The effectiveness of increasing the amount of *Return Activated Sludge (RAS)* in wastewater with a combination biofilter system on bulking parameters

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**Abstract.** Control of industrial wastewater treatment is very important to produce good effluent. Secondary processing is the heart of wastewater treatment. The problem that often occurs in secondary processing using activated sludge is bulking in the mixed liquor. Various studies on bulking have been done. The optimal aeration time is 3 hours to remove bulking in the mixed liquor caused by S.Natans bacteria. This research aims to determine the effectiveness of the addition of the amount of Return Activated Sludge (RAS) in wastewater with a combination biofilter system on bulking parameters. The method used is experimental in the laboratory. The research design used a completely randomized design. The variation of the test that will be carried out is the addition of the Return Activated Sludge variation test to determine the effectiveness of adding RAS to wastewater with a biofilter combination system on bulking parameters. The experiment was repeated 3 times, resulting in 27 treatments. To test bulking, it is tested using the parameters SVI (Sludge Volume Index), DO, MLSS (Mixed Liquor Suspended Solid), and BOD. The results showed that the addition of Return Activated Sludge in wastewater was very effective in a combination biofilter system against bulking parameters.

1. **Introduction**

Control at the waste management stage is very important, such as control in pretreatment, primary treatment, and secondary treatment. Of the three processing processes, secondary treatment is one of the important factors in waste treatment. In secondary processing, a problem that often occurs is the formation of bulking in the mixed liquor. Bulking can cause the mud to not settle easily (unsettale) and prevent the activated sludge floc from becoming a larger floc. This event inhibits the process of sludge deposition and will ultimately reduce the overall effluent quality [1]. Based on previous theory and research related to bulking, many have done, including finding an intelligent method with an algorithmic program to detect the presence of bulking in activated sludge by [2]. Research on bulking control strategies using Bench-scale tests and full-scale applications by [3]. Research on a review of the technical aspects of selecting biofilter media for wastewater treatment by [4]. Another study, namely examining the effect of mixed liquor aeration time on SVI, DO, and MLSS to handle bulking in secondary processing, resulted in an optimal time of 3 hours by [5].
2. Literature reviews

2.1. Bulking
Bulking is a term used in the activated sludge process to define a mixed liquor condition with too many filament organisms. The presence of organism films causes biological floc to become tenuous. Filament organisms contained in the activated sludge process are from various types of bacteria, actinomycetes, and fungi [6]. The picture of bulking can be seen in figure 1.

![Figure 1. Bulking](image)

2.1.1. Sludge Volume Index (SVI)
SVI is one of the important parameters for bulking control. SVI can be calculated with equation 1.

\[
SVI = \frac{\text{volume of sludge to settle (ml)} \times 1000}{\text{MLSS (mg/l)}}
\]  

(1)

2.1.2. Dissolved Oxygen / DO
The formula for calculating DO is calculated with equation 2.

\[
DO = \frac{a \times f \times 1000 \times 0.2}{v - z}
\]  

(2)

Where:
- DO = Amount of dissolved oxygen (mg / lt)
- a = Volume of the titration Na2S2O3.5H2O
- f = Number of standardization of Na2S2O3.5H2O solution
- v = Volume of incubation bottle (ml)

2.1.3. MLSS (Mixed Liquor Suspended Solid)
MLSS can be calculated with the equation 3.

\[
MLSS = (A + B) \times \frac{1000}{v}
\]  

(3)

Where:
- A = Weight of filter paper + suspended residue (mg)
- B = weight of filter paper (mg)
- C = Volume of wastewater sample

2.2. Biofilter
A biofilter is a place where microorganisms grow and develop on a medium, by forming a layer of mucus to adhere to the surface of the media to form a biofilm layer. The process of treating wastewater with a biofilter can be generally carried out in aerobic, anaerobic, or a combination of anaerobic and aerobic conditions. The aerobic process is carried out in the presence of dissolved oxygen in the wastewater reactor.
2.3. Return Activated Sludge (RAS)

The activated sludge process developed in England in 1914, called activated sludge because it contains active microorganisms that can aerobically stabilize organic waste [7]. In this process, it can remove suspended solids and BOD up to 90% [8]. Activated sludge is effective for removing dissolved and undissolved organic matter in the waste stream and converting it into bacterial floc and some are returned to secondary processes, some are ready to precipitate by gravity according to [9].

3. Research methods

3.1. Types of research

This research is experimental. The research design used a completely randomized design (CRD) with the assumption that the population was relatively homogeneous [10]. This research was conducted in a laboratory so that the research data obtained came from primary data, namely data directly from the research results.

3.2. Research Samples and Equipment

Wastewater volume 1000 ml per experimental unit, Reactor / experimental container size D = 12 cm, Height = 32 cm, Caldnes biofilter model, namely random packing, 1 cm diameter. Air discharge aerator = 2, Room temperature ranges between 27-29 0C, The temperature of the wastewater ranges, the pH of the wastewater ranges 7.6-8, the number of experimental and repetitive treatments is 27 experiments.

3.3. Research implementation

The research was conducted at the Environmental Laboratory of the Civil Engineering Department, Faculty of Engineering, Hasanuddin University Makassar.

In this study, the addition of the RAS was carried out with an aeration time of 3 hours (A) (Aryani M.I, 2004) (1). Test for the addition of Return Activated Sludge (B) to wastewater as much as 10% (B1), 20% (B2), and 30% (B3) to determine the effectiveness of the optimal amount of RAS in 1000 ml of liquid waste solution with a combination of the biofilter system with a random packing model (C ) with variations in the addition of 100gr (C1), 200gr (C2) and 300gr (C3), against the bulking parameter.

4. Results and discussion

4.1. Research result data

The observation result of this research can be seen in table 1.

| No | Kode Sample | DO | pH | SVI | MLSS (mg/l) | Suhu (C) | Kec. Udara |
|----|-------------|----|----|-----|-------------|---------|-----------|
| 1  | A3B1C1      | 2.6| 8.0| 34  | 2.918       | 29      | 2         |
| 2  | A3B1C2      | 2.5| 7.8| 20  | 4.970       | 28      | 2         |
4.2. Time relationship and MLSS
The time relationship and MLSS can be seen in figure 3.

![Figure 3. Time relationship and MLSS](image)

4.2. Time relationship and MLSS
The time relationship and MLSS can be seen in figure 3.

5. Conclusions
The amount of the addition of Return Activated Sludge in wastewater, is very effective in a combination biofilter system for bulking parameters.
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