The effect of aeration time on chicken slaughterhouse water treatment using GAS-SBR

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Abstract. Granular Activated Sludge - Sequencing Batch Reactor (GAS-SBR) has the ability to treat wastewater with high organic content. This study was conducted to determine the effect of aeration time in setting aside parameters COD, BOD, TSS and Total Ammonia in chicken slaughterhouse wastewater. Chicken slaughterhouse waste water used in this processing is artificial waste water made from a mixture of sucrose, KNO3 and KH2PO4. GAS formation is cultured by reacting activated sludge with stirring (20 rpm). SBR has a total work volume of 45L which is operated in 5 stages (fill – 0.25 hours, aeration time varied for 2 hours, 4 hours and 6 hours, settle - 0.25 hours, draw - 0.25 hours and idle - 6 hour). The results showed that the variation of aeration time for 2 hours resulted in the efficiency of removing COD obtained was 72.83% (influent of 6016 mg / L), BOD was 72.23% (influent of 3614 mg / L) and TSS 59.8% (influent of 2, 8 mg / L). While the variation of aeration time for 4 hours resulted in a total ammonia removal efficiency of 65.85% (influent of 2.29 mg / L).

1. Introduction

Chicken slaughterhouse wastes contain high blood, protein, fat, and suspended solids which have an impact on pollution in the river basin [1]. Based on the results of the research analysis in the environmental laboratory, Environmental Engineering Department, Trisakti University, 2018, chicken slaughterhouse wastewater contains TSS 126 mg/L, BOD 3215.28 mg/L, COD 6406.4 mg/L, oil and fat 15 mg/L, detergent (MBAS) 5.85 mg/L, total ammonia 13.8 mg/L and pH 7.19. Some of these concentrations exceeds waste water quality standards for slaughter activities (BOD 100 mg/L, COD 200 mg/L, TSS 100 mg/L, oil and fat 15 mg/L, NH3-N 25 mg / L and pH 6-9) [2]. As a result of the high content in chicken slaughterhouse wastewater, processing is needed that is able to process chicken slaughterhouse water properly and efficiently before being discharged into the river basin. One of the related studies that has been carried out is the processing of slaughterhouse wastewater with activated sludge capable of removing BOD by 89% [3].

The SBR process is known to save 60% of the operating costs of conventional activated sludge processes and can achieve high waste quality in very short aeration times [4]. Based on several studies that have been conducted revealing that SBR is able to treat wastewater with high organic content. SBR is an effective process for post-processing of anaerobically digested palm oil mill effluents (POME), which reaches removal of COD, BOD, and TSS, each ranging between 91-96%, 92-99% and 94-99% [5]. Other studies have shown that anaerobic SBR can reduce COD and Total Nitrogen (TN) by 80% and 50% in landfill leachates [6].
The processing technology with SBR reactors can be combined with Granular Activated Sludge (GAS). GAS has advantages compared to wastewater treatment with conventional activated sludge. The granular biomass can be formed under aerobic conditions without the need for other ingredients as the nucleus Morgenroth et al. [7] in Zheng et al. [8]. Various references mention the superiority of this technology especially in the ability of rapid deposition of biomass, due to its large density, so that it can reduce land requirements for precipitation [9]. This study aims to treat chicken slaughterhouse wastewater using a combination of SBR and GAS and its performance in setting aside parameters COD, BOD, TSS and Ammonia Total with variations in aeration time. Some reviews regarding the use of this technology reveal that GAS-SBR technology can reduce COD up to 96.5% at the end of the granulation period, while ammonia and total nitrogen removal efficiency increase to 94.7% and 89.4% [10].

2. Material and methods

The reactor used in this study was made of acrylic material with a total volume capacity of 45 liters (50 cm high, 30 cm length and 30 cm wide). SBR is equipped with an air pump that has an oxygen supply capacity of 4200 liters/hour. The wastewater used in this study is artificial wastewater that resembles the characteristics of Pulogadung Chicken Slaughterhouse, East Jakarta. Artificial wastewater is made to equalize the parameters COD (6000 mg/L) with a COD: N: P ratio of 100: 5: 1 Benefiel and Randall [11] in Hadiwidodo and Junaidi [12]. The active sludge used in this study was taken from the RAS (Return Activated Sludge) unit of clarifier Waste Water Treatment Mall, North Jakarta which will be used as seeds for the GAS formation granulation process.

Seeding process is carried out by reacting the activated sludge with slow stirring (20 rpm) for 26 days as well as the preparation stage for GAS formation. In the seeding process, MLSS and MLVSS were checked to control the quantity of suspended solids and biomass content in activated sludge. Furthermore, the activated sludge is acclimatized in SBR by gradually adding artificial wastewater to obtain a biomass culture that can adapt. The operation of the SBR starts with the filling stage carried out for 0.25 hours and is continued by turning on the air pump for variations in the aeration process (2 hours, 4 hours and 6 hours). After the aeration process is complete, the next process is settling for 1.5 hours, decantation for 0.25 hours and stabilization of sludge for 6 hours. The parameters analyzed were COD, BOD, TSS and total ammonia. The analyzed wastewater samples were taken from the decantation results. This check is done every one cycle.

