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Abstract. Biosand Filters (BSF) has great potential to improve the water quality. BSF is used extensively in the treatment of drinking water in rural areas because it is affordable, simple to use, and has a high removal efficiency. This study used actual latex effluent to examine the effectiveness of SBR. The growth of the biolayer in the BSF is also observed. This study analyzes consistent and stable results for COD, DO and NH_4-N^+. With removal performance ranging from 87 % to 99 %. DO value for BSF varied from lowest value of 1.5 mg/L to 8mg/L. Overall, the BSF was capable of producing treated water for water reclamation.

Keywords: Biosand Filter, biolayer, wastewater

1. Introduction

Because industrial latex effluent has varied levels of contamination, treating it can be challenging. Chemicals applied during the concentrating process in latex production led to increase level of contamination [1]. Rubber effluent has a high ammonia content and is rich in diverse nutrients, making traditional biological treatment ineffective. Moreover, a significant volume of wastewater is produced during the manufacture of latex products. Enhanced the need for workable and feasible technologies to handle latex wastewater with varied levels of pollution, especially in industrial compound with constrained space.

The biologically active granular media filters known as "biosand filter" (BSF) are usually made of concrete or plastic chambers that are packed with media. Both the design and operation are comparable to those of a traditional slow sand filter. But an adjustment tothe intermittent operation made it possible to pause and resume filtration without upsetting the biological layer [2]. BSF are easy to use, economical, and efficient at eliminating pollutants [3]. BSF requires small sand size (typically 0.15 to 0.4 mm) and slow filtration rate of 0.1 to 0.2 m/hr to maintain its high removal pollutants performance [4].

Although BSF was reported to effectively remove contaminants, modifications were still proposed to increase its efficiency. Therefore, this study will investigate the modification of BSF applying constructional changes of the filter with BSF sand size of 2 mm and added thickness of 0.4 m height of sand media. Proposed increment of sand media will be able to increase the overall treatment efficiency of BSF.

To date, no comprehensive study has been done on the effect of performance for modification for BSF system. This study for the first time investigated the performance of BSF for three most significant parameters in wastewater quality standard (i.e., COD, DO and NH_4-N^+).

2. Materials and methods

Latex wastewater was fed to the reactors during "Fill" phase through a dosing pump. Adiffuser was installed at the bottom part of the bioreactor. To attain a constant source ofaeration, gas flow meter was fixed between aeration pump and the diffuser. Fine bubbles were initiated by the diffuser and the sequential batch operation of the reactor was automatically controlled by timers.

2.1 Reactor design

Cylindrical shaped perspex was utilized with a diameter of 0.05 m. Fine sand was placed in the column to the height of 0.4 m, followed by gravel at the bottom of the column. Sand was collected from Kuala Perlis and initially cleaned by using Milli-Q water to remove dirt and finest grain before applying it to the perspex column. The sand was then sieved using 2.0 mm sieve size. Figure 1 illustrated the dimension and the depth of sand and gravel in BSF.

