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Research Paper

Performance of Moving Bed Biofilm Reactor Integrated Septic Tank in Treating Office Building Wastewater

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Abstract

This research aimed to find the effect of initial concentration and hydraulic retention time (HRT) on modified septic tank (MST) performance in treating wastewater from an office building. The synthetic wastewater used had an average COD:TN:TP ratio of 84:28:1, adjusted to office building wastewater characteristics. The experiment was executed under steady conditions using three variations of HRT (12, 24, and 36 hours) and different initial concentrations of COD (106, 252 and 432 mg COD/L), TN (35, 85 and 146 mg N/L) and TP (1.26, 3 and 5.14 mg P/L). The result showed that the MST removed 82% to 92% of COD, 41% to 60% of TN, 45% to 61% of NH4, and 39% to 55% of TP. The maximum removal was achieved at 36 h of HRT, COD:TN (3:1), and COD:TP (84:1). One-way ANOVA showed that the initial concentration and HRT had significant effects on the performance of MST ($p < 0.05$). This suggests that appropriate control of the initial concentration and HRT in the MST can effectively remove organics and nutrients from office building wastewater.

Keywords: *hydraulic retention time; initial concentration; moving bed biofilm reactor; modified septic tank; office building wastewater.*

Introduction

The characteristics of office building wastewater are different from household wastewater. Office building wastewater has unique characteristics, containing high nutrients but organic matter at a low concentration. Wastewater from office buildings consists of 106 to 432 mg COD/L, 41 to 114 mg N/L, and 0.99 to 8.21 mg P/L, with an average COD:TN:TP ratio of 84:28:1. In comparison, wastewater from households consists of 250 to 800 mg COD/L, 20 to 70 mg N/L, and 4 to 12 mg P/L. Wastewater discharged from office buildings varies over time, with a range of 39.61 to 49.93 L/p/d, with a peak factor of 1.83 [1]. Therefore, an appropriate treatment technology is needed to treat this kind of wastewater.

The conventional septic tank (CST) is the most commonly onsite system used for wastewater from domestic activities. Raw wastewater is generally treated in a CST before being discharged into the subsurface. A CST can be applied individually or with the addition of other technologies based on the purpose of the wastewater treatment. Wastewater treated in a CST is formed into three layers: a scum layer as a crust forming on the surface of the tank liquid; wastewater under the scum layer; and a sludge layer of precipitated solids on the bottom. The CST functions as an anaerobic bioreactor to process organic matter and removes settleable solids [2]. The removal of BOD, COD, TSS, TKN, TP, and NH_4 in the CST with HRT operations of 24, 48, and 72 hours ranged from 53% to 65%, 54% to 68%, 55% to 65%, 18% to 27%, 4% to 7% and 26% to 29 %, respectively [3]. Moreover, research on a novel insulated anaerobic filter (IAF) system combined with building wastewater treatment has been conducted by Bouted & Ratanatamskul (2018). The maximum removal of COD, TKN, and TP was 61%, 51%, and 20%, respectively [4]. A CST is not effective for nutrient and pathogenic organism removal

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[5]. In order to meet effluent regulations, CST effluents must be further processed in a post-treatment system, which increases cost and complexity.

When municipal sewers are not available, a CST is not sufficient to treat the wastewater from office buildings. A modified septic tank (MST) that integrates a moving bed biofilm reactor (MBBR) for denitrification and nitrification processes is expected to improve the quality of the treated wastewater in the removal of organic matter and nutrients. The purpose of this study was to examine the performance of the MST in the treatment of wastewater from office buildings.

Material and Method

Wastewater Preparation

Synthetic wastewater without sludge was used in this experiment and was adjusted based on office building wastewater. The initial concentrations were determined with an average COD:TN:TP ratio of 84:28:1 [6]. The compositions of the synthetic wastewater were glucose (C6H12O6) for COD, potassium dihydrogen phosphate (KH2PO4) for TP, ammonium chloride (NH4Cl), potassium nitrate (KNO3), and sodium nitrite (NaNO2) for TN [1].

Experimental Setup of Lab-scale MST

The lab-scale MST had four compartments: Anaerobic 1 (An1), Anaerobic 2 (An2), Moving Bed Biofilm Reactor (MBBR), and Sedimentation Tank (Figure 1). The synthetic wastewater in the feeding tank was pumped using a peristaltic pump into the system continuously. The system with a total volume of 91.15 L was operated based on office working hours for 10 hours (7 am to 5 pm) on Monday until Friday. Anaerobic 1 had a working volume of 30.4 L and was 30% filled with 30.48 mm diameter bioballs (ball-shaped plastic medium with many grooves to provide additional surface area for microorganisms). Anaerobic 2 had a working volume of 16.75 L and was 60% filled with bioballs. Wastewater from Anaerobic 2 was then flowed into the cylindrical-shaped MBBR, which had a volume of 31 L and 20% filled with Kaldness (white tube-shaped polyethylene medium that looks like wheels) as moving bed biofilm media. The oxygen for aerobic microorganism growth was supplied inside the MBBR by an air pump with a flow rate of 20L/minute under the control of an airflow meter. The MBBR was equipped with an air stone at its bottom to distribute the air evenly in the reactor. The MBBR was made of polyethylene material with a diameter of 10 mm and a density of 0.123 g/mL with a cross inside. The media consisted of two different types: plastic polyethylene bio-balls were used for Anaerobic 1 and Anaerobic 2, while Kaldness media was used in the aerobic compartment. The specification of Kaldness K1 media was PE material, 10 mm diameter, cylinder shape, 0.123 g/mL density, and 500 m^2/m^3 surface area. The specification of the bioballs was PE material, 19 mm diameter, spherical shape, 0.92 g/cm^3 density, and 378 m^2/m^3 surface area.

