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Evaluation of Bio-Carrier in Attached Growth Wastewater Treatment System

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Abstract – *Biocarrier is being used more frequently to support biofilm growth in the treatment of wastewater through oxidation of organic particles and nitrification of ammonia. For this experiment the influent was taken from the intake house where the incoming of wastewater around university campus. The clogging problems that occur were observed physically or visually and the thickness of the clogging was closely monitored. In this experiment, the test that carried out was total suspended solid (TSS) and MLSS. With these tests carried out, the TSS and attached growth were obtained. Besides that, there were three types of biocarriers were filled in three tanks and the system operated continuously to identify the performance in each configuration. The resulted development of attached growth in Type One showed that the performance is better compared to Type Two and Type Three. In addition, the performance was relevant to the configuration as the bio-balls in Type One were position closely so that more bio-balls were fixed in the tank. The Type Two configuration showed similar results as the Type One where the high reduction of suspended solids achieved. In addition, Type Three efficiency did not show positive results as the configuration performed poorly compared to the other two types. During the whole process, there was no clogging occurred and this showed that the configurations presented positive outcome. The attached growth development was monitored weekly visually to determine the clogging.*

Keywords: Biocarrier, TSS; MLSS, Attached growth, Bio-film

1.0 INTRODUCTION

The purposes of using a bio-film for the bio-film process with biocarriers are for filtration, bioremediation or barrier formation. A bio-film is a complicated and heterogeneous matrix of microorganisms attached to and develops on a surface [1-3]. An important element of both fixed and moving-medium bio-film systems are the properties of the carriers because they directly affect the ability for bio-film growth, the amount of biomass and the effectiveness of the treatment [4]. Carriers can be found in many shapes, sizes and materials so can be optimizing these carriers for the best potential of the performance of bio-film. According to the state of the support material, the difference between fixed and moving bed processes is normally done. Fix bed systems together with all systems where the bio-film is developed on

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fixed media such as rocks, plastic profiles, sponges, granular carriers or membranes [5]. The liquid flow pass the fix media provides the microorganisms with nutrients and oxygen. Moving bed systems include all bio-film processes with non-stop moving media, controlled by high air or water velocity or mechanical stirring [6,7]. In attached growth wastewater treatment processes, the microorganisms and bacteria treating the wastes are attached to the biocarriers in the reactor. The wastes being treated flow through the media. Rotating biological contactors and trickling filters are attached growth processes. These reactors possibly used for BOD removal, nitrification, and denitrification [8-10].

2.0 MATERIALS AND METHODS

This section discuss about the materials and methods in this research. This experiment was conducted at local sewage treatment plant and the duration of this study was 3 months. For this experiment the influent was taken from the intake house where the incoming of wastewater around university campus. There were 3 tanks with different bio-carriers configurations set up and the tanks were referred as Tank 1, Tank 2 and Tank 3. The type of tank used was FRP tank with 1200 mm × 1200 mm × 2000 mm dimension.

2.1 Bio-carrier Configurations

Three different bio-carrier configurations were introduced and operated to determine the performance. The bio-carriers configurations are referred as Type One, Type Two and Type Three. The bio-carriers were arranged in three (3) different types of configuration. The arrangement of bio-carriers is vital to ensure it works perfectly in terms of bacteria growth on the bio-balls surfaces and also to prevent clogging. Furthermore, this is to ensure that the bio-ball will not close each other which will affect the arrangement. For type one configuration, two bio-balls were tied together and fixed to a net. The numbers of bio-ball used are 3072 balls for type one arrangement. As for Type two configuration, three bio-balls tied together. After that, the bio-balls were filled in bags. The bags were stacked together and filled the tank. A total of 2400 bio-balls used for type two configurations. 10 bags filled with 80 tied bio-balls in each bag and stacked in the tank. Type Three configurations, the bio-balls inserted into rope. A total number of 2496 bio-balls needed for type three as 26 bio-balls used for each rope and bio-balls secured to be remained in the tank [11].

