JOURNAL OF
NATURAL SCIENCES AND MATHEMATICS RESEARCH

Available online at http://journal.walisongo.ac.id/index.php/jnsmr

Shrimp cracker industrial wastewater treatment with aerobic biological properties utilizing modified Contact-Stabilization method

Sintha Soraya Santi[1], Kindriari Nurma Wahyusi[1], Ketut Sumada[1], Srie Muljani[1]
[1]Chemical Engineering Study Program, Faculty of Engineering, Universitas Pembangunan Nasional Veteran Jawa Timur, Indonesia

Corresponding author:
sintha.tk@upnjatim.ac.id
Received : 20 Oct 2021
Revised : 20 Nov 2021
Accepted : 1 Dec 2021

Abstracts

The prawn cracker industry is one of the most common types of food industry in Indonesia. The existence of this industry has a positive impact in maintaining and improving the Indonesian economy, but it can also have a negative impact on the environment in particular, because this industry produces wastewater which can have a negative impact on the aquatic environment if the wastewater is directly discharged into the river. Based on the results of the analysis of the quality of wastewater from one of the shrimp cracker industries, it is known that wastewater contains Chemical Oxygen Demand (COD) which is 3446 mg/L, Biological Oxygen Demand (BOD) 1118.9 mg/L and acidity (pH) 5.88 – 6.13. Referring to the wastewater quality standards for the shrimp cracker industry, namely COD: 120 mg/L, BOD: 50 mg/L, and acidity pH: 6-9, the shrimp cracker industrial wastewater must be treated first before being channeled into the body. river receiving water. In this study, the treatment process used is an aerobic biological process with a modified contact-stabilization method. This method is the development of the contact-stabilization method, where in this modified method the wastewater from the treatment is recycled to the stabilization tank and together with the bacteria is transferred to the contact tank. Variations carried out in this study are the incoming wastewater flow rate (liters/hour): 4,5 ; 5.5; 6.5 ; 7.5 and 8.5 and flow rate of recycled water from treatment to stabilization tank (%) : 10 ; 20 ; 30 of the incoming wastewater flow rate. The best results were obtained at the wastewater flow rate of 5.5 liters/hour and the recycled water flow rate from the treatment to the stabilization tank 20% with a decrease in the COD value of 97.3% and BOD of 98.4% and the pH of the treated water 6.9.

Keywords: aerobic; wastewater; COD; BOD; contact-stabilization

1. Introduction

The prawn cracker industry is one of the most common types of food industry in Indonesia. The existence of this industry has a positive impact in maintaining and improving the Indonesian economy, but it can also have a negative impact on the environment, especially because the industry produces wastewater which can have a negative impact on the aquatic environment if the wastewater is directly discharged into the river. Domestic wastewater (greywater) is waste water originating from kitchen activities, toilets, sinks and so on which, if directly discharged into the environment without prior processing, will cause pollution and have an impact on life in the water [3].

In previous research on the cow skin cracker processing industry that was carried out by Karimah & Rhomadhoni [17], this industry still uses production process technology with a simple or minimal use of tools. According to Ummi and Akliyah , when viewed from a positive and negative perspective on the existence of industrial activities, the positive impact of the perceived industry is the availability of jobs in the industrial sector, while the negative impact is waste water pollution. The impact of environmental pollution is the destruction of natural ecosystems and reduced environmental quality standards [16]. With the presence of pollution, the surrounding environment, both the abiotic environment, the biotic environment, and the social environment, will be disturbed by its intended function [18, 19]. Wastewater requires a treatment process to reduce organic pollutant materials to meet the permitted wastewater quality standards [15].

Various methods of processing cracker liquid waste have been carried out, including the technology of the subsurface flow constructed wetland system using the *Typha angustifolia* plant [4] which can reduce the concentration of TSS up to 79.9% . Waste treatment technology is of course different for various wastes, including for electroplating waste [5] using physical chemical processes and ion exchange. Likewise for wood waste [6]. Another method for treating liquid waste is the Oxidation Pond method in the form of a series of ponds used to purify liquid waste so that it is hoped that it will be harmless if released into the environment [20].

