soaps, and cooking oil. Two samples, each 1 liter in volume (totaling 2 liters), are collected from the pre-treatment holding tank. Five liters of post-treatment wastewater are collected in jerry cans to

p-ISSN: 2303-2332; e-ISSN: 2597-8020 DOI : doi.org/10.21009/jgg.132.06

ensure reliability and accuracy. Standard procedures for wastewater sample collection, as per Indonesian National Standard (SNI 6989.59:2008), are followed to maintain sample integrity.

Wastewater Treatment Plant (WWTP) Process

The study aims to understand the treatment methods used by Alner's WWTP and evaluate their effectiveness. Alner's WWTP employs electrochemical treatment and the Moving Bed Biofilm Reactor (MBBR) method. The electrochemical process involves using electrical currents to facilitate the removal of contaminants from the wastewater, known for its efficiency in breaking down complex pollutants and reducing Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD). Detailed information about the electrochemical and MBBR processes, including operational parameters, is gathered through interviews with Alner's environmental engineers and reviews of technical documents.

Data Analysis

The objective of data analysis is to evaluate the quality of wastewater before and after treatment and compare the results with Indonesian wastewater regulations based on PerMenLHK No. P68/MenLHK/Setjen/Kum.1/8/2016. Laboratory analysis of wastewater samples is conducted by TUV Nord Indonesia, focusing on key parameters using methods from the APHA 24th Edition 2023:

- Ammonia (NH3-N): APHA 4500-NH3 F
- Chemical Oxygen Demand (COD): APHA 5220 D
- Phosphate (PO4-P): APHA 4500-P E
- Surfactant/Methylene Blue Active Substances: APHA 5540 C
- Free Chlorine (Cl2): APHA 4500-Cl G
- Oil & Grease: APHA 5520 B
- Biological Oxygen Demand (BOD5): APHA 5210 D
- pH: APHA 4500-H+ B
- Total Suspended Solids (TSS): APHA 2540 D

The treated wastewater results are compared against the limits set by PerMenLHK No. P68/MenLHK/Setjen/Kum.1/8/2016.

Evaluation Criteria

The study aims to determine the effectiveness of Alner's WWTP and its compliance with regulatory standards. The effectiveness is assessed by calculating the percentage reduction in COD, BOD, TSS, and other pollutants. Compliance is

Vol. 13 No. 2 July 2024
DOI : doi.org/10.21009/jgg.132.06

verified by comparing the quality of post-treatment wastewater against the limits established in PerMenLHK No. P68/MenLHK/Setjen/Kum.1/8/2016.

Ethical Considerations

Informed consent is obtained from all personnel involved in sample collection and interviews. Data collected from Alner is kept confidential and used solely for research purposes. Samples and analysis results are securely stored and accessible only to the research team.

By conducting this empirical research, the study aims to provide a robust assessment of the effectiveness of Alner's wastewater treatment process, ensure compliance with environmental standards, and demonstrate the potential of the reuse model as a comprehensive and environmentally friendly solution.

RESULTS AND DISCUSSION

Wastewater Testing Results

The wastewater generated from the cleaning process of reusable packaging by the startup Alner was sent to a certified laboratory, TUV Nord Indonesia, in Bekasi, West Java. Testing was conducted for hazardous wastewater parameters based on the Ministry of Environment and Forestry Regulation (PerMenLHK) No. P68/MenLHK/Setjen/Kum.1/8/2016. The reusable packaging is used for various products, including liquid detergents, dishwashing liquids, shampoos, and food products like cooking oil and rice. The cleaning process is carried out according to product categories to prevent cross-contamination; for example, used cooking oil containers are not washed together with detergent containers. However, wastewater from all cleaning processes is treated together. The parameters of the wastewater tested and the results are shown below in Table 1.

Alner's Wastewater Treatment Process

Alner adopts electrochemical and Moving Bed Biofilm Reactor (MBBR) technologies in its wastewater treatment system to achieve high efficiency in treating industrial wastewater (Gzar et al., 1973). The principles and processes of Alner's WWTP are as follows:

1. **Equalization Tank:**
   - **Function:** Balances flow variations and pollutant concentrations from various wastewater sources.
   - **Process:** Wastewater is collected in this tank to reduce fluctuations before entering the subsequent treatment processes.