2.2 Testing Procedure

TSS and MLSS were measured following the standard procedure for wastewater as per standard method. However, the estimation for the attached growth was done by measuring the quantity of biomass on the surface of the biomedia. The attached growth was collected in a beaker by scraping the biomass from the biomedia and cleaned with distilled water. Besides that, the concentration was calculated using the difference in weight. The difference in weight multiplied and divided by the numbers of balls and volume of the water in tank respectively.

3.0 RESULTS AND DISCUSSION

For the influent, the highest concentration obtained was 582 mg/l while the first concentration obtained was 355 mg/l, after that, the concentration kept in slight increasing while the overall average of the influent concentration was 379 mg/l. The initial effluent concentration for Type

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One configuration was 38 mg/l from the first test as shown in Figure 1. Then the concentration rose to 87 mg/l and decreased to 49 mg/l at the end of the monitoring period and the overall average for the effluent obtained was 49 mg/l. The reduction of the TSS concentration between influent and effluent was 87% in Type One configuration. The recorded values were compared with Acceptable Conditions from Environmental Quality (Industrial Effluent) Regulations 2009 [12] where the Standard A is 50 mg/l and Standard B is 100 mg/l. The effluent concentration from this configuration is acceptable. In addition, the attached growth concentration measured from first test was 532 mg/l, it reached the highest concentration which was 557 mg/l and the average attached growth concentration was 348 mg/l.

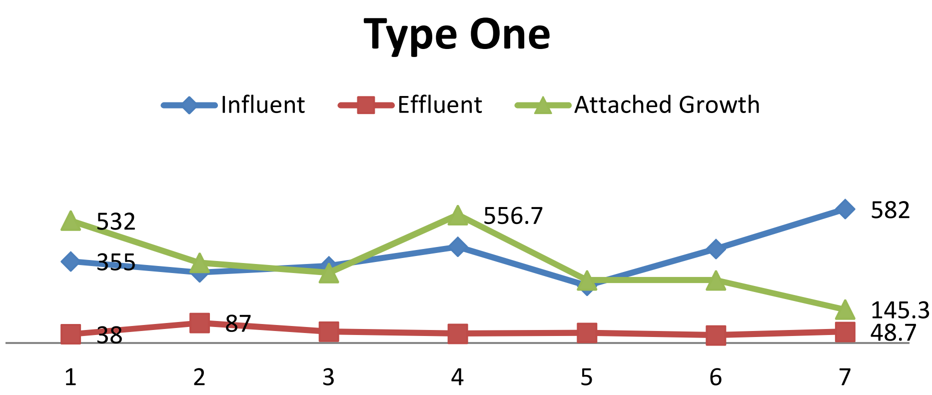

Figure 1: Results for Type One

Figure 2 shows the graphical data for Type Two configuration. In this configuration, for the influent, the highest concentration obtained was 582 mg/l. The first concentration obtained was 355 mg/l and dropped to 249 mg/l, then the concentration increased until the last test. The average influent concentration is 379 mg/l. The effluent concentration obtained showed a constant pattern. In addition, from the first test the concentration increased from 47 mg/l to 64 mg/l and then dropped to the concentration of 44 mg/l on the last test. The average effluent for this configuration was 49 mg/l.

