고도단계유입폭기법과 표준활성슬러지법의 처리특성 비교

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A Study of the comparison of the treatment characteristics between ASA system and CAS system

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Abstract

Currently an increase in domestic sewage and industrial wastewater causes serious water pollution in Korea. To solve water pollution problems, conventional activated sludge (CAS) system is generally used in wastewater treatment plant but this process is so ineffective in nitrogen and phosphorus. Even if CAS system is the major process, it must be improved instantly so as to remove nitrogen and phosphorus. Otherwise, the serious water pollution problems can't be resolved with CAS system. Therefore this study focused on the comparison of the treatment characteristics between ASA system and CAS system. And also the mass balance of each process of ASA system. The results from operating advanced step aeration (ASA) system indicated that the removal efficiency of BOD, COD, and SS was 89.9%, 74.5%, and 89.0% respectively. In comparison, the removal efficiency of BOD, COD, and SS for CAS system was 89.5%, 71.8%, and 89.5% respectively. In addition to the results, the TN removal efficiency of ASA system was 76.5% comparing to 32.7% of CAS system. It was concluded that the TN removal efficiency of ASA system was 44% higher than CAS system. And the TP removal efficiency was 81.4% in ASA system comparing to 25.2% in CAS system. It also means that over 56% of TP was removed in ASA system comparing to CAS system.

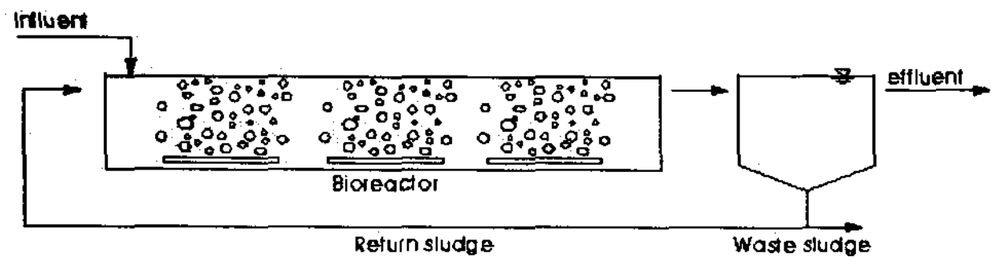
1. INTRODUCTION

In the past two decades, a number of BNR processes have beendeveloped [1,2,3]. Most of the developed BNR processes including anaerobic /anoxic/oxide (A_2O) and modified Bardenpho processes consist of a sequential anaerobic and aerobic stage for biological phosphorus removal, and recycle nitrified liquor into anoxic zones to promote the removal efficiency of total nitrogen (TN). This approach will require additional energy for liquid circulation or addition of external carbon substrate for denitrification in anoxic zones. As a result, the operational cost of these processes will increase. The disadvantage of the developed BNR processes were improved by reconfiguring the BNR process without internal nitrified liquor circulation. This was done by configuring the process into an anaerobic zone followed by multiple atages of aerobic-anoxic-aerobic zones (ASA system). In the ASA system, a step feed was used to direct the influent into the first anaerobic zone(0.8Q) as an energy source for phosphous release and to the other anoxic zones(0.2%) as an external corbon source for denitrification. In other words, this study adopts the step feeding concept that was applied in the

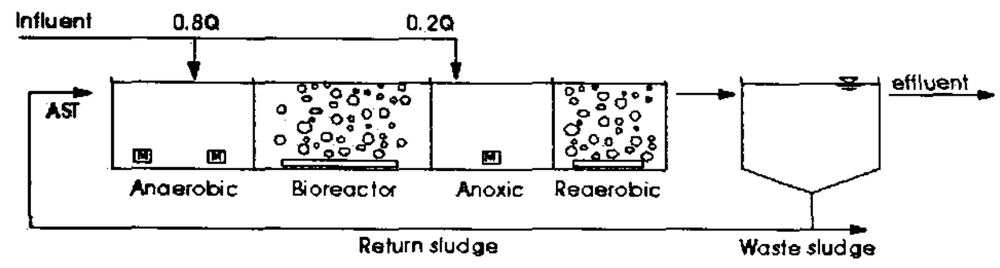
ASA process that used raw wastewater as the external corbon source for denitrification. The objective of this study focused on the comparison of the treatment characteristics between ASA system and AS system. In particular, this study has been to experimental profiles of nitrogen and phosphous in the ASA system.

2. EXPERIMENT

Each CAS system and ASA system was operated for treating 5m^3 of the wastewater daily respectively, consisting of two different lines. The schematic diagrams of Line-A (CAS system) and Line-B (ASA system) are shown in Figure. 1. Also, the operating conditions and the characteristics of raw wastewater are shown in Table 1 and Table 2 respectively.