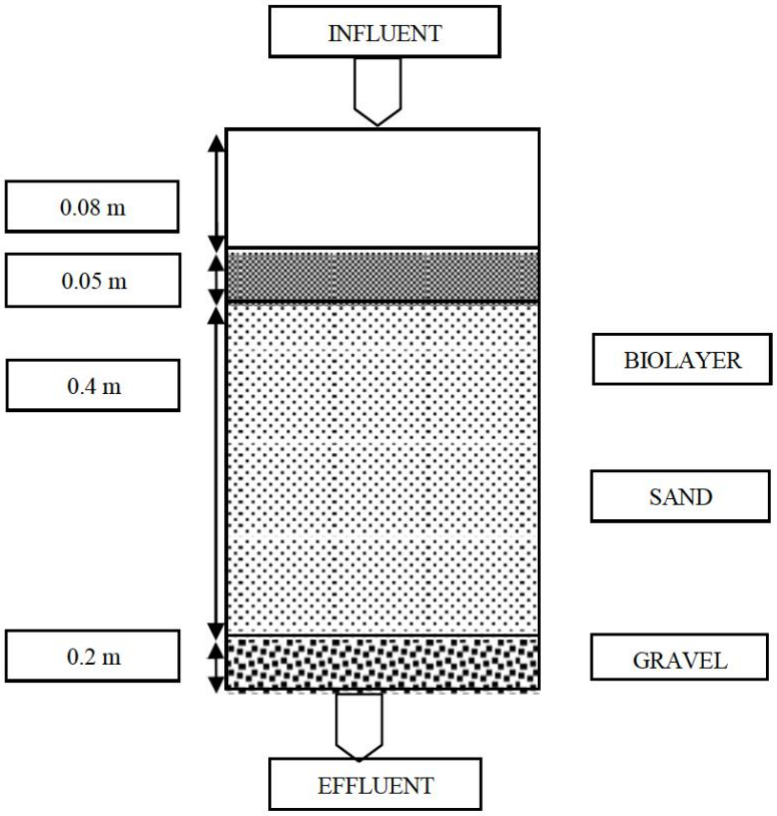

Figure 1. Schematic diagram of BSF

2.2 Analytical techniques

COD, NH_4^+, NO_2^-, NO_3^- and PO_4^{3-} were analyzed in the effluent and influent from both reactors using test kits (DR 2800, Hach Lange and Shimadzu ion chromatography). Whilst a bench top pH meter is used to test pH, a DO meter was used to measure dissolved oxygen (DO). The APHA standard method 2005 was used to assess the sludge sample for mixed liquor suspended solids (MLSS) and mixed liquor volatile suspended solids (MLVSS).

2.3 Applied wastewater

Every twice a week, industrial latex wastewater was collected and kept at 4-6 ºC from the WWTP storage pond operated by Shorubber (M) Sdn. Bhd. Consequently, effluent collected from storage pond was directly pumped into the reactor without any pH adjustment, the sample was left outside the fridge until it reaches to room temperature of 28±2 ºC. The wastewater sample contained a COD content ranging from 30 mg/L to 978 mg/L.

2.4 Sand media characteristics

By using typical and homogenous sand samples, the effective diameter of the sand was determined. The sand was sieved and dried through stainless steel sieves. Subsequently the particle size distribution curves were plotted and retained sand were calculated by weighing each screen. The effective diameter size of the sand is at 2.36 mm and for gravel is in the range of 6-12 mm.

3. Results and discussion

3.1 COD and NH4-N removal efficiency of Biosand Filter

Lab scale BSF were assessed for approximately 17 days to treat industrial latex wastewater. The height and size of the sand in the column encourages the formation of a biolayer, which results in dense, well-constructed biolayer that will derive effective COD elimination. Figure 2 depicted the reactor's performance for sand height and size of 0.4 m and 2 mm, respectively, throughout the preliminary experiment's operational period.

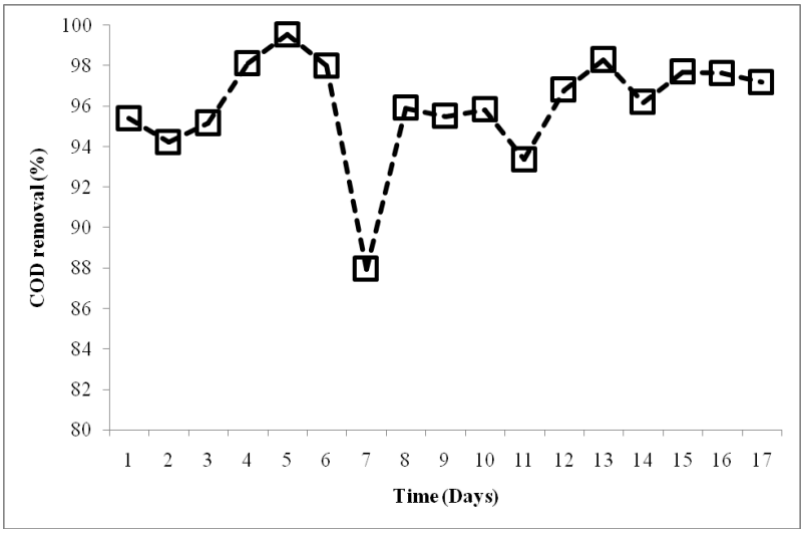

Figure 2. Elimination of COD during filtration

As seen in Figure 2 shows, the COD removal efficacy ranged from 87 to 99 %. Day 4 showed the highest COD removal effectiveness at the highest level of COD input. The biofilm microorganism's ability to quickly break down a basic form of organic substrate helps to explain this matter [5]. But as the analysis reached to the end, COD removal demonstrated a constant declining pattern, as Li proposed, the biofilm on the sand media was growing at its optimal rate [6].

Monitoring the conversion of ammonium is necessary to look into the removal ofnitrogen compounds (organics) (Figure 3). Given that the nitrification process shows that the reactor contains nitrifying bacteria [7, 8, 9]. After ammonium was completely broken down, nitrite was formed, nitrite was then further oxidized to nitrate [9].