At the end of the experiment, samples were taken and isolated to see the bacteria morphology by microscope. The gram staining of bacteria was identified in each compartment of the MST according to Cappucino & Shearman, (2008) [7]. The Sedimentation Tank in which the sludge settled had a working volume of 13 L. In order to promote the denitrification process, the recycled water was pumped from Sedimentation Tank to Anaerobic 1 continuously for better organic and nutrient removal.

Table 1 Experimental design in lab-scale MST model.

COD (mg/L)	TN (mg/L)	TP (mg/L)	Q (L/h)	V (L)	HRT (h)	OLR $kg/m^3.d$	NLR $kg/m^3.d$	PLR $kg/m^3.d$
106	36	1.26	2.53	91.15		0.07	0.02	0.0008
252	85	3	2.53	91.15	36	0.17	0.06	0.002
432	146	5.14	2.53	91.15		0.29	0.1	0.0034
252	85	3	3.8	91.15	24	0.25	0.09	0.003
252	85	3	7.6	91.15	12	0.5	0.17	0.006

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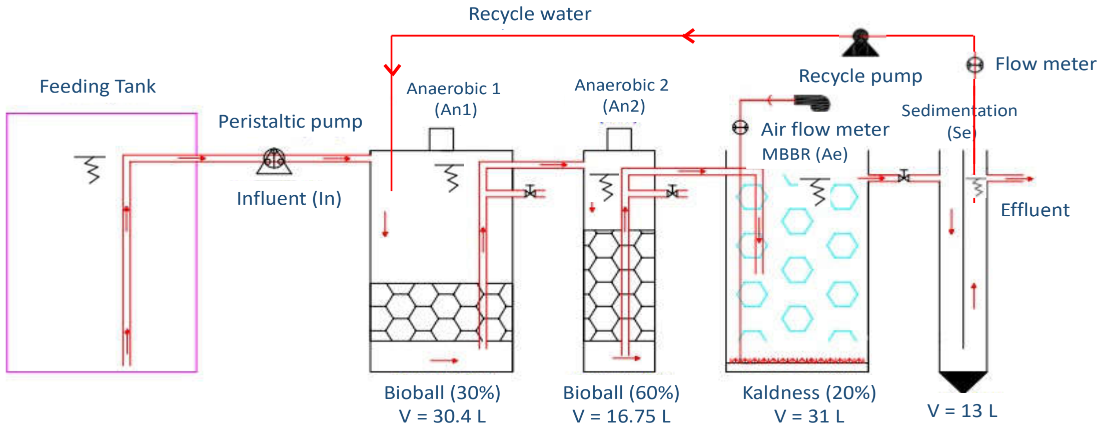

Figure 1 Schematic of the lab-scale MST model.

Experimental Design and Reactor Operation

To start up the reactor, the sludge for inoculation was taken from Bojongsoang Wastewater Treatment Plant (WWTP) in Bandung City, Indonesia. The nitrogen gas was rinsed in anaerobic compartments for 15 minutes to create anaerobic conditions. The food for the microorganisms in the reactor was provided by adding glucose and ammonium chloride [8]. After six weeks, a significant amount of biomass grew on the media, especially inside the aerobic chamber. The synthetic wastewater was continuously fed into the reactor at a constant feeding concentration. As shown in Table 1, this system was supplied with synthetic wastewater from a low initial concentration to a high initial concentration. After steady-state condition was reached, the initial concentration and HRT were changed to another variation. The MST was operated with different initial concentrations of COD (106, 252, 432 mg COD/L), TN (35, 85, 146 mg N/L), and TP (1.26, 3, and 5.14 mg P/L) with 36 h of HRT. After getting the optimum conditions for the initial concentrations, the MST was operated with different HRT values (24 h and 12 h). The performance of the system was evaluated after the system reached steady-state condition. The duration of each experiment was dependent on the HRT and steady-state condition. The samples were taken from the feeding tank, the effluent of Anaerobic 1, Anaerobic 2, MBBR, and the Sedimentation Tank. Samples from the effluent of the Sedimentation Tank were taken for daily analysis of COD, TP, and TN before and after reaching steady-state condition. Moreover, COD, TP, TN, NH_4, NO_2, NO_3, and PO_4 were measured in each compartment of the system when steady-state condition was reached. In addition, temperature, pH, and DO were periodically measured in every compartment to know the biological process condition before and after steady-state condition. The experiment was running at room temperature of about 22.9 °C to 26 °C. The DO concentration in the aerobic compartment was around 6.65 mg/L as measured by a DO meter (DO-5512SD). Moreover, pH in anaerobic and aerobic compartments was about 6.88 measured by pH meter (CT-6022).

Analytical Techniques

Standard methods were used as a reference to analyze the following parameters [9]: pH (SMEWW 4500-H+), temperature (SMEWW-2550), DO (SMEWW 4500-0-G), COD (SMEWW 5220-B), TN (SMEWW-4500-B), NH_4 (SMEWW-4500-B), NO_2 (SMEWW-4500-B), NO_3 (SMEWW-4500-C), TP (SMEWW 4500-P-D), and PO_4 (SMEWW-450-D).

In addition, isolation of bacteria was done according to Cappucino & Shearman (2008) to see the morphological characteristic of the bacteria [7]. The microbes were observed in the form of mixed culture. The effect of initial concentration and HRT on the performance of the MST in removing organics was analyzed using one-way analysis of variance (ANOVA) with Microsoft Office Excel 2016 at a significance level of 0.05. The average removal efficiency is shown as average ± standard deviation values in the text.