Line-A (CAS system)



Line-B (ASA system)

Figure 1. Schematic diagrams of pilot-plant

Table 1. Design conditions of pilot-plant

Process	Item	Unit	Condition
Primary setting basin	Size	cm	40W×40L×270H
	HRT	hr	2.1
	Surface loading	$m^3/m^2 \cdot day$	31.25
AS system	Size	cm	72W×200L×120H
	HRT	hr	6.9
ASA system	Size	cm	72W×200L×120H
	Total HRT	hr	6.9
	AST		0.5
	Aeaerobic		0.9
	Aerobic		2.5
	Anoxic		2.0
	Reaerobic		1.0
Final setting basin	Size	cm	Ø50×350H
	HRT	hr	3.3
	Surface loading	$m^3/m^2 \cdot day$	25.5
	Recycle rations	%	40

Table 2. Chracteristics of raw wastewater.

Parameter	Unit	Min.	Max.	Average
Temp.	℃	9.9	25.5	16.9
pH	-	6.9	7.4	7.1
DO	mg/L	1.16	5.69	3.57
BOD	mg/L	32.3	102.3	56.0
COD_{Mn}	mg/L	12.2	41.2	24.5
SS	mg/L	30.3	206.0	72.5
T-N	mg/L	13.86	59.75	27.19
TKN	mg/L	13.74	59.72	27.08
NH_3-N	mg/L	8.30	26.64	15.92
NO_3-N	mg/L	0.01	0.18	0.11
T-P	mg/L	0.86	3.68	1.91
PO_4-P	mg/L	0.37	1.56	0.81
Alkalinity	mg/L	116.8	139.6	129.5
BOD/T-N	-	1.2	3.6	2.1
BOD/T-P	-	17.1	73.8	31.3

3. RESULTS AND DISCUSSION

3.1 Comparison of treatment characteristics

Figure 2, 3, 4 and 5 shows that the removal efficiency of BOD, SS, TN and TP respectively. The treatment characteristic of BOD is illustrated in Figure 2. Influent concentration was varied from 32 - 102.3 mg/L. And the effluent BOD of ASA system and CAS system were 2.3 - 8.3 mg/L and 2.9 - 8.7 mg/L respectively. Consequently, Average removal efficiency was 89.9% and 89.5% respectively. Figure 3 illustrate the evolutions of removal characteristic of SS during the operation period. In the ASA system, influent concentration was 30.3-12.2 mg/L. In case of CAS system effluent concentration was 2.4-12.4 mg/L. Accordingly, The average efficiency was 89.0% and 89.5% respectively. In conclusion, during the operation periods of ASA system and CAS system, the Removal efficiency of BOD and SS was similar to the whole system

In the CAS system, the influent concentration of TN was 13.86-59.75 mg/L(average 27.19 mg/L) and the effluent concentrations were 8.4-28.5 mg/L(agerage 18.1 mg/L). Thus, 23.9-52.2% (averge 32.75) of TN was removed. However, in case of ASA system, the concentration of effluent TN was varied from 1.16-11.97 mg/L. Thus 60.1%-94.6%(average 76.5%) of TN was removal. Accordingly, At the TN removal efficiency, the ASA system was about 45 percent higher than the CAS system. It is illustrated in Figure 4.

Figure 5 shows that treatment charcateristic of TP. The influent concentration of TP was 0.86-3.68 mg/L(average 1.91 mg/L). The effluent concentration in the CAS system were 0.64-2.87 mg/L(average 1.43 mg/L). Thus, 20.1-30.0% (average25.2%) of TP was removal. However, the effluent concentration in the ASA system were 0.06-0.83 mg/L(average 0.37 mg/L). Thus, 66.5-94.9%(average 81.4%) of TP was removed, Accordingly, at the TP removal efficiency, the ASA system was about 56 percent higher than the CAS system.

