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Combination of Bioreactor Biofilter and RAS System for Bulking Handling Efficient

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Abstract - *The problem of pollution of the aquatic environment caused by the disposal of industrial liquid waste can be prevented by controlling the waste treatment. Bulking is a common problem in the secondary processing of mixed liquor. Many studies have been conducted to address this problem. This study aims to produce an efficient composition to overcome bulking due to low DO in industrial organic wastewater by using a combination system of the biofilter and RAS (return active sludge). The research method used is a laboratory experiment. The tests carried out were the variation of aeration time (A), the addition of a 1 cm diameter biofilter (B), and the variation of the addition of RAS (C), using RAL. Further test using Duncan's test. The results showed that the combined biofilter and RAS system resulted in time effectiveness of 2 hours on the variation of the biofilter 200 and RAS as much as 10% in dealing with bulking. The results of the Duncan test showed that there was a very significant difference between treatments in dealing with bulking.*

Keywords — *Biofilter, Bulking, Industrial Organic Liquid Waste, Mixed Liquor, Return Activated Sludge*

I. INTRODUCTION

The methods and stages of the wastewater treatment process that have been developed are very diverse. Liquid waste with different pollutant content is likely to require different treatment processes. These processes can be applied as a whole, in the form of a combination of several processes or only one. The process can also be modified according to needs or financial factors. The secondary processing stage is a biological process involving microorganisms that can decompose/degrade organic matter. The microorganisms used are generally aerobic bacteria. There are three commonly used biological treatment methods, namely the trickling filter method, the activated sludge method, and the treatment ponds/lagoons method.

In the activated sludge method, the liquid waste is channeled into a tank where the waste is mixed with sludge which is rich in aerobic bacteria. The degradation process takes place in the tank for several hours, assisted by the provision of aerated air bubbles (oxygen). Aeration can accelerate the work of bacteria in degrading waste. Furthermore, the effluent is channeled to a settling tank to undergo a settling process, while the sludge containing bacteria is channeled back to the aeration tank. As in the trickling filter method, waste that has gone through this process can be discharged into the environment or further processed if it is still needed.

This study aims to produce an efficient composition to overcome bulking due to low DO in industrial organic wastewater by using a combination system of the biofilter and RAS (return active sludge)to the Sludge Volume Index value (SVI), Dissolved Oxygen (DO), Mixed Liquor Suspended Solid (MLSS), Biological Oxygen Demand and Acidity (pH), of the output.

II. LITERATURE STUDY

Both municipal and industrial wastewater can be treated using the activated sludge process. The activated sludge process is a multi-chamber reactor unit that degrades organics and removes nutrients from wastewater, resulting in high-quality effluent. It is one of the oldest biotechnology-based industrial uses for water filtration. [14, 20] This method has undergone numerous changes and diversifications.

The physical properties of activated sludge are mostly determined by filamentous bacteria. Filament out growth from activated sludge flocs happens when conditions within the floc interior allow filamentous microorganisms to develop faster than zoogleal bacteria[17]. Fungal bulking is induced by fungi's excessive growth and morphological changes as a result of the evolution of activated sludge to be fungidominant[21].

Bacteria account for approximately 95% of the entire microbial population[5]. In the aeration tank, those values are critical for biological elimination of organic carbon, ammonium, and phosphate[16].

Despite significant study on sludge bulking, it continues to be a prevalent issue in the operation of activated sludge processes, with severe economic and environmental repercussions[4]due to alack of knowledge of the bulking mechanisms[19]. For a wastewater treatment plant, the sludge volume index(SVI)should be monitored to anticipate sludge thickening[10].

Sludge bulking is a regular occurrence that has a significant impact on the normal operation of activated sludge biological waste water treatment systems, lowering effluent quality and lengthening the recovery period[15]. Significantalterationsinthebacterialcommunitycausedsludg ethickening.Despite the large number of phages found in sludge systems, little is known about how they react to sludge bulking and the phage-host connections that develop during bulking [9].

The seize off locs is a crucial fact or that affects the settling of activated sludge. When the predominate size class of the flocsis around 50µm, it is thought that the activated sludge settles snicely[1].