Result and Discussion

Effect of Initial Concentration on MST Performance

The reactor was operated with initial concentrations of COD (106, 252, and 432 mg/L), TN (35, 85, 146 mg/L) and TP (1.26, 3, 5.14 mg/L) with 36 h of HRT. The average values of COD removal for initial concentrations of 106, 252 and 432 mg COD/L were 81 ± 0.016%, 92 ± 0.035% and 88 ± 0.078%, respectively (Figure 2 (c)). The higher the initial COD concentration, the higher the effluent concentration of COD. OLR affects the substrate utilization at different concentrations and may result in organics removal [10]. The increase of the effluent concentration may be due to the initial accumulation and the microorganisms' initial shock to the sudden change of environment [11]. Environmental changes cause a significantly rapid change of the related variables in microorganisms. In addition, due to the slow metabolic processes of microorganisms, COD accumulates in the reactor when it is disturbed and tries to recover, causing an increase in COD concentration. The one-way ANOVA noted a significant effect ($p = < 0.05$) of the initial COD concentration on COD removal in the MST and the optimum condition was achieved at 252 mg COD/L (Table 2).

Table 2 Results of one-way ANOVA statistical analysis for the initial concentration effect on the removal of COD, TN, and TP in MST with 36 h of HRT.

IC^a	Source of Variation	SS^b	df^c	MS^d	*P-value*
COD	Between Groups	166.629	2	83.315	4E-13
	Within Groups	0.013	6	0.002	
	Total	166.642	8		
TN	Between Groups	377.494	2	188.747	6E-10
	Within Groups	0.322	6	0.054	
	Total	377.816	8		
TP	Between Groups	76.959	2	38.480	0.002
	Within Groups	10.899	6	1.817	
	Total	87.858	8		

^{a} Initial concentration, ^{b} sum of square, ^{c} degree of freedom, ^{d} mean square

Figure 2(b) showed that the average values of TN removal for initial concentrations of 35, 85 and 146 mg N/L were 45 ± 0.049 %, 63 ± 0.3401 % and 51 ± 0.21%, respectively. The higher the initial TN concentration, the higher the TN concentration in the effluent. TN represented as organic nitrogen and ammonia were not reduced greatly. The low carbon-to-nitrogen ratio (3:1) of this wastewater may require an additional external carbon source so that biological denitrification works quickly and efficiently [12]. The one-way ANOVA showed that the initial TN concentration had a significant effect on TN removal ($p < 0.05$) in MST and the optimum condition was achieved at 85 mg N/L (Table 2). Figure 2(a) shows that the average values of TP removal for initial concentrations of 1.26, 3, and 5 P mg/L were 48 ± 1.99%, 55 ± 0.19%, and 50 ± 1.21%, respectively. Biological P removal was then performed based on the Andrearzyk principle, namely alternating heterotrophic microorganism in an aerobic and anoxic environment alternately. A high initial TP concentration may have resulted in a high TP concentration of the effluent. The one-way ANOVA noted that the initial TP concentration had a significant effect on TP removal ($p < 0.05$) in the MST and the optimum condition was achieved at 3 mg P/L (Table 2). The results showed that all variations had a significant impact on the performance of organic and nutrient removal in MST ($p < 0.05$) and the optimum condition was achieved at 525 mg COD/L, 85 mg N/L, and 3 mg P/L.