Based on the analysis of wastewater quality from one of the shrimp cracker industries, it is known that wastewater contains chemical oxygen demand (COD) which is 3446 mg/L, biological oxygen demand (BOD) 1118.9 mg/L and acidity (pH) 5.88 – 6.13. Refers to regulations regarding the quality of the shrimp cracker industrial wastewater based on the Decree of the Governor of East Java No. 72 of 2013 (SK Gubernur Jawa Timur No 72 Tahun 2013) [11] regarding the Wastewater Quality Standards, it is known that the waste water quality standards for the shrimp cracker industry are COD: 120 mg/L, BOD: 50 mg/L, and the degree of acidity pH: 6-9. Based on the provisions of these quality standards and looking at the quality of the shrimp cracker industrial wastewater, the shrimp cracker industrial wastewater must be treated first before being channeled into the river receiving water bodies.

There are various waste treatment processes, one of which is by utilizing aerobic microbial activity to decompose organic substances under aerobic conditions into stable inorganic substances that do not pollute the environment [7,14]. One of the wastewater treatment processes that are in accordance with the characteristics of the shrimp cracker industrial wastewater is an aerobic biological process because the cracker industrial wastewater contains organic materials and normal acidity. Biological wastewater treatment is wastewater treatment by utilizing microorganisms, where these microorganisms are used to decompose organic materials contained in wastewater into simpler and harmless materials [8, 14].

Aerobic biological wastewater treatment is wastewater treatment that uses bacteria type microorganisms and is accompanied by oxygen or air injection [13]. This air injection aims to maintain the life of aerobic bacteria and also functions for the oxidation process of organic matter in wastewater. The reaction mechanism of the decomposition of organic matter by microorganisms (biodegradation), and the

formation of new cells (biosynthesis) and oxidation with oxygen (air) is explained by the following reaction:

$$\text{C H O N S (organic matter)} + \text{MO (bacteria)} \longrightarrow CO_2 + H_2O + NH_3 + \text{New Cells} \quad (1)$$

$$\text{C H O N S (organic matter)} + O_2 \text{ (air)} \longrightarrow CO_2 + NH_3 + C_5H_7NO_2 \quad (2)$$

Handling organic waste biologically by utilizing microorganisms is a relatively safer method compared to chemical and physical methods. Every microorganism in maintaining its survival always metabolizes, so it needs additional organic materials such as substrates [1]. Contact-stabilization technology is one of the technologies developed from conventional technology in aerobic biological wastewater treatment [2,9,12]. The block diagram of the contact-stabilization technology is as shown in Figure 1.

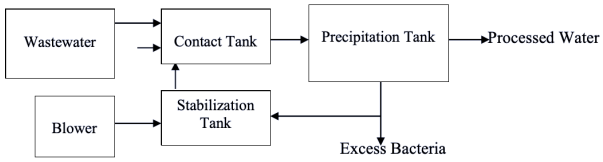

Figure 1. Aerobic biological wastewater treatment with contact-stabilization technology [10]

In this study, modification of contact-stabilization technology was carried out by changing the flow pattern such as a block diagram as shown in Figure 2.

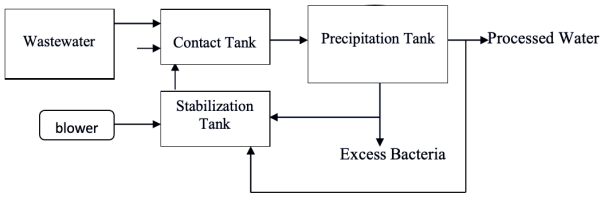

Figure 2. Aerobic biological wastewater treatment with modified contact-stabilization technology

This research on aerobic biological shrimp cracker industrial wastewater treatment with a modified contact-stabilization method aims to study the effect of contact time and recycle flow rate of treated water into the stabilization tank on the decrease in COD and BOD values of shrimp cracker industrial wastewater. The results of this study are expected to provide information on industrial wastewater treatment methods, especially industrial wastewater that is organic.

2. Experiments Procedure

The materials used in this research include industrial wastewater from one of the shrimp cracker industries located in East Java Province, while the microorganisms used are sourced from one of the industries which is the industrial wastewater treatment area in the Rungkut area, Surabaya city. The wastewater treatment method is aerobic biological treatment by modifying contact stabilization technology as shown in Figure 3.