Disturbances can lead to fluctuations in the biomass contents, affecting The MLSS and SVI. As a result, [13, 18] focuses on forecasting the MLSS and SVI Parameters for various forms of disturbances influencing an activated sludge system

Factors such as water temperature [8], dissolved oxygen (DO) [3], sludge retention time (SRT) [7], pH [12], influent quality [11], the nutrient ratio [2], and sludge loading [6] are responsible for filamentous sludge bulking. The microbial community responsible for sludge bulking varies depending on the water quality and operational conditions.

III. METHODOLOGY

The amount of wastewater used is 1000 ml for each testing for every varied treatment. Wastewater sample is treated using a combined system using bioreactor and RAS. To obtain the optimum aeration time, the duration is set to 1 hour, 2 hours, 3 hours, and 4 hours. The biofilter amount used is also varied from 200 pcs, 300 pcs up to 400 pcs. While the RAS given is varied from 10%, 20%, and 30%. The biofilter used has been treated for 21 days to create a biofilm layer on the biofilter surface.

The Mixed liquor and wastewater from the inlet are then collected and put into a 500 ml measuring cup to settle the sediment for 30 minutes.DO calculation is done by the Winkler titration method.

A total of 30 ml of the sample in a 500 ml measuring cup, added with a diluent solution that has been aerated to a volume of 300 ml. The MLSS test was carried out by the gravimetric method.

The filter paper was rinsed with distilled water until the entire surface of the filter paper was wet. Then dried at 105°C for 1 hour and cooled in a desiccator to be weighed later. Measurements of the final SVI, DO, and MLSS tests were carried out for each treatment (after treatment) in the same way as the initial SVI, DO, and MLSS measurements.

Measurements of pH and BOD5 were measured for each treatment at the beginning and end of the test. The pH was measured using a pH meter, and BOD5 was measured by the Winkler titration method. The research data on the SVI, DO, and MLSS parameters were analyzed using a completely randomized design (CRD) to see the effect of treatment on the SVI, DO, and MLSS parameter values.

TABLE I
SUMMARY OF VARIED TREATMENT FOR EACH PARAMETER

Biofilter in Pcs (B)	RAS in Percent (C)	Test Code
200	10	B1C1
300	10	B2C1
400	10	B3C1
200	20	B1C2
300	20	B2C2
400	20	B3C2
200	30	B1C3
300	30	B2C3
400	30	B3C3

IV. RESULTS AND DISCUSSION

A. Sludge Volume Index

Aeration for 2 hours with the combination of the addition of 200 biofilters and 10% RAS (A2B1C1) of 34.7 ml/g gave optimal results for the SVI parameter by looking at the other parameters (MLSS and DO). The A2B1C1 treatment resulted in a decrease in the SVI value of 68.17% from the initial SVI value of the study (109 ml/g). The standard SVI value is a maximum of 150 ml/g, and mud with low SVI shows good depositional characteristics and density, while mud with high SVI shows a tendency for bulking to occur.

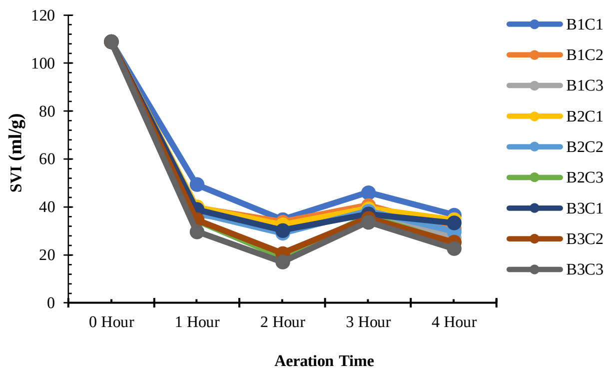

Fig 1. SVI Observation Result

SVI value fluctuated. The greatest decrease occurred in the treatment with an aeration time of 2 hours with a combination of the addition of a biofilter of 400 bh and RAS 30% (A2B3C3), from 109 ml/g at the beginning of the test to 17 ml/g at the end of the test (84.4%). The highest increase in SVI value at the time of testing occurred in the 1 hour aeration time treatment with a combination of adding a biofilter of 200 bh and 10% RAS

(A1B1C1) with a final SVI value of 49.3 mg/l, but this SVI value was still lower than the initial value (109 mg/l) and decreased from the initial SVI value of 54.8%. The SVI value tends to decrease, then increase, and decrease again with increasing aeration time. The initial decrease occurred because the application of aeration tends to increase dissolved oxygen (DO), thereby reducing bulking and resulting in a low SVI value. The SVI value seems to have increased due to bulking due to over aeration.