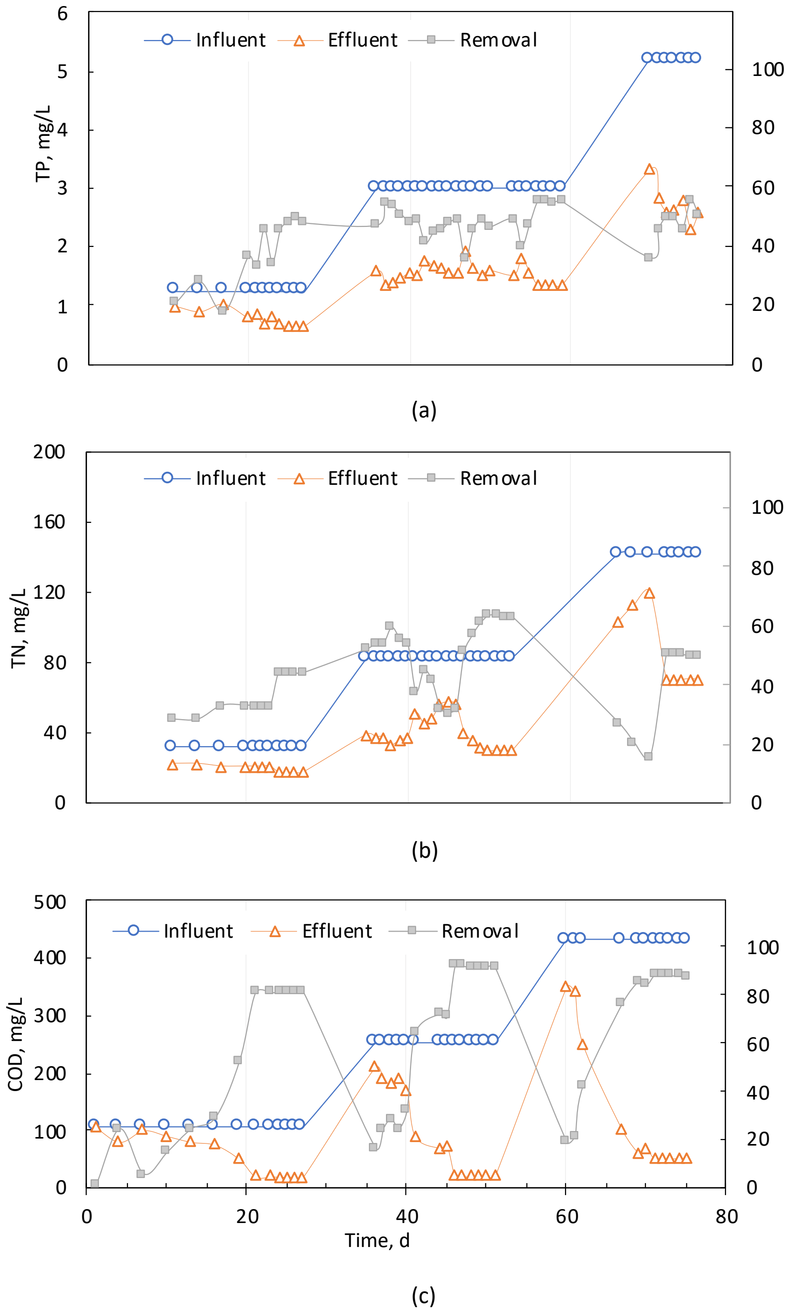

Figure 2 (a) Variations of influent, effluent, and removal efficiency of TP in the lab-scale MST; (b) variations of influent, effluent and removal efficiency of TN in the lab-scale MST, and (c) variations of influent, effluent and removal efficiency of COD in the lab-scale MST.

Effect of HRT on MST Performance

The MST was operated with HRT values of 36 h, 24 h and 12 h, and initial concentrations of 252 mg COD/L, 85 mg N/L, and 3 mg P/L. The average values of COD removal for an HRT of 36 h, 24 h, and 12 h were 92%, 91% and 86%, respectively (Figure 3). The one-way ANOVA showed that HRT had a significant effect ($p < 0.05$) on the COD removal and the optimum condition was achieved at 36 h of HRT (Table 3). A higher HRT had the effect of increasing the efficiency of COD removal. Chiemchaisri *et al.* have also reported that a higher HRT gave a significant improvement in COD removal using an MBR [13]. The average values of TN removal for an HRT of 36 h, 24 h, and 12 h were 60%, 51%, and 45 %, respectively. One-way ANOVA showed that HRT had a significant effect ($p < 0.05$) on the TN removal and the optimum condition was achieved at 36 h of HRT. A high HRT gave high efficiency of TN removal. The average values of TP removal for HRT of 36 h, 24 h, and 12 h were 55%, 48%, and 39 %, respectively. One-way ANOVA showed that HRT significantly affected the TP removal ($p < 0.05$) and the optimum condition was achieved at 36h of HRT. TP removal was more efficient with increasing HRT. In summary, increasing HRT values resulted in higher removal rates across all parameters.

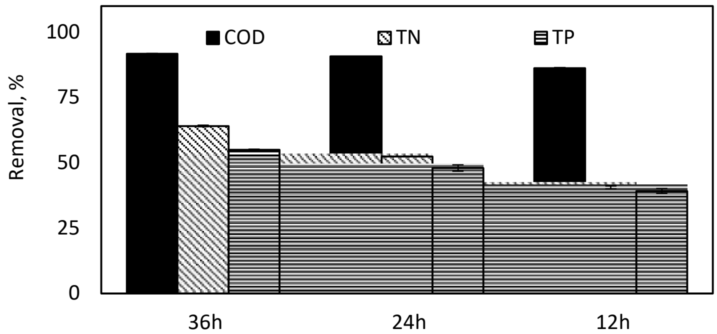

Figure 3 COD, TN, and TP removal efficiency based on different HRT values (36, 24 and 12 h) in the MST.

Table 3 The one-way ANOVA results for the HRT effects values on COD removal, TN removal, and TP removal performance in the MST.

IC[a]	HRT[b]	Source of Variation	SS[c]	df[d]	MS[e]	*P-value*
252 mg COD/L	36h 24h 12h	Between groups	56.52	2	28.26	3E-08
		Within groups	0.17	6	0.03	
		Total	56.69	8		
85 mg N/L		Between groups	830.81	2	415.40	1E-09
		Within groups	0.83	6	0.14	
		Total	831.63	8		
3 mg P/L		Between groups	386.93	2	193.46	1E-06
		Within groups	4.77	6	0.79	
		Total	391.69	8		

[a] Initial concentration, [b] hydraulic retention time, [c] sum of square, [d] degree of freedom, [e] mean square

COD Removal Process

COD concentrations were slightly removed in the anaerobic and aerobic compartments and the effluent concentrations were below 52 mg COD/L under all operating conditions (Figure 4(a)). This indicates that there was anaerobic and aerobic microorganism growth to remove organic matter in the MST. Based on Figure 4(b), 252 mg COD/L of initial concentration was removed in the MST under HRT variation at 36 h, 24 h, and 12 h with effluent concentrations ranging from 20 to 52 mg/L. Most of the COD was removed in the aerobic compartment. This indicates that the MBBR compartment had a better performance on organic removal than the anaerobic compartments. The most impressive finding was that the HRT reduced from 36 h to 12 h with initial concentrations from 106 to 432 mg COD/L, giving effluent connections of COD below 52 mg/L and COD removal ranging between 82 to 92%.