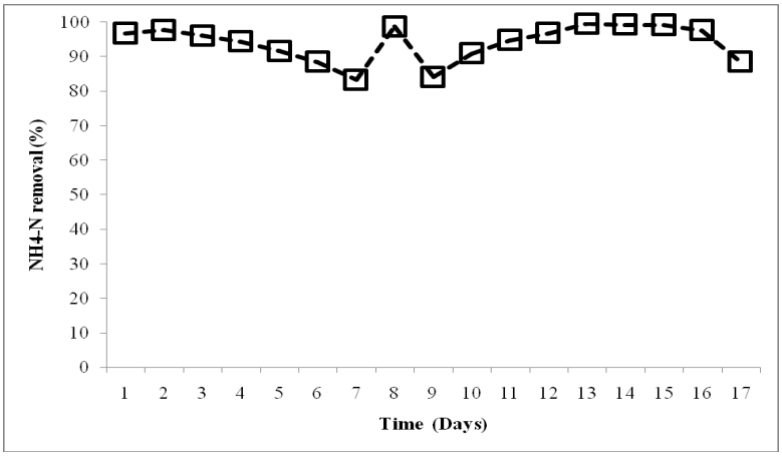

Figure 3. Percentage of NH^{+}_{4}-N removal by biosand filter

Figure 3 demonstrated that the biosand filter's ammonium removal performance was comparatively steady. This show that all of the ammonium in the influent was broken down into nitrite and nitrate by nitrifying bacteria [10,11,12]. Slow growing nitrifying bacteria, as they are called prefer a longer contact period, because they have to compete with the heterotrophs [11]. Longer sand height in the column with high COD concentration led to the establishment of a noticeable heterotroph, which was able to overtake the reactor's nitrifying bacteria. Additionally, Figure 3 illustrates that an average removal of 93 % of ammonium was achieved. The BSF remained anaerobic by the deficiency of measureable ammonia nitrogen and DO. Complete ammonia nitrogen removal took place above the sand media. The filtered effluent however met the drinking water standard.

One of the possible causes of the decrement in ammonium removal is an increase in COD value throughout the operation period. Since nitrifiers and heterotrophs do not effectively compete for oxygen, nitrification was interrupted as the COD level rises [11]. Since nitrifying bacteria grew at a much slower rate than heterotrophic bacteria, $NH4^{+}$-N reacted slowly to NO_2-N and NO_3-N, which then decreased removal effectiveness [9]. These results may provide an explanation for the decrease in ammonium on days 7, 9 and17.

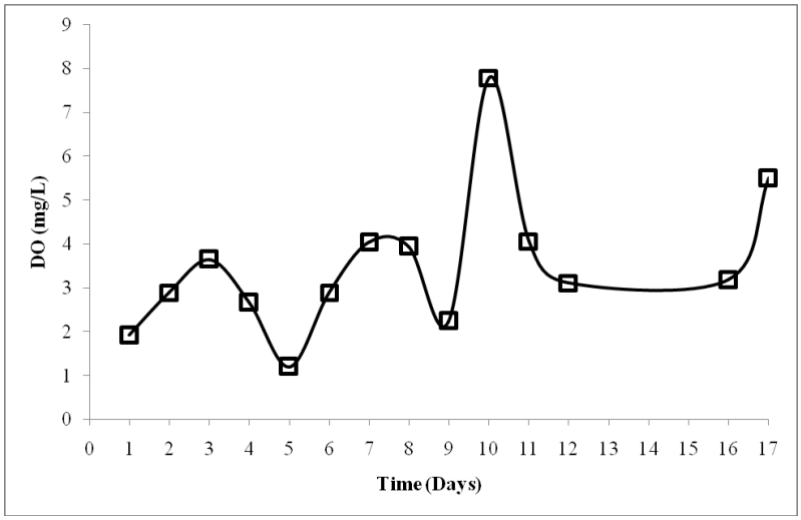

Figure 4. Percentage of dissolved oxygen in BSF

After day 10, DO decreases rapidly due to considerable biofilm regrowth. Regrowth of biofilm was observed within one day of sand media cleaning. Indicating that the microbial community in the biofilm quickly replenished itself after disruption (Figure 4). As stated by Haig et al, 2014 [14] during the filter runs when DO value did not reduced below 1.5 mg/L it indicates that the filters were always under aerobic conditions. However, DO value decreases and reaches its lowest point on Day 5, this is due to readily available organic nutrients in filter that will consequently promote microbial growth on the surface of the biolayer [15]. Biofilm layer o top of the sand media was always visible on the inside wall of the column, reactor contributing to the varying concentration of DO.

4. Conclusions

The presented study is an attempt to determine the effect of sand depth and size on the treated effluent quality. Industrial latex wastewater was applied to this study for the development of biolayer in the BSF. Sudden fluctuation of influent characteristics (COD level) does not affect the biolayer of the BSF.The BSF improved the filtered effluent values of COD and NH_4-N^+. Effluent COD and NH_4-N^+ was reduced to 99 % and 93 % respectively with sand size of 4 mm. Although DO value in the filter seems to be more dependent on the availability of organic nutrients, higher microbial activity increases the oxygen consumption in the filter.

Acknowledgement

The authors wish to thank Shorubber (M) Sdn. Bhd. for consistent supplies of sludge and industrial influents and Universiti Malaysia Perlis (UniMAP) for kindly providing supports.

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