B. Dissolved Oxygen (DO)

The addition of dissolved oxygen (DO) to the aeration basin improves the oxidation process by delivering oxygen to aerobic microorganism, so them to successfully convert organic wastes into inorganic by-products. The aeration time treatment of 2 hours with a combination of adding 200 biofilters and 10% RAS (A2B1C1) or as much as 1.3 mg/l gave optimal results compared to other treatments, where the standard for DO content was in the range of 1 to 4 mg/l. In the A2B1C1 treatment, the DO value increased by 225% from the initial DO value (0.4 mg/l).

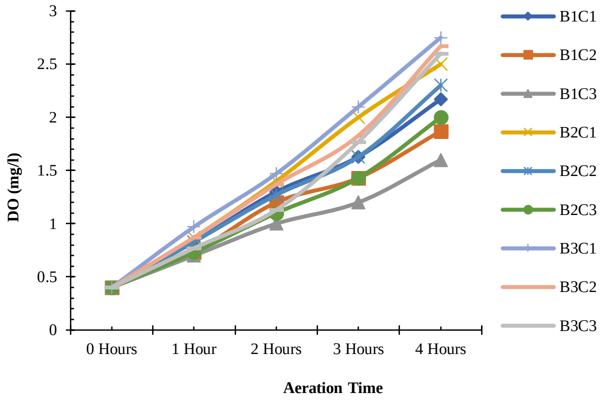

Fig 2. DO Observation Result

DO content fluctuates and tends to increase with increasing aeration time. The oxygen flow rate is 1.9 l/min. The highest increase in DO occurred in the A4B3C1 treatment, from 0.40 mg/l at the beginning to 2.75 mg/l at the end of the test (587.5%). The DO concentration tends to increase with increasing aeration time due to the support of the aerator, which continuously supplies oxygen into the mixed liquor. As a result of reduced organic matter and oxygen-using bacteria in wastewater, the dissolved oxygen (DO) content will increase. The content of organic matter decreases with increasing aeration time because more and more decomposed bacteria in the biofilter and RAS are added to the wastewater.

C. MLSS (Mixed Liquid Suspended Solid)

The A2B1C1 treatment gave optimal results for the MLSS parameter of 3,217 mg/I, where a good standard MLSS value was in the range of 2000 to 4000 mg/I. In this A2B1C1 treatment, the maximum MLSS value approached the highest standard value (4,000 mg/l) and gave optimal results by looking at other parameters (SVI and DO). In the A2B1C1 treatment, the MLSS value increased by 6.893% from the initial MLSS value (46 mg/l).

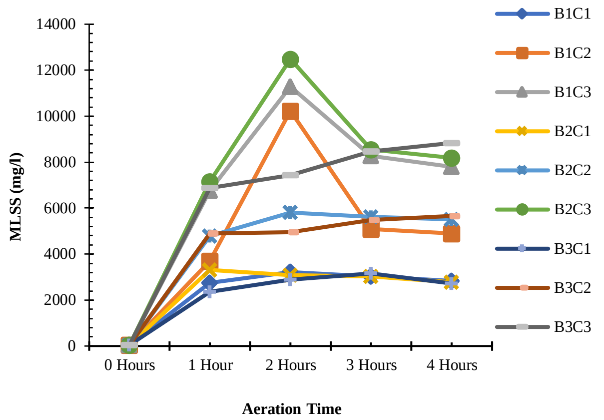

Fig 3. MLSS Parameter Observation Result

MLSS value fluctuated. The highest MLSS value occurred in the A2B2C3 treatment, which was 12,487 mg/I (27,047% of the initial MLLS value of 46 mg/l), and the lowest MLSS value occurred in the A1B3C1 treatment, which was 2,361 mg/I (5,033% of the initial MLLS value of 46 mg/I). l). The MLSS value in this study tends to increase and then decrease with increasing aeration time. The increase in MLSS levels occurs due to the provision of aeration, which can increase dissolved oxygen levels, thereby reducing bulking and supporting the formation of activated sludge flocs into larger flocs. The MLSS value has decreased because the amount of organic matter in wastewater decreases with increasing aeration time.

Treatment A2B1C1 (3,217 mg/l) gave optimal results to the MLSS value. If the optimal MLSS concentration has been obtained, then that value can be maintained by adjusting the amount and speed of waste disposal.