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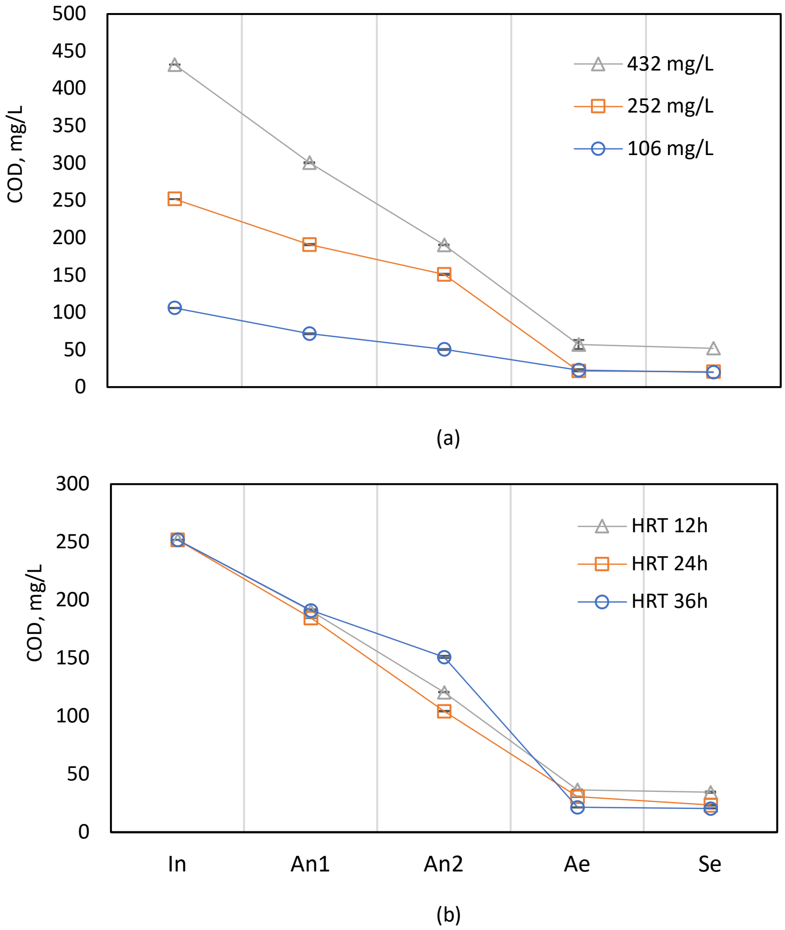

Figure 4 (a) COD removal in different compartments of the MST with different initial COD concentrations of 106, 252 and 432 mg COD/L, and (b) COD removal at different HRT values of 36 h, 24 h, and 12 h in each compartment of the MST with an initial concentration of 252 mg COD/L.

Nitrogen Removal Process

Generally, nitrogen compounds are in the form of ammonia nitrogen, nitrite, nitrate, and organic nitrogen. According to the literature, nitrogen removal can occur through nitrification under aerobic conditions and through denitrification under anaerobic conditions [14]. Heterotroph bacteria use organic substances as a carbon source to convert nitrate to nitrogen gas during denitrification, resulting in total nitrogen removal. There are two steps in the nitrification process: first, the nitrification process, in which ammonia is converted to nitrite with the help of *Nitrosomonas*, and then *Nitrobacter* oxidizes the nitrite to nitrate [15]. In the experimental system, the ammonia was removed in both anaerobic compartments. Anammox bacteria can use nitrite as electron acceptor to convert part of the ammonia into nitrogen gas in the absence of oxygen content. Most of the ammonia concentration continue to decrease in the aerobic compartment through the nitrification process, in which the nitrifying bacteria use oxygen as electron acceptor to convert ammonia nitrogen to nitrite and then to nitrate at the end of the process (Figure 5(c)). A complete nitrification process was obtained in the aerobic compartment since the nitrate content was mainly removed in the anaerobic compartments beforehand and therefore the nitrate in the aerobic compartment resulted in a sharp increase as shown in Figure 5(a) and Figure 5(b). The denitrification process was highly successful since nitrate was mainly removed in the anaerobic tank, as shown in Figure 6.