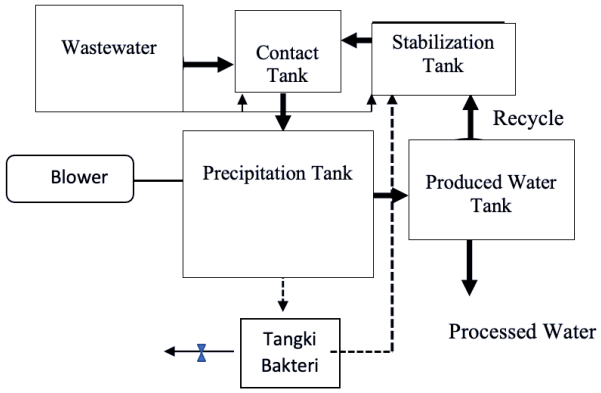

Figure 3. Aerobic biological wastewater treatment with modified contact-stabilization technology

The wastewater treatment equipment is arranged as shown in Figure 3 with the size of the waste water tank: 60 liters, contact tank: 27 liters, stabilization tank: 36 liters and settling tank: 70 liters and air pump: 100 liters/minute.

The quality of the shrimp cracker industrial wastewater was analyzed by analyzing the levels of COD, BOD and the degree of acidity (pH). Microorganisms (Bacteria) used were bred and acclimatized in contact tanks and stabilized so that the levels of microorganisms reached 5000 mg/L. Wastewater is pumped with a certain flow rate (liters/hour): 4,5 ; 5.5; 6.5 ; 7.5 and 8;5 into the contact tank, then flowed to the settling tank for the separation of microorganisms (bacteria). These microorganisms are accommodated in a microorganism holding tank and flowed into a

stabilization tank with a flow rate of 90% of the incoming wastewater flow rate. The treated wastewater comes out of the top of the settling tank and is accommodated in the treated water storage tank, then pumped at a flow rate of 10%, 20% and 30% of the wastewater enters the stabilization tank and then goes to the contact tank. The treated water that is accommodated is analyzed for levels of COD, BOD and acidity (pH).

3. Result and Discussion

Some of the research data obtained are as follows:

3.1. Shrimp cracker industry wastewater quality

The results of the analysis of the wastewater quality of the shrimp cracker industry, as listed in Table 4.1.

Table 4.1. Data on the quality of the shrimp cracker industry wastewater before processing

No	Parameter	Level (mg/L)	Shrimp Cracker Industrial Wastewater Quality Standard (mg/L) Governor of East Java
1	COD	1146	120
2	BOD	618	50
3	pH	6,2	6 - 9

Based on the data in table 4.1. As mentioned above, it can be seen that the COD and BOD levels of the cracker industrial wastewater are still above the specified quality standards, so it is necessary to treat them first before flowing into the receiving water body.

3.2. The quality of the cracker industrial wastewater after processing

The results of the analysis of the quality of the shrimp cracker industrial wastewater after aerobic biological treatment with variations in the incoming wastewater flow rate and the recycled water flow rate from the treatment are as listed in table 4.2. and 4.3. below :

Table 4.2. Percentage of COD removal of shrimp cracker industrial wastewater

No	Incoming wastewater flow rate (litre/hour)	COD Allowance Percent (%) The recycled water flow rate from the treatment to the wastewater flow rate (%)		
		10	20	30
1	4,5	93,4	95,5	96,4
2	5,5	94,5	97,3	97,5
3	6,5	92,7	96,4	96,6
4	7,5	91,8	93,2	96,1
5	8,5	89,4	92,3	95,2

Table 4.3. Percentage of BOD allowance for shrimp cracker industrial wastewater

No	Incoming wastewater flow rate (litre/hour)	Percent Allowance for BOD (%) The recycled water flow rate from the treatment to the wastewater flow rate (%)		
		10	20	30
1	4,5	94,8	96,4	97,2
2	5,5	96,2	98,4	97,5
3	6,5	95,3	97,9	97,4
4	7,5	93,8	95,2	96,5
5	8,5	91,4	93,4	94,7

The results of the removal of COD and BOD from the shrimp cracker industrial wastewater are listed in table 4.2. and 4.3. above, can be illustrated graphically as shown in Figures 4.1 and 4.2. below :

