Analysis of load variation on chicken slaughterhouse waste water treatment using GAS-SBR

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Abstract. In general, chicken slaughterhouses have capacity of slaughtering more than 40,000 chickens per day so its produce a high waste water. It takes sewage treatment appropriate technology, Granular Aerobic Sludge which use Sequencing Batch Reactor (GAS-SBR) due to the high of BOD and COD. The purpose of this research was to explore GAS ability in decreasing parameter of COD, BOD, TSS and ammonia. The initial concentration COD influent was 6,406.4 mg/L then it was varied into three concentrations were 6,144 mg/L (100%), 4,608 mg/L (75%) and 3,072 mg/L (50%) of diluted pure water. As the result with four hours' aeration time, the highest removal of 100% BOD load was 56.25% and an effluent was 1,400 mg/L. The highest removal of 50% COD load was 75% and an effluent was 768 mg/L. The highest removal of 100% TSS load was 36.73% an effluent was 1.79 mg/L. And the highest removal of 75% Ammonia load was 67.91% and an effluent was 1.11 mg/L. The parameter for the TSS and ammonia have meet the quality ministry environment no.5 2014 law for slaughterhouses, while the BOD and COD parameters are exceeding the standards due to its high organic content.

1. Introduction

Chicken slaughterhouse business in Indonesia has become a small industrial activity whose development contributes significantly to the economic sector. This is because poultry products, including chicken, namely chicken and eggs, are relatively cheap and easily obtained by the public [1]. In East Jakarta, there are 572 chicken slaughterhouses with the capacity to slaughter chickens with a cutting capacity of more than 40,000 head / day [2]. With the increase in the amount of chicken meat consumption it will have an impact on the increase in waste water produced by the Chicken Slaughterhouse Industry [3]. Chicken slaughter waste water can act as a place for microbial growth and development because it contains protein, carbohydrates, fats and salts, so it easily decomposes. In the process of decomposition in water can result in an increase in BOD, COD, NH3, H2S, and changes in pH [4]. In the processing of chicken slaughterhouse wastewater with anaerobic-aerobic biofilter process it can produce a fairly good quality and meet the requirements of quality standards for industrial wastewater. This process has advantages such as low operating costs compared to the activated sludge process [5].

To reduce environmental pollution in water bodies due to chicken slaughterhouse waste water, SBR technology can be used to break down the waste pollutants. SBR is waste water treatment based on system activated sludge and is operated in a fill-and-draw cycle [6]. In SBR, waste water that has been put into a "batch" reactor is processed to remove pollutant parameters, then flow out [7]. SBR has five stages of the process carried out in stages, namely, filling, reaction, deposition, disposal and stabilization.
and after the last stage the process starts from the beginning so that it becomes a cycle. All process stages occur in the same tank [8]. Hospital wastewater treatment using SBR can provide a range of efficiency of organic (COD) removal is 36% - 81%, efficiency of removal of ammonia-nitrogen is 45% - 97% and phosphate removal efficiency was 55% - 95% [9].

One that can be used simultaneously in the SBR technology is aerobic granular biomass [10]. The advantages this technology has the ability to deposition of large biomass, due to a large density so as to minimize land requirement for precipitation [11]. Aerobic Granular Sludge (AGS) can be defined as the aggregate derived from microorganisms which do not coagulate and settle significantly faster when compared to the activated sludge floc [12]. SBR reactors are often the main choice because the contact process and separation occur in a relatively simple reactor [13].

Because chicken slaughterhouse wastewater has the potential to cause environmental pollution, it is necessary to treat it efficiently and reduce the load of organic in it, by applying the principle of aerobic granular sludge formation in Sequencing Batch Reactor (SBR). In this study, Granular Aerobic Sludge used in the SBR focusing on effect of load variation to reduce BOD, COD, Ammonia and TSS parameters from chicken slaughterhouse wastewater.

2. Methods

![Figure 1. Cycle of sequencing batch reactor [14].](image1)

![Figure 2. Sequencing batch reactor.](image2)

This study consists of two stages of activities, namely preliminary research and main research. In the preliminary stage, an initial characteristic analysis was carried out, namely analysis the characteristics of chicken slaughter houses wastewater and analysis the characteristics of the activated sludge Waste Water Treatment Plant (WWTP) domestic originating from the Mall.