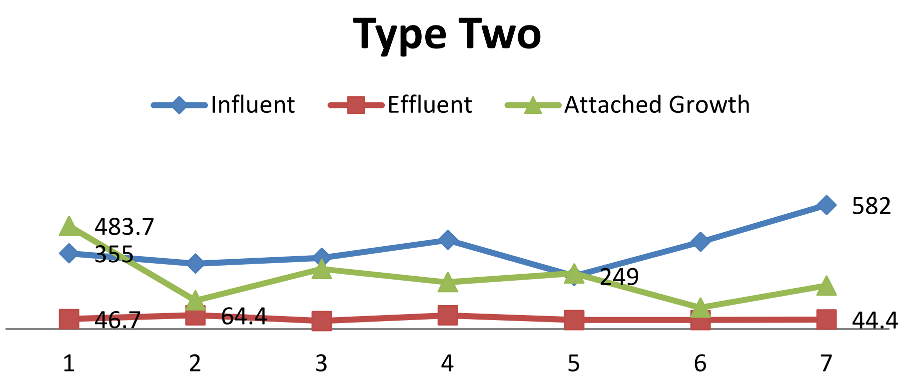

Figure 2: Results for Type Two

The attached growth did not show a consistent pattern as the concentration was low despite the presence of suspended growth biomass. The reduction of the TSS concentration between influent and effluent is 87% in Type Two configuration. The recorded values were compared

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with Acceptable Conditions from Environmental Quality (Industrial Effluent) Regulations 2009 [12] where the Standard A is 50 mg/l and Standard B is 100 mg/l. The effluent concentration from this configuration is acceptable.

Figure 3 shows the graphical data for Type Three configuration. In this configuration, for the influent, the highest concentration obtained was 582 mg/l. The first concentration obtained was 355 mg/l and dropped to as minimum as 249 mg/l. The average influent concentration is 379 mg/l. The highest effluent concentration was 80 mg/l. From the first test to last test the concentration decreased from 60 mg/l to 34 mg/l. The average effluent concentration is 56 mg/l. In addition, the average attached growth concentration was not high as prove efficient biofilm development. The reduction of the TSS concentration between influent and effluent is 85% in Type Three configuration. The recorded values were compared with Acceptable Conditions from Environmental Quality (Industrial Effluent) Regulations 2009 [12] where the Standard A is 50 mg/l and Standard B is 100 mg/l. The effluent concentration from this configuration is acceptable.

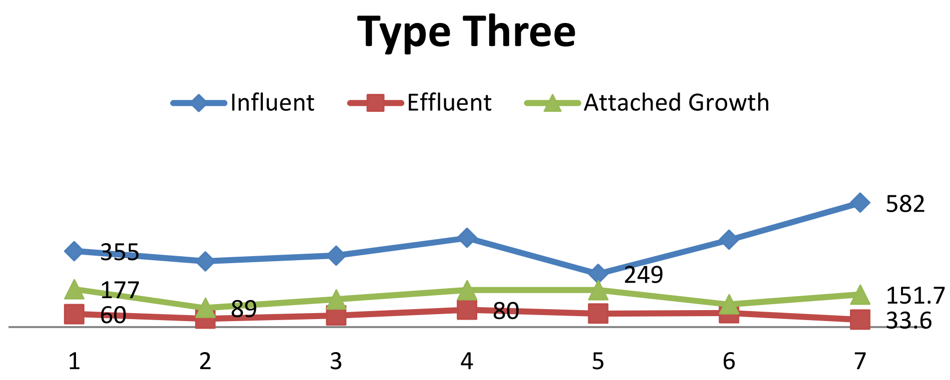

Figure 3: Results for Type Three

In this study, TSS and MLSS were tested to identify the performance in each configuration. The resulted development of attached growth in Type One showed that the performance is better compared to Type Two and Type Three. In addition, the performance was relevant to the configuration as the bio-balls in Type One were position closely so that more bio-balls were fixed in the tank. During the whole process, there was no clogging occurred and this showed that the configurations presented positive outcome. The attached growth development was monitored weekly visually to determine the clogging.

4.0 CONCLUSION

In this study, the efficiency of different design arrangement of the bio-carrier to prevent clogging was evaluated. In Type One configuration or arrangement, the efficiency resulted positively as the reduction of suspended solids was high. The Type Two configuration showed similar results as the Type One where the high reduction of suspended solids achieved. In addition, Type Three efficiency did not show positive results as the configuration performed poorly compared to the other two types. The overall removal efficiency was satisfying the standard discharged. However, the biofilm attachment was not showing potential for thick growth but observed to thin layer but the system performed good in the removal of TSS.

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