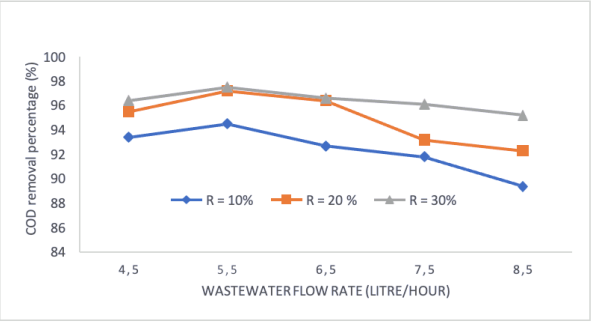

Figure 4.1. Effect of wastewater flow rate and microorganism recycle rate on the percentage of wastewater COD removal.

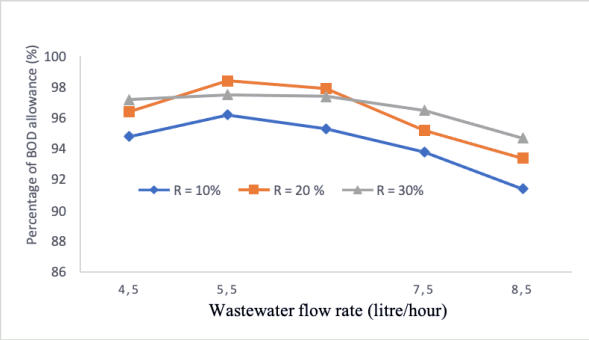

Figure 4.2. Effect of wastewater flow rate and microorganism recycle rate on the percentage of wastewater BOD removal.

Based on Figure 4.1. and 4.2. it can be seen that the greater the flow rate of incoming wastewater, the percent removal of COD and BOD there is an increase and also a decrease this is due to changes in the flow rate of incoming wastewater resulting in a smaller contact time in the contact tank, so the decomposition time of organic matter into simpler materials. be short. The best wastewater flow rate is at a wastewater flow rate of 5.5 liters per hour, with a contact tank volume of 27 liters, the best contact time is 2.3 hours. The recycle flow rate of treated water into the stabilization tank also affects the decrease in COD and BOD levels, where the greater the recycle rate, the decrease in COD and BOD levels, there is an increase and decrease, this is because the greater the recycled treated water, the shorter the residence time in the contact tank. and the decrease in COD and BOD also decreased. The recycle rate of treated water into the best stabilization tank is 20% based on the highest decrease in BOD.

4. Conclusion

Aerobic biological wastewater treatment of shrimp cracker industry with modified contact-stabilization technology can reduce COD levels by 97.3% with residual COD of 30.95 mg/L and BOD: 98.4% with residual BOD of 9.91 mg/L and residence time in the contact tank for 2-3 hours and in the stabilization tank for 5.4 hours. Shrimp cracker industrial wastewater after processing meets quality standards.

Acknowledgments

We would like to express our gratitude to the Head of the Chemical Engineering Study Program at the National Development University, East Java, especially the factory waste treatment laboratory which has facilitated the implementation of this research.

References

[1] Anshah, A. S., & Suryawan, I. W. K. (2018). Efektifitas Penambahan substrat pada pengolahan biologis limbah cair tahu menggunakan sistem CSTR. ENVIROSAN: Jurnal Teknik Lingkungan, 1(2), 46-51.

[2] Ehab M Rashed, Maha M.El-Shafei, Mohamed A. Heikal, and Ahmed M. Noureldin, (2014), "Application of Contact Stabilization Activated Sludge for Enhancing Biological Phosphorous Removal (EBPR) in Domestic Wastewater, HBRC Journal, http://dx.doi.org/10.1016/j.hbrcj.2013

[3] Filliazati, M. (2013). Pengolahan limbah cair domestik dengan biofilter aerob menggunakan media bioball dan tanaman kiambang. Jurnal Teknologi Lingkungan Lahan Basah, 1(1).