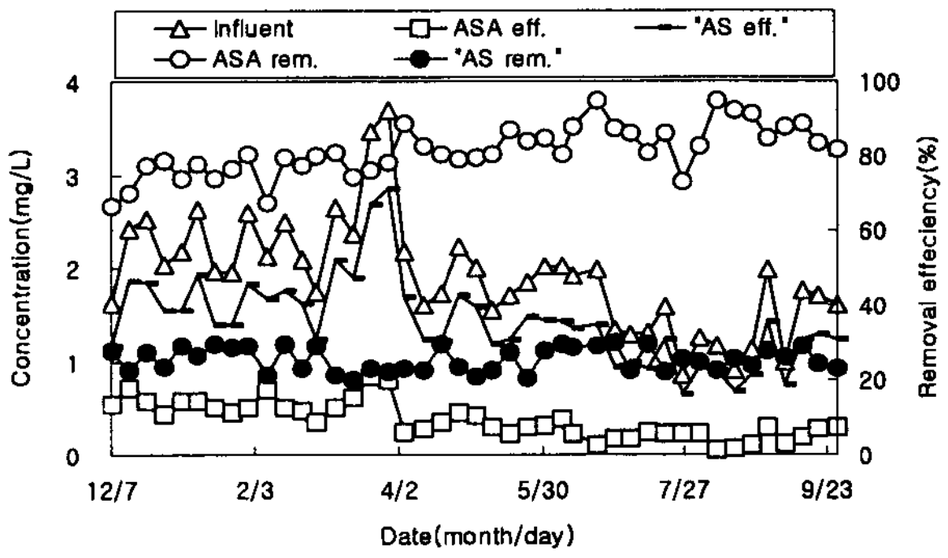


Figure 5. Comparison of TP concentrations between ASA system and CAS system.

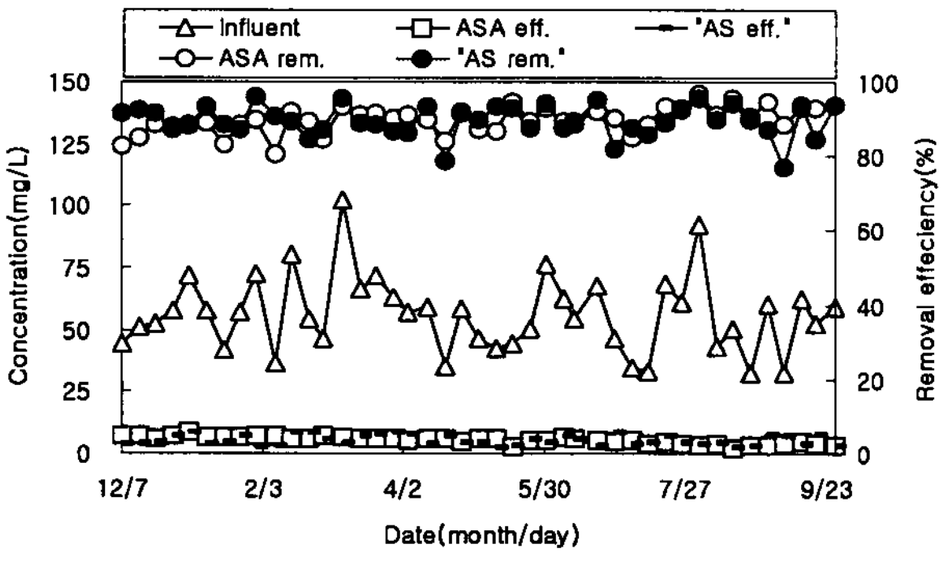


Figure 2. Comparison of BOD concentrations between ASA system and CAS system.

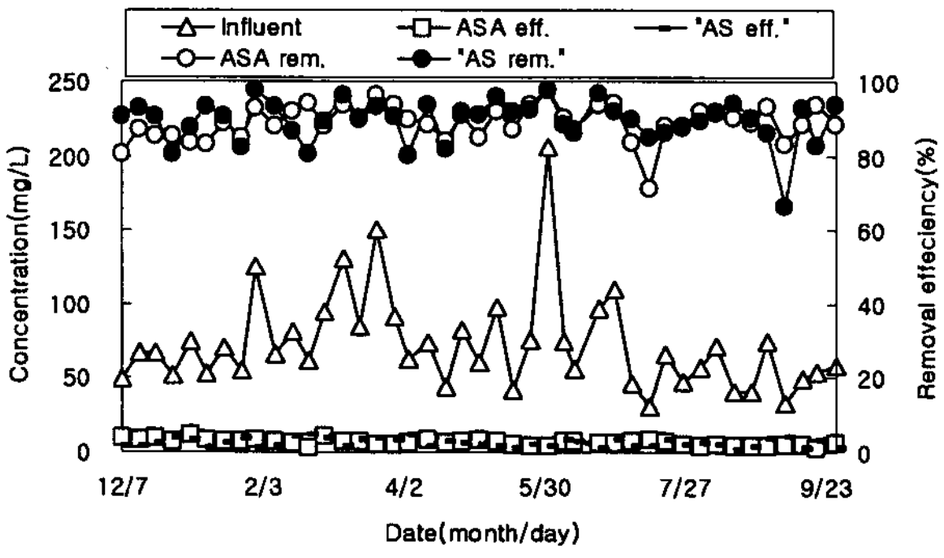


Figure 3. Comparison of SS concentrations between ASA system and CAS system.