After carrying out the initial characteristic analysis, the second stage was started using Sequencing Batch Reactor (SBR). Slow stirring was carried out in SBR for 1 month to form granular in the activated sludge using additional flocculants in the form of Xanthan Gum. After that, seeding and acclimatization were carried out, in the seeding process to breed microorganisms was sufficient to treat waste water, the sludge come from RAS (Return Activated Sludge) clarifier unit [15]. In the acclimatization process which aims as a process of adjusting microorganisms to the waste water to be treated [16]. After seeding and acclimatization, the main research was conducted in reactor as can be seen in Figure 2. In the main research, waste water used was waste water artificially that resembles characteristic of the waste water chicken slaughterhouses. Whereas the sludge used was still from domestic WWTP. Stages carried out on SBR were, as shown at Figure 1, fill stage (15 minutes), reaction stage (4 hours), settle stage (1.5 hours), decantation stage (15 minutes) and stabilization stage (2 hours). On 100% load and 10 hours of aeration time, it has largest efficiency qualifying on parameter COD and ammonia-nitrogen [9]. In the fill stage, 3 variations in the concentration of COD were carried out, namely 100%, 75%, and 50%. In this study the parameters of COD, BOD, TSS and Ammonia then were being analysed.
In the SBR cycle there are used 4 variation of load are 10,000 mg/L, 8,000 mg/L, 4,000 mg/L and 2,000 mg/L with fill stage (120 minutes), reaction stage (2 hours, 4 hours, and 8 hours), decant stage (20 minutes), and settle stage (1 hour) [17].

3. Results and discussion

3.1. Preliminary research

3.1.1. Analysis of chicken slaughter houses and activated sludge. The purpose of characteristics analysis of chicken slaughter houses waste water was to find out the average concentration value of various parameters to be tested in the wastewater. In this chicken slaughter houses wastewater, the COD was 6,406.4 mg/L and BOD is 3,215.8 mg/L. While for the analysis of the initial characteristics of the activated sludge was carried out to determine the amount of biomass contained in the activated sludge. The MLSS value used in this study was 4,000 mg/L which corresponds to the design criteria which ranged from 2,000-5,000 mg/L [17]. For MLSS and MLVSS content, the value obtained is 7,146 mg/L and 4,356 mg/L. After carrying out the initial characteristic analysis, seeding and acclimatization were carried out where the acclimatization process was carried out until the steady state conditions which meant that microorganisms in activated sludge could adapt to waste water.

3.2. Main research

3.2.1. Removal of COD. The testing of the COD parameters aims to determine the concentration of organic matter that was successfully removed in processing. In this study the COD concentration was 6,144 mg/L. When processing at 100% loading initial, COD effluent of 3,840 mg/L was obtained with an efficiency of 37.5%. When at 75% loading initial, COD effluent was 2,176 mg/L with an efficiency of 52.78%. While at 50% loading initial, COD effluent was 768 mg/L with an efficiency of 75%. Of the three variations of loading, the highest removal of COD was the loading initial of 50%. The following data can be seen in Figure 3. These result quite good, comparing with SBR with an aeration time of 10 hours can remove COD by 36%-81% with an influent is 385.30 mg/L [9].

![Figure 3. COD analysis in load variation.](image)

3.2.2. Removal of BOD

The parameter BOD is the amount of oxygen used by an organism when consuming organic compounds contained in waste. In this study the influent at 100% loading was 3200 mg/L. After processing in effluent SBR BOD became equal to 1400 mg/L and experienced an allowance of 56.25%. At the loading of 75% influent of 2400 mg/L. After processing in effluent SBR it was 1760 mg/L and experienced an allowance of 26.67%. At 50% influent loading of 1860 mg/L and the effluent to be 1660 mg/L and the allowance was 10.75%. Of the three variations of loading the biggest remove for BOD is a variation of 100% loading. Efficiency of BOD using SBR is 97.49% with an influent is 77 mg/L and the aeration time 3 hours [14]. The following data can be seen in Figure 4.
3.2.3. Removal of TSS
TSS analysis is carried out to determine the total suspended solids found in wastewater. Suspended solids contained in wastewater have a negative impact on aquatic ecosystems if they are directly discharged into water bodies without treatment first. At 100% loading the influent value of 2.83 mg/L and after processing in the effluent SBR produced was 1.79 mg/L with an allowance of 36.73%. At 75% loading the influent value of 1.51 mg/L and after processing in effluent SBR produced was 1.34 mg/L with an allowance of 11.46%. At 50% loading has an influent value of 1.31 mg/L after being processed in the effluent SBR produced at 1.18 mg/L with an allowance of 9.92%. Of the three variations of loading, the largest of the total suspended solids is 100% loading variation. Efficiency of TSS using SBR is 75.93% [14]. The following data can be seen in Figure 5.