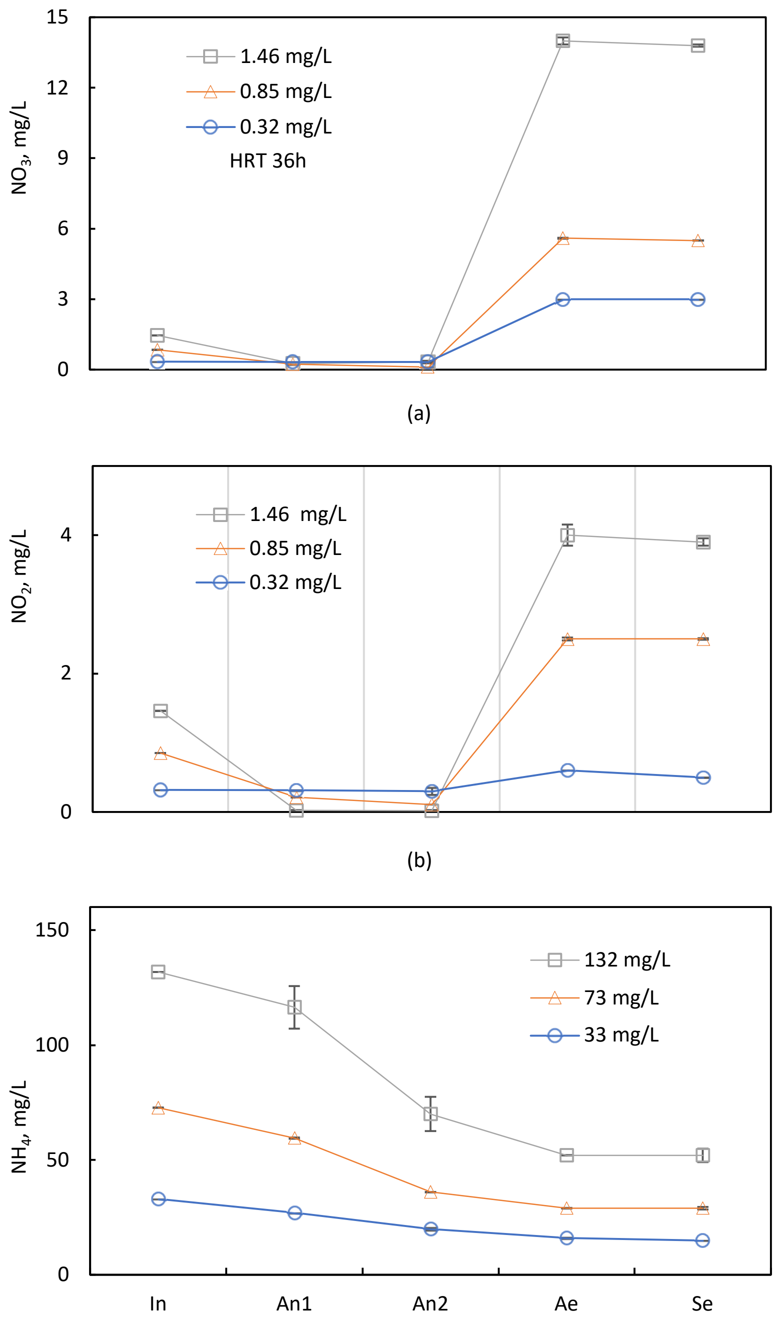

Figure 5 (a) NO_3 concentration in each compartment at different initial NO_3 concentrations with HRT 36 h, (b) NO_2 concentration contained in each compartment at different initial NO_2 concentrations with HRT 36 h, and (c) NO_3 concentration in each compartment at different initial NO_4 concentrations with HRT 36 h.

Phosphorus Removal Process

Phosphate can be removed by assimilation and enhanced biological phosphorus removal (EBPR). Assimilation occurs in the phases of growth, whereas EBPR happens when wastewater passes through the aerobic and anaerobic zones alternatively. The assimilation and EBPR processes stop when the growth of microorganisms

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stops and is saturated [16]. The phosphorous removed during the EBPR process can be calculated from the biodegradable soluble COD (bsCOD) quantity in the wastewater influent on the basis that most of the bsCOD is converted to acetate during a short HRT of anaerobic digestion. In theory, the EBPR mechanism requires around 10 g of bsCOD for 1 g of phosphorus. Another bsCOD removal process in the system is driven by phosphorus assimilation mechanisms by normal cell synthesis [15].