2. **Electrochemical Reactor (Tubular EC):**
    - **Function:** Coagulates fine particles in wastewater using electrical energy.
    - **Process:** Wastewater is pumped from the equalization tank to this reactor, where anode and cathode electrodes are used to separate pollutants through electrocoagulation.
3. **Upground Clarifier:**
    - **Function:** Separates flocculated solids formed from the electrochemical process.
    - **Process:** Polymer is added to aid floc formation. An agitator helps in mixing and forming larger flocs, making it easier to separate solids from water.
4. **Moving Bed Biofilm Reactor (MBBR):**
    - **Function:** Reduces organic load and contaminants using biofilm grown on plastic media surfaces.
    - **Process:** Water from the clarifier enters the MBBR. Here, microorganisms grow on free-moving plastic media, with air supplied by a blower.
5. **Sedimentation:**
    - **Function:** Settles suspended solids produced from the biological process in the MBBR.
    - **Process:** Water from the MBBR enters the sedimentation tank to settle solids before the water flows to the next process.
6. **Buffer Tank:**
    - **Function:** Temporarily holds water before entering the final filtration process.
    - **Process:** Water from the sedimentation tank flows into the buffer tank for temporary storage.
7. **Filtration and UV Disinfection:**
    - **Function:** Filters small particles and remaining pollutants, and sterilizes water from pathogenic microorganisms.
    - **Process:** Water from the buffer tank is pumped through a filtration unit using zeolite and activated carbon media. After that, water is sterilized using UV light before exiting as treated and clean water.

Wastewater Treatment Effectiveness

The wastewater treatment by the startup Alner, using a combination of

p-ISSN: 2303-2332; e-ISSN: 2597-8020
DOI : doi.org/10.21009/jgg.132.06

electrochemical technology and Moving Bed Biofilm Reactor (MBBR), shows highly effective results in reducing various pollutant parameters to meet the standards set by Government Regulation No. 82/2001 on Water Quality Management and Water Pollution Control (Ongena et al., 2023). The wastewater test results before and after treatment at Alner's WWTP are shown in Table 2.

Analysis of Wastewater Quality Parameters

1. pH

The pH value of the wastewater before treatment was 7.08, which is within the neutral range. After treatment, the pH increased to 7.80. This value remains within the safe limits set by regulations, which is 9. The increase in pH after treatment may be due to the electrochemical process, which tends to increase the alkalinity of the water.

2. Chemical Oxygen Demand (COD)

COD measures the amount of oxygen required to oxidize organic matter in the wastewater. Before treatment, the COD value was recorded at 4275 mg/L. After undergoing the electrochemical and MBBR processes, the COD value drastically decreased to 18 mg/L, showing a reduction of 99.58%, indicating high efficiency in organic matter removal.

3. Biological Oxygen Demand (BOD5)

BOD5 measures the amount of oxygen required by microorganisms to decompose organic matter over five days. Before treatment, the BOD5 value was 2051 mg/L, and after treatment, it dropped to 9 mg/L, showing a reduction of 99.56%, demonstrating the high effectiveness of the treatment system in reducing the organic load.

4. Total Suspended Solids (TSS)

TSS indicates the amount of solid particles suspended in the water. The TSS value before treatment was 510 mg/L, which then decreased to <5 mg/L after treatment. This reduction indicates the high efficiency of the sedimentation and filtration processes in removing solid particles from the wastewater.

5. Oil & Grease

The oil and grease content in the wastewater before treatment was 114.8 mg/L. After treatment, this value decreased to <5 mg/L, meeting the maximum limit set by regulations. The electrochemical and MBBR processes proved effective in removing oil and grease from the wastewater.

6. Surfactant / Methylene Blue Active Substances

p-ISSN: 2303-2332; e-ISSN: 2597-8020
DOI : doi.org/10.21009/jgg.132.06

The surfactant content before treatment was 613.82 mg/L. After treatment, this value decreased to <0.02 mg/L, indicating a significant reduction. Surfactants, commonly found in detergent and cleaning products, can be effectively removed by the electrochemical process used by Alner.