3.2.4. Removal of ammonia-nitrogen
Analysis of nitrogen ammonia is an important parameter because one of the quality standards that need to be considered. At 100% loading has an influent value of 2.29 mg/L and after processing in SBR has an effluent value of 1.76 mg/L with allowance of 23.09%. At 75% loading has an influent value of 3.45 mg/L and after processing it in SBR has an effluent value of 1.11 mg/L with an allowance of 67.91%. At 50% loading the influent value was 7.09 mg/L and had an effluent value of 6.26 mg/L with an allowance of 11.64%. Of the three largest variations of loading which remove ammonia-nitrogen is a load variation of 75%. On the provision of ammonia nitrogen using SBR with an aeration time of 10 hours can remove high ammonia nitrogen by 45%-97% [9]. The following data can be seen in Figure 6.
4. Conclusion
Based on the data it can be concluded that, for COD and BOD parameters are still above the level of quality standards determined in accordance with Government Regulation No. 5 of 2014 [18] which states that the COD and BOD values allowed are 200 mg / L and 100 mg / L. And it can be seen from the data, the ability of SBR to remove COD and BOD parameters is not maximal, due to the high content of organic substances found in chicken slaughter houses waste water and it can be lowered if the aeration time is longer than 4 hours of aeration time. Whereas for TSS and Ammonia-nitrogen has a grade value below the specified quality standard.

References
[1] Singgih and Kariana 2008 Peningkatan Produktivitas dan Kinerja Lingkungan Dengan Pendekatan Green Productivity Pada Rumah Pemotongan Ayam XX. Purifikasi: Jurnal Manajemen Lingkungan 9 1-2
[2] Dinas Peternakan Perikanan Dan Kelautan, Provinsi DKI Jakarta, Tempat Penampungan ayam Wilayah Jakarta Timur JAI 2 83
[3] Al Kholif 2015 Pengaruh Penggunaan Media Dalam Menurunkan Kandungan Amonia Pada Limbah Cair Rumah Potong Ayam (RPA) Dengan Sistem Biofilter Anaerob Jurnal Teknik Waktu B (01) 13-18
[4] Suardana and Suacita 2006 Studi Pengaruh Air Limbah Pemotongan Hewan Dan Unggas Terhadap Kualitas Air Sungai Subak Pakel 1 Di Desa Darmasaba Kecamatan Abiansemal Kabupaten Badung Ecotrophic 3(2) 55-60
[5] Satmoko Yudo 2006 Rancang Bangun Instalasi Pengolahan Air Limbah Rumah (RPH) Ayam dengan Proses Biofilter JAI 2 83
[6] Vives 2005 SBR Technology for Wastewater Treatment: Suitable Operational Conditions for a Nutrient Removal. Ph.D Thesis, Universitat de Girona
[7] Mahvi A H 2008 Sequencing Batch Reactor: A Promising Technology in Wastewater Treatment (Iran) 5(2) 79-90
[8] Lita Darmayanti 2011 Kinetika Penyisihan Nitrogen dalam Air Buangan Rumah Potong Hewan pada Sequencing Batch Reactor Aerob. Jurnal Teknobiologi II(1) 23-28
[9] Erillia Afifah Haque 2017 Pengolahan Air Limbah Rumah Sakit dengan Sistem Lumpur Aktif Model SBR Skala Laboratorium Thesis Institut Teknologi Sepuluh November Surabaya
[10] Casto-Barros C M, Revised by Voleke E I P 2013 Guidline for granular sludge reactor design, SANITAS Sustainable and Integrated Urban Water System Management Jurnal Sains dan Teknologi Lingkungan 7 84-94
[11] Beun 2000 Aerobic granulation. Water Science & Technonolgy 41 41-48

Figure 6. Ammonia-nitrogen analysis in load variation.
[12] Ni B J 2013 Formation, characterization, and Mathematical Modelling of The Aerobic Granular Sludge. *Springer Theses* (Berlin)

[13] Liu Y 2006 Biosorption Properties of Aerobic Granules. Chapter in Waste Management Series 6: Biogranulation Technologies for Wastewater Treatment 244-245

[14] Husain M I 2018 Pengembangan Instalasi Pengolahan Air Limbah (IPAL) Domestik dengan menggunakan Metode Sequencing Batch Biofilm Reactor (SBBR) di Kawasan Industri *Thesis Universitas Surya*

[15] Indriani B R 2006 Pengaruh Rasio F/M Terhadap Pengolahan Air Terproduksi dengan *Sequencing Batch Reactor (SBR)* *Thesis Institut Teknologi Sepuluh November Surabaya*

[16] Kundu, Pradyut, Anupam Debsarkar 2013 Treatment of Slaughter Houses Wastewater in a Sequencing Batch Reactor *BioMed Research International* 1-11

[17] Mindriany S, Tjandra S and Pingkan A 2003 Kinerja Sequencing Batch Reactor Aerob Pada Degradasi Glukosa Dengan Variasi Rasio Waktu Pengisian Terhadap Waktu Reaksi *Jurnal Purifikasi* 4 109-114

[18] Kementerian Lingkungan Hidup Republik Indonesia 2014 Peraturan Menteri Lingkungan Hidup No. 5 Tahun 2014 Tentang Baku Mutu Air Limbah