[4] Hamdani Abdul Gani, Munifati Izzati, Sudarno, (2013), "Pengolahan Limbah Cair Industri Kerupuk Dengan Sistem Subfarce Flow Constructed Wetland Menggunakan Tanaman Typha Angustifolia", Prosiding Seminar Nasional Pengelolaan Sumber daya Alam dan Lingkungan. Hal 482-488. ISBN 978-602-17001-1-2

[5] Ketut Sumada, (2006) "Kajian Instalasi Pengolahan Air Limbah Industri Elektroplating yang Efdisien. Jurnal Teknik Kimia, 1 (1). pp. 26-36. ISSN 1978-0419

[6] Ketut Sumada, (2012). "Kinerja Koagulan untuk Pengolahan Air Limbah Industri Pengolahan Kayu". Prosiding Seminar Nasional Teknik Kimia Soebardjo Brotohardjono IX "Pengelolaan Sumber Daya Alam Ramah Lingkungan Berbasis Efisiensi Energi, 21 Juni 2012, Surabaya.

[7] Sumada, K., Chaerani, N. C., Priambodo, M. D., & Saputro, E. A. (2021). Pengolahan Limbah Cair Industri Pakan Ternak dengan Kombinasi Proses Aerasi dan Biologi Aerob. Jurnal Teknologi Lingkungan, 22(2), 249-256.

[8] Mbachu A.E., Chukwura E.L., and Mbachu N.A., (2020), "Role of microorganisms in the Degradation of Organic Pollutants : A Review", Energy and Environmental Engineering Journal, vol 7, No 1, hal 1-11.

[9] Nancy Vascquez, Patricia Torres Lozada, Alexander Rodriguez and Carlos Madera, (2011), "Performance of the Contact Stabilization Process for Domestic Wastewater Treatment of Cali, Colombia" Dyna Journal, Vol 78, No 168, hal 98-107

[10] Oskar Modin, Frank Persson, Brtii-Marie Wilen, and Malte Hermansson, (2016), "Non- Oxidative Removal of Organics in the Activated Sludge Process", Critical Reviews in Environmental Science and Technology Journal, vol 46, No 7, hal 635-672.

[11] Peraturan Gubernur Jawa Timur nomor 72 Tahun 2013, "Baku Mutu Air Limbah Bagi Industri Dan/Atau Kegiatan Usaha Lainnya"

[12] Rashed Zimmo, (2004), "Process Performance Evaluation of the Contact Stabilization System at Birzeit University", Int. J, Environment and Pollution, Vol 21, No 5, hal 1-7

[13] Tumpa Mondal, Ankan Jana, Debajyoti Kundu, (2017), "Aerobic wastewater treatment technologies : A mini review", Int J Env Tech Sci, vol 4, No 1, hal 135-140 (www.journalijets.org)

[14] Utami, L. I., Wahyusi, K. N., Utari, Y. K., & Wafiyah, K. (2019). Pengolahan limbah cair rumput laut secara biologi aerob proses batch. Jurnal Teknik Kimia, 13(2), 39-43.

[15] Anggraeni, D., & Sutanhaji, A. T. (2014). Pengaruh volume lumpur aktif dengan proses kontak stabilisasi pada efektivitas pengolahan air limbah industri pengolahan ikan. Jurnal Sumberdaya Alam dan Lingkungan, 1(3), 6-12.

[16] Rofik, M., & Mokhtar, A. (2021). PENCEMARAN DALAM LINGKUNGAN HIDUP. In Seminar Keinsinyuran Program Studi Program Profesi Insinyur (Vol. 1).

[17] Karimah, R. R. S., & Rhomadhoni, M. N. (2021). Pengolahan Limbah Cair di Sektor Industri Informal Pabrik Pengolahan Kerupuk Kulit UD. X Kabupaten Mojokerto. HIGIENE: Jurnal Kesehatan Lingkungan, 7(1), 17-22.

[18] Ningsih, R. W. (2018). Dampak Pencemaran Air Laut Akibat Sampah Terhadap Kelestarian Laut Di Indonesia. Jurnal Universitas Muhammadiyah Yogyakarta, 0-12.

[19] Ummi, N. S. D., & Akliyah, L. S. (2016). Kajian Dampak Pencemaran Air Limbah Industri Terhadap Kondisi Fisik Lingkungan, Sosial-Ekonomi Masyarakat Kecamatan Rancaekek Kabupaten Bandung. Prosiding Perencanaan Wilayah dan Kota, 167-175.

[20] Andiese, V. W. (2011). Pengolahan limbah cair rumah tangga dengan metode kolam oksidasi. JOURNAL TEKNIK SIPIL DAN INFRASTRUKTUR, 1(2).