If the MLSS value is still below the expected concentration in accordance with quality standards, the sludge disposal process must be stopped.

Returned Activated Sludge (RAS) is the amount of MLSS that settles as sludge and is returned to the aeration tank. Meanwhile, if the MLSS value is above the expected concentration in accordance with quality standards, the volume of the sludge disposal process must be increased. Conventionally, the RAS value ranges from 20 to 40% of the incoming waste volume. This value should be considered to obtain a good MLSS score.

D. BOD (Biological Oxygen Demand)

BOD5 tends to decrease with increasing aeration time. The initial value of BOD5 was 312 mg/I, and the lowest value was obtained at the end of the test in the A4B3C1 treatment to 119 mg/I (a decrease of 61.59%).

In this A4B3C1 treatment, the BOD5 content has met the wastewater quality standard, which is below 150 mg/I. The decrease in the value of BOD5 is closely related to the decrease in the amount of organic matter and the increase in the concentration of dissolved oxygen (DO) in the wastewater. Dissolved oxygen is needed by aerobic microorganisms to decompose organic matter

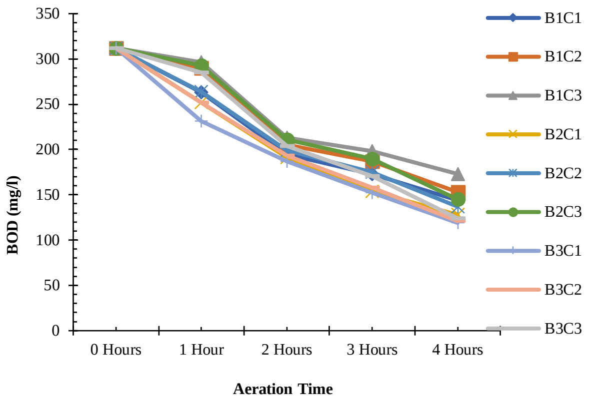

Fig 4. BOD5 Parameter Observation Result

With an increase in dissolved oxygen concentration, the ability of aerobic microorganisms will be optimal in decomposing/reducing organic matter content. Therefore, with decreasing organic matter content, the dissolved oxygen concentration required by microorganisms to decompose organic matter will also decrease.

E. Acidity (pH)

Observation of pH starting from the beginning before treatment on the sample (0 hours) and at the treatment of 1 hour, 2 hours, 3 hours, to 4 hours after treatment in each reactor.

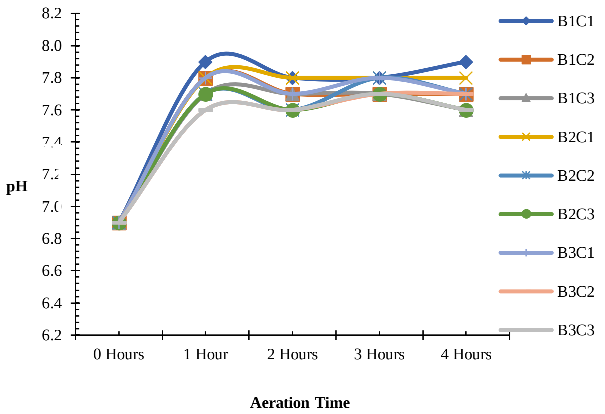

Fig 5. pH Observation Result

The pH value changed and fluctuated in the range of 7.6 to 7.9 and increased from the initial pH value (6.9). This is related to the increase in dissolved oxygen (DO) content in each treatment. pH is directly proportional to DO and inversely proportional to CO_2.

The pH range for each treatment in this study is still within the range specified in the Minister of the Environment of the Republic of Indonesia Number 5 of 2014 Regulation on Wastewater Quality Standards, which is between 6 and 9. Under these pH conditions, the microorganisms contained in the mixed liquor can grow and carry out degradation activities (remodeling) well.

V. CONCLUSION

The combination system of the biofilter and RAS (Return Activated Sludge) has a very significant effect on the parameters of Sludge Volume Index (SVI), Dissolved Oxygen (DO), and Mixed Liquor Suspended Solid (MLSS) for handle bulking efficient. In this study, the effectiveness of aeration time was 2 hours, with variations in the addition of a biofilter of 200 and RAS of 10%. With an SVI value of 34.7 ml/g, DO 1.3 mg/l, and MLSS 3,217 mg/l, which are efficient for bulking handling with a combination of the biofilter and RAS systems.

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