Treatment Process Effectiveness

The treatment technologies used by Alner, namely electrochemical and MBBR, show excellent results in reducing various pollutant parameters. The electrochemical process, involving electrocoagulation, proves effective in reducing COD, BOD5, and TSS. The MBBR, using biofilm, effectively reduces the organic load further. The clarifier aids in floc sedimentation, while filtration and UV disinfection ensure the removal of small particles and remaining pathogens. This combination of technologies ensures that the treated wastewater meets the quality standards set by regulations.

Comparison with Regulatory Limits

The treated wastewater results compared to the limits set by Government Regulation No. 82/2001 show that all parameters are below the permissible thresholds. This indicates that Alner's wastewater treatment system is not only effective but also compliant with the prevailing environmental regulations in Indonesia.

Environmental Implications and Contributions

The effective wastewater treatment demonstrates that the reuse model implemented by Alner not only reduces the use of single-use plastics but also ensures that the cleaning process of reusable packaging does not further pollute the environment. By integrating advanced wastewater treatment technologies, Alner sets an example of how startups can contribute to holistic and sustainable solutions for plastic pollution. Additionally, this approach provides a model that can be adopted by other companies in the same industry, reinforcing the argument that reuse solutions with proper wastewater treatment are an effective and sustainable way to address the plastic crisis.

Study Limitations

While this study provides a comprehensive overview of the effectiveness of Alner's wastewater treatment system, there are some limitations to consider. The study focuses on a single startup, so the results may not be generalizable to other contexts or

 Vol. 13 No. 2 July 2024
DOI : doi.org/10.21009/jgg.132.06

regions. Additionally, reliance on data provided by Alner and the quality of laboratory analysis may influence the study's outcomes

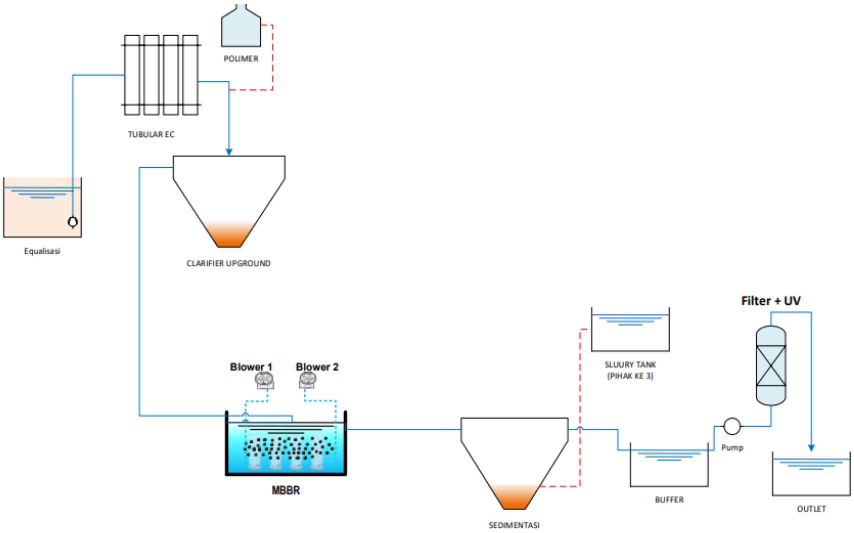

Figure 3. Process Flow Diagram of Alner's WWTP

Table 1. Test Results of Wastewater Samples at Alner's WWTP

Parameters	Sample 1	Sample 2
pH	7.08	7.24
Chemical Oxygen Demand (COD)	4275	3146
Ammonia (NH3-N)	0.244	0.127
Biologycal Oxygen Demand (BOD5)	2051	1510
Oil & Grease	114.8	49.2
Total Suspended Solids (TSS)	510	116
Free Chlorine (Cl2)	< 0.02	< 0.02
Surfactan / Methylene Blue Active Substances	613.82	507.69
Phospate (PO4- P)	< 0.020	0.115