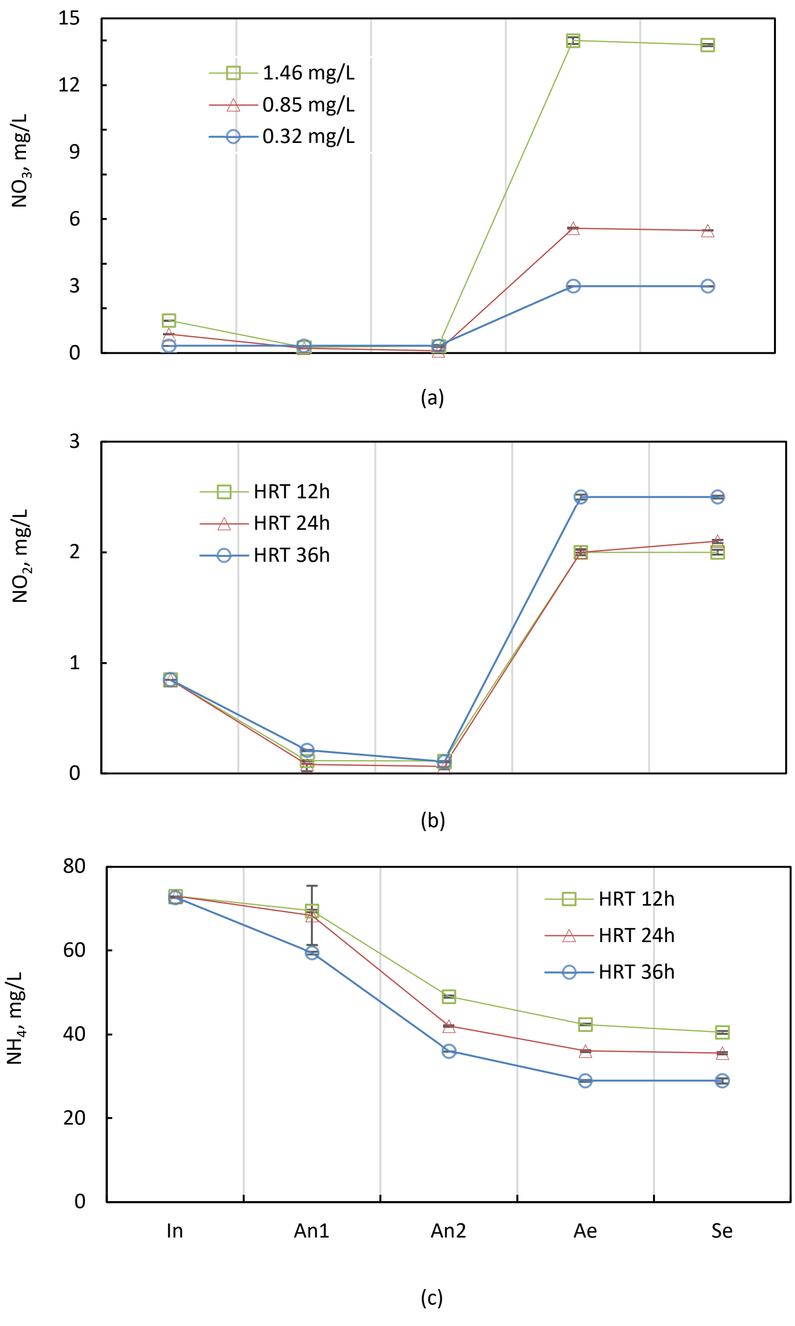

Figure 6 (a) NO_3 content in each compartment at different HRTs of 36 h, 24 h and 12 h with an initial NO_3 concentration of 0.85 mg/L, (b) NO_2 content in each compartment at different HRTs of 36 h, 24 h and 12 h with an initial NO_2 concentration of 0.85 mg/L, and (c) NH_4 content in each compartment at different HRTs of 36 h, 24 h and 12 h with an initial NH_4 concentration of 73 mg/L.

As shown in Figure 7, TP and PO_4 were not removed well in the anaerobic compartments. This may be because the anaerobic zone initially allows the phosphate accumulating microorganisms (PAOs) to take up VFAs as polyhydroxybutyrate (PHB) in their cells. The stored polyphosphate serves as an energy source after the oxidation process. Besides, the store polyphosphate is used for generating ATP and converted to the liquid phase. After the mixed liquor reaches the aerobic zone, the stored PHB is used by the PAOs for cell growth, to provide energy to reform polyphosphate from all the available orthophosphate and also for the synthesis of polyglucose (glycogen), resulting in high removal of TP in the aerobic compartment. The literature confirms that inorganic phosphorus in domestic wastewater is in the form of orthophosphate, condensed phosphate, and organic phosphate. Compound condensed phosphate and organic phosphate are converted to orthophosphate through microbial activity. Orthophosphate will be removed by PAOs during the uptake process and the settlement of the sludge [17].

TP removal in the MST ranged from 39% to 55%. Yang *et al.* (2010) and Brown *et al.* (2011) reported a maximum of 84% of TP was removed in the system [18],[19]. Both experiments used an anaerobic-anoxic MBR system to treat synthetic wastewater with the goal of removing phosphorus. Another relevant study found that a pilot plant operated by the University of Cape Town-MBR (UCT: MBR) in treating actual household wastewater with a low COD:TP ratio had a high TP removal effectiveness of between 80% and 92% [20]. The possible case that causes low phosphorus removal is a low COD concentration in the influent. The availability of biodegradable soluble COD (bsCOD) or acetate at a steady state provides a better performance of biological phosphorus removal.

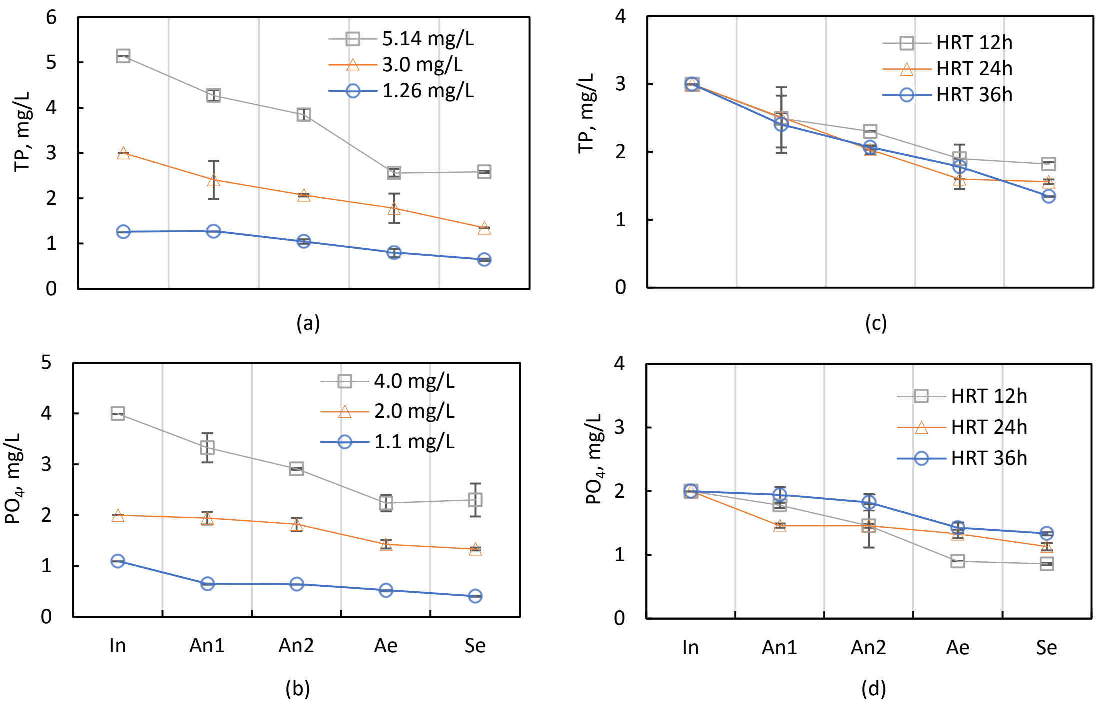

Figure 7 (a) TP removal content in each compartment with an HRT of 36 h and different initial TP concentrations of 1.26, 3, and 5.24 P mg/L, (b) PO_4 content removal in each compartment of the reactor with an HRT of 36 and different initial PO_4 concentrations of 1.1, 2, and 4 PO_4 mg/L, (c) TP content removal in each compartment of the reactor with an HRT of 36 h, 24 h and 12h and an initial TP concentration of 3 mg P/L, and (d) PO_4 removal in each compartment of the reactor with an HRT of 36 h, 24 h and 12 h and an initial PO_4 concentration of 2 PO_4 mg/L.