3. Results and discussion

This study was conducted to determine the effect of variations in aeration time in optimizing the performance of GAS-SBR. Therefore, the analysis of the allowance for parameters COD, BOD, TSS and Ammonia Total is important to determine the performance of the GAS-SBR.
3.1. **COD and BOD removal**
COD and BOD are parameters commonly used to determine water pollution. Analysis of COD and BOD is needed to show a decrease in water soluble oxygen content that is easy or difficult to decompose [13]. The high content of COD and BOD in chicken slaughterhouse wastewater is caused by the high content of organic waste from the remaining slices in the form of organs, blood and unused chicken parts [14].

![COD influent vs COD effluent](image1)

**Figure 2. COD removal.**

![BOD influent vs BOD effluent](image2)

**Figure 3. BOD removal.**

At the concentration of COD 6016 mg/L GAS-SBR can reduce up to 1600 mg/L, 2944 mg/L and 2112 mg/L for each aeration time of 2 hours, 4 hours and 6 hours. This also happened to BOD, where at a concentration of 3614 mg/L there was a reduction of 1007 mg/L, 1732 mg/L and 1319 mg/L for each aeration time of 2 hours, 4 hours and 6 hours. So that it can be seen that the aeration time affects the allowance for COD and BOD. Based on these data shows that at 2 hours’ aeration time is the highest allowance for GAS-SBR to set aside COD and BOD parameters with the efficiency of the allowance of 72.83% and 72.23% respectively. This result was also supported by other studies which revealed an aerobic batch process which showed that at 2 hours’ aeration time was the best result obtained by decreasing COD 86.35% (from influent 1264.03 mg/L) and BOD 86.26% (from influent 538.88 mg/L) [15].

3.2. **TSS removal**
Observations on the distribution of TSS are often used to determine water quality. High TSS values indicate high levels of pollution and inhibit the penetration of light into water, causing photosynthesis to be disturbed [16]. In addition, TSS will absorb solar thermal energy and will be able to increase water temperature, which can ultimately reduce dissolved oxygen [17].
Figure 4. TSS removal.

Figure 4 shows that aeration time in the GAS-SBR process has an effect on TSS removal. This result is shown at a concentration of 2.3 mg/L. GAS-SBR TSS can reduce up to 1.1 mg/L, 2.3 mg/L and 1.5 mg/L for each aeration time of 2 hours, 4 hours and 6 hours. Based on these data, it shows that at 2 hours’ aeration time TSS removal efficiency was 59%, which is the highest allowance that occurs in the GAS-SBR process. This allowance is smaller than the previous research by using a multilevel batch aeration process showing that at 2 hours’ aeration time it can set aside TSS by 68.15% (from influent 1014 mg/L) [18].

3.3. Total ammonia removal

The presence of ammonia compounds can cause conditions toxic to aquatic life. Ammonia in surface water comes from urine, feces and decomposition of organic matter microbiologically from natural water or industrial waste water [19]. Water life affected by ammonia at a concentration of 1 mg/L can cause death because it can reduce the oxygen concentration in water [20].

Figure 5. Total ammonia removal.

Figure 5 shows that at a total ammonia concentration of 2.29 mg/L GAS-SBR it can reduce up to 1.6 mg/L, 1.3 mg/L and 1.4 mg/L for each 2-hour aeration time, 4 hours and 6 hours. So it can be seen that the allowance for total ammonia in the GAS-SBR can be influenced by the time of aeration. Based on these data, the 4-hour aeration time is the best time for the GAS-SBR to reduce the total ammonia parameter with the allowance efficiency of 44%. This result is supported by previous research in processing using bioreactors with an aeration time of 2 hours which can reduce ammonia by 41.45% [21].

3.4. GAS size

The form of the GAS in this research SBR can be seen in figure 6. It can be seen that the GAS is 1 mm at the end of the SBR operation process. Based on analysis of the Specific Oxygen Demand Rates...
(SOUR) carried out by previous researchers, granule sizes from 0.6 to 1.2 and 1.2 to 1.8 mm were superior sizes for the growth of ammonia-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB) as bacteria used in the nitrification process [22]. So that shows that the GAS in this study has reached a good measure for processing chicken slaughterhouse wastewater.

![Figure 6. Granular activated sludge.](image)

4. Conclusion
In this study, the best removal of COD, BOD and TSS occurred at 2 hours’ aeration time while the best total ammonia allowance occurred at 4 hours. If compared with the quality standard Regulation of the Minister of Environment No. 5 In 2014 the values of COD and BOD were still too high because of that research was needed on the effect on stabilization time to minimize pollutant concentration.