Table 2. Test Results of Treated Wastewater at Alner's WWTP

Parameters	Test Results	Maximum Limit	Unit
pH	7.80	6 - 9	-
Chemical Oxygen Demand (COD)	18	100	mg/L
Ammonia (NH3-N)	< 0.020	10	mg/L
Biologycal Oxygen Demand (BOD5)	9	30	mg/L
Oil & Grease	< 5	5	mg/L
Total Suspended Solids (TSS)	< 5	5	mg/L
Free Chlorine (Cl2)	< 0.02	-	
Surfactan / Methylene Blue Active Substances	< 0.02	-	
Phospate (PO4- P)	< 0.02	-	

CONCLUSION

Vol. 13 No. 2 July 2024
DOI : doi.org/10.21009/jgg.132.06

This study demonstrates that the wastewater treatment system implemented by Alner is highly effective in reducing various pollutant parameters to meet regulatory standards. The technologies used, namely electrochemical and MBBR, have proven to be very efficient in treating wastewater from the cleaning process of reusable packaging. With this approach, Alner not only contributes to the reduction of single-use plastic usage but also ensures that its wastewater treatment process is environmentally friendly and sustainable.

ACKNOWLEDGMENTS

I would like to extend my heartfelt gratitude to the entire Alner and Enviu teams for their relentless efforts in implementing reuse solutions in Indonesia and pioneering the reuse ecosystem in the country. Your unwavering dedication, hard work, and commitment to sustainability and innovation have been the cornerstone of this research. Your pioneering spirit and determination to create a greener, more sustainable future are truly inspiring. Thank you for your invaluable contributions and tireless efforts.

REFERENCES

Bor, W. (2020). *Releasing the reuse revolution in the global south: The transition of businesses from single-use plastic packaging to reuse models at the base of the pyramid in Indonesia* (Master's thesis, Utrecht University).

Ellen MacArthur Foundation. (2019). Reuse: Rethinking Packaging. Retrieved from https://www.ellenmacarthurfoundation.org/publications/reuse

Evita, Pasongli, H., Salam, R., & Marthinu, E. (2023). Analisis Hubungan antara Pengetahuan dan Sikap Peduli. *Green Growth dan Manajemen Lingkungan*, *13*(1), 31–43.

Gzar, Hatem A., Wisam S. Al-Rekabi, and Zahraa K. Shuhaieb. "Applicaion of Moving Bed Biofilm Reactor (MBBR) for Treatment of Industrial Wastewater: A mini-Review." *Journal of Physics: Conference Series*. Vol. 1973. No. 1. IOP Publishing, 2021.

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., ... & Law, K. L. (2015). Plastic waste inputs from land into the ocean. Science, 347(6223), 768-771.

Mohamad Moklis, G. M. E. P., Larasati Nabila, S., & Indra Puspikawati, S. (2020). Evaluasi Pelaksanaan Program Adiwiyata Dalam Mewujudkan Sekolah Peduli Dan Berbudaya Lingkungan Di Sdn Model Banyuwangi. *Jurnal Green Growth dan Manajemen Lingkungan*, *8*(2), 63–79. https://doi.org/10.21009/jgg.082.01

Ongena, S., Van de Walle, A., Mosquera-Romero, S., Driesen, N., Gutierrez, L., & Rabaey, K. (2023). Comparison of MBR and MBBR followed by UV or electrochemical disinfection for decentralized greywater treatment. *Water Research*, *235*, 119818.

Parlindungan Sigalingging, B. H. (2020). Evaluasi Implementasi Manajemen Rumah Sakit Dalam Rangka Green Hospital Di Wilayah Bali. *Jurnal Green Growth dan Manajemen Lingkungan*, *8*(2), 90–105. https://doi.org/10.21009/jgg.082.03

Poggenpohl, A. (2018). Revealing opportunities to reduce single-use plastics by a systemic design approach on Java (Master’s Thesis).

Syahrial, S. S., Wahyuari, W., & Julianto, H. (2023). Enterprise Risk Management pada Perguruan Tinggi Swasta (Studi Kasus di STMA Trisakti). *Jurnal Green Growth dan Manajemen Lingkungan*, *13*(1), 62–79. https://doi.org/10.21009/10.21009/jgg.v13i1.04