In addition, the morphological characteristics of the bacteria showed that the bacteria in Anaerobic 1 may be close to Bacillus bacteria, the bacteria in Anaerobic 2 may be close to coccus bacteria, and the bacteria in the aerobic compartment may be close to Bacillus bacteria (Table 4). The morphological characteristic of the bacteria in Anaerobic 1 and Anaerobic 2 were different, while the bacteria in Anaerobic 1 were similar to those found in

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the aerobic compartment. Dominant heterotrophic bacteria such as pseudomonas, cocci, and bacillus are highly correlated to the removal of COD, TN, and TP [21].

Table 4 Colony and cell morphology of the bacteria.

Characteristics	Tests	Anaerobic 1	Anaerobic 2	Aerobic
Colony and cell morphology	Macroscopic	Circular, smooth rounded edge, convex, pigmented, yellow, translucent.	Circular, smooth rounded edge, convex, unpigmented, yellow, translucent.	Circular, smooth rounded edge, convex, pigmented, yellow, translucent.
	Microscopic	Short bacilli, gram (-), non-endospore-forming.	Coccoid, gram (-), non-endospore-forming.	Short bacilli, gram (-), non-endospore-forming.

MST Performance Evaluation

The efficiencies of COD, TN, NH_4, and TP removal by the MST in this study varied from 82% to 92%, 41% to 60%, 45% to 61%, and 39% to 55%, respectively. The effluent concentrations of COD, TN, NH_4, and TP from the MST varied from 19 to 52 mg/L, 19 to 72 mg/L, 15 to 52 mg/L, and 0.41 to 2.3 mg/L, respectively. Different operational conditions in terms of initial concentration and HRT value in the MST resulted in higher performance than CST, SBST, TBST, PST, and AF from previous studies regarding NH_4, TN and TP. Table 5 shows that the MST has the potential to significantly improve the treatment performance of conventional septic tanks and can be used to treat office building wastewater. However, further observation of the performance of the MST due to sludge accumulation is needed since this study ran the experiment over a short period.

Table 5 Comparison between the performance of the MST and previous studies on CST, SBST, TBST, PST, and AF in removing COD, NH_4, TN and TP.

STT[a]	HRT	Parameters	Influent	Effluent	Removal, %	References
MST[b]	12 h 24 h 36 h	COD, mg/L	106-432	19-52	82-92	This research
		NH_4, mg/L	33-132	15-52	45-61	
		TN, mg/L	35-146	19-72	41-60	
		TP, mg/L	1.26-5.14	0.41-2.3	39-55	
CST[c]	24 h 48 h 72 h	COD, mg/L	960	334	38-65	Nasr & Mikhaeil, 2014 [3]
		NH_4, mg/L	26.2	28	4-7	
		TN, mg/L	71	52.3	17-26	
		TP, mg/L	4.44	3.14	25-29	
SBST[d]		COD, mg/L	817-1184	266-396	55-72	
TBST[e]		COD, mg/L	817-1185	248-380	57-74	
PST[f]		COD, mg/L	817-1186	221-359	56 - 68	
PST	50 h	COD, mg/L	651	111	83	Sharma & Absar, 2015 [22]
AF[g]	24h 48h 72h	COD, mg/L	187-252	40-126	32-81	Ladu & Lu, 2014 [23]
		NH_4, mg/L	27-30	17-20	31-36	
		TN, mg/L	29-34	18-22	30-41	
		TP, mg/L	3-6	2-3	12-48	

[a] Septic tank type, [b] modified septic tank, [c] conventional septic tank, [d] single-baffle septic tank, [e] two-baffle septic tank, [f] packed septic tank, [g] anaerobic filter

Conclusion

This research was the first attempt to investigate the effects of initial concentration and hydraulic retention time (HRT) in the treatment of synthetic office building wastewater by a moving bed biofilm reactor integrated septic tank (MST). The variations of initial concentrations and HRT values during operation of the MST were evaluated. The initial concentration and HRT had significant effects on the organics and nutrients removal. Optimum conditions were achieved at 36 h of HRT and a COD:TN:TP ratio of 252:85:3 with removal efficiencies of COD, TN, and TP at 92%, 60%, and 55%, respectively. Nitrification and denitrification processes occurred in this system since the nitrate content in the anaerobic compartment was mostly removed and the nitrate content gave a sharp increase in the aerobic compartment. Phosphorus accumulating microorganisms (PAOs) possibly removed the phosphorus in the aerobic compartment. The low COD concentration and the low ratio of COD:TP in the office building wastewater can affect the low phosphorus removal through the mechanism of enhanced biological phosphorus removal (EBPR). The result of microscopic morphological bacteria characteristics indicated that bacillus and coccoid bacteria were found, which were possibly correlated to the removal of COD, TN, and TP in the MST. Compared to a conventional septic tank, this system has a relatively higher efficiency in removing organic matter and nutrients, and thus it was proven to be an excellent choice for treating office building wastewater.

Acknowledgments

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