References
[1] Kundu P, Debsarkar A and Mukherjee S 2013 Treatment of slaughter house wastewater in a sequencing batch reactor: performance evaluation and biodegradation kinetics Hindawi Publishing Corporation, BioMed Research International 2013 II
[2] Kementerian Lingkungan Hidup Republik Indonesia 2014. Peraturan Menteri Lingkungan Hidup No. 5 Tahun 2014 Tentang Baku Mutu Air Limbah.
[3] Alfiah T 2015 Perbandingan kinerja lumpur aktif dan trickling filter untuk mengolah limbah cair rumah pemotongan ungas IPTEK 19 87-97
[4] Singh M and Srivastava R K 2010 Sequencing batch reactor technology for biological wastewater treatment: a review Asia-Pac J. Chem Eng. 6 3-13
[5] Chan Y J, Chong M F, Law C L 2010 Biological treatment of anaerobically digested palm oil mill effluent (POME) using a lab-scale sequencing batch reactor (SBR) J. Environmental Management 91 1738-46
[6] Wang K, wang S, Zhu R, Miao L and Peng Y 2013 Advanced nitrogen removal from landfill leachate without addition of external carbon using a novel system coupling ASBR and modified SBR Bioresource Tech. 134 212-18
[7] Morgenroth E, Shereden T, Loosdrecht M C M V, Heijnen J J and Wilderter P A 1997 Aerobic granular sludge in a sequencing batch reactor Water Research 31 3191-94
[8] Zheng Y-M, Yu H-Q, Liu S-J and Liu X-Z 2006 Formation and instability of aerobic granules under high organic loading conditions Chemosphere 63 1791-1800
[9] Yulianto A, Soewondo P, Handayani M and Arisyady H D 2015 Tinjauan literatur pengolahan air limbah dengan biomassa granular aerobik pada mode operasi kontinu J. Sains dan Teknologi Lingkungan 7 84-94
[10] Rosma N H, Anuar A N, Othman I, Harun H, Sulong M Z, Elias S H, Hassan M A H M,
Chelliapan S and Ujang Z 2013 Cultivation of aerobic granular sludge for rubber wastewater treatment Bioresource Tech. 129 620-23

[11] Benefiel L D and Randall CW 1980 Biological Process Design For Wastewater Treatment Prentice Hall Inc. Englewood Cliffs

[12] Hadiwidodo M and Junaidi 2007 Pengaruh waktu aerasi dan waktu tinggal stabilisasi pada sequencing batch reactor aerob dengan penambahan karbon aktif terhadap penurunan chemical oxygen demand J. Presipitasi. 3 67-72

[13] Atima W 2015 BOD dan COD sebagai parameter pencemaran air dan baku mutu air limbah J. Science & Education 4 83-93

[14] Aini, Sriasih M and Kisworo D 2017 Studi pendahuluan cemaran air limbah rumah potong hewan di kota mataram J. Ilmu Lingkungan 15 42-48

[15] Utami L I, Wihandhita W, Marsela S, Nurma K and Wahyusi 2017 pengolahan limbah cair minyak bumi secara biologi aerob proses batch J. Teknik Kimia 11 37-41

[16] Wirasatriya A 2011 Pola distribusi klorofil-a dan total suspended solid (TSS) di teluk toli toli, sulawesi Buletin Oseanografi Marina 137 137-49

[17] Hendrawan I G, Uniluha D and Maharta I P R F 2016 Karakteristik total padatan tersuspensi (total suspended solid) dan kekeruhan (turbidity) secara vertikal di perairan teluk benoa, Bali J. Marine and Aquatic Sciences 2 29-33

[18] Anwari F, Muslim G R Hadi A and Unlam 2011 Studi penurunan kadar BOD, COD, TSS dan pH limbah pabrik tahu menggunakan metode aerasi bertingkat J. Prestasi 1 1-7

[19] Titiresmi and Sopiah N 2006 Teknologi biofilter untuk pengolahan limbah ammonia J.Tek. Ling. 7 173-79

[20] Widayat W, Suprihatin and Herlambang A 2010 Penyisihan amoniak dalam upaya meningkatkan kualitas air baku PDAM-IPA bojong renged dengan proses biofiltrasi menggunakan media plastik tipe sarang tawon J. A.I. 6 64-76

[21] Hardanti N, Sudarno and Amali F 2006 Efisiensi penurun kekeruhan, zat organik dn amoniak dengan teknologi biofiltrasi dan ultrafiltrasi dalam pengolahan air minum Berkala Imiah Tenik Keairan 1 1-7

[22] Liu Y, Kang X, Li X and Yuan Y 2015 Performance of aerobic granular sludge in a sequencing batch bioreactor for slaughterhouse wastewater treatment Bioresource Tech. 190 487-9