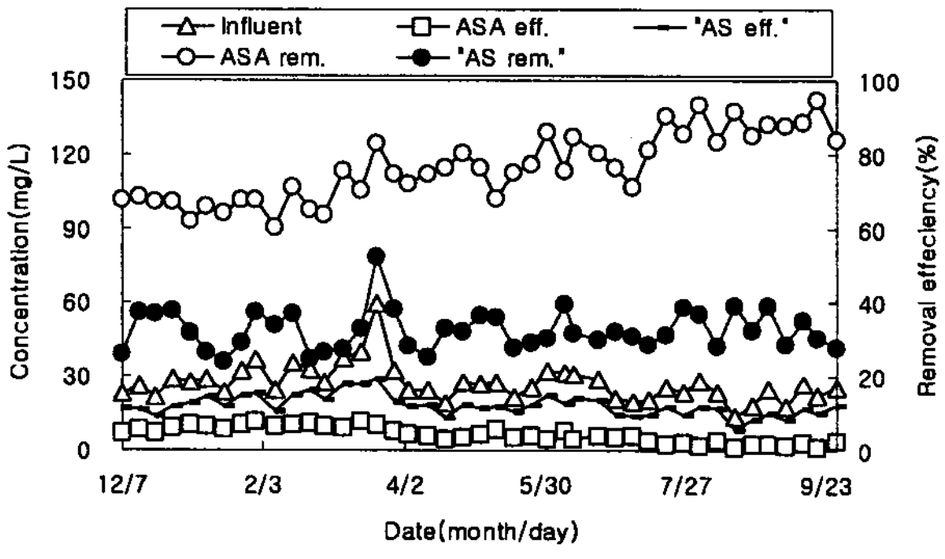


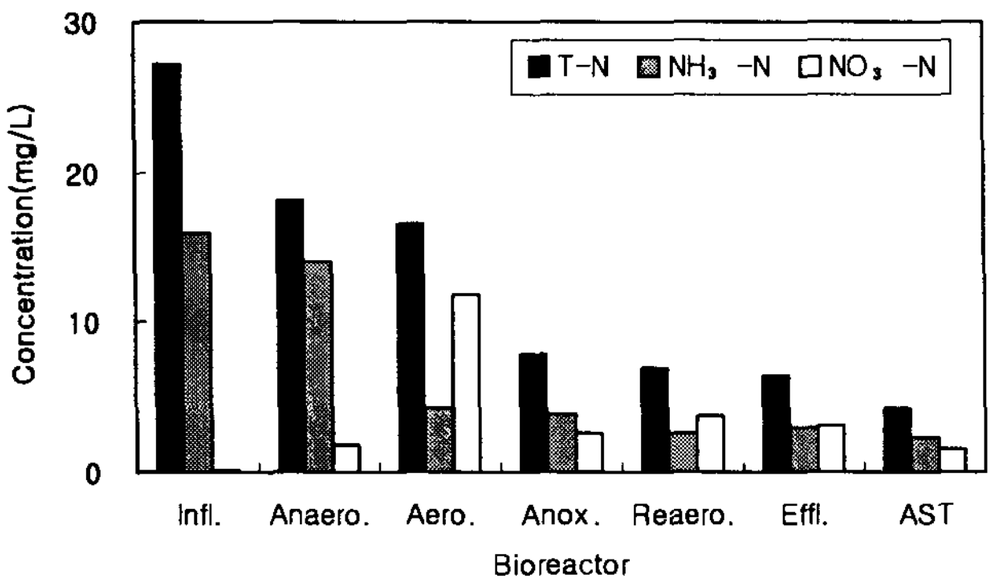
Figure 4. Comparison of TN concentrations between ASA system and CAS system.

3.2 Mass blance of unit process in ASA system

Figure 6 illustrates the experimental profiles of TN, NH_3-N and NO_3-N in the ASA system. The influent average concentrations of NH_3-N and NO_3-N were average 15.92 mg/L and 0.11 mg/L respectively. Concentration of NH_3-N in aerobic reactor was decreased to 4.28 mg/L. Thus, nitrification rate was about 70 percent. And the concentration of NO_3-N in aerobic reactor was increased to 11.86 mg/L. Because of denitrification reaction depend on step feed of 0.2Q, the concentration of NO_3-N in anoxic reactor was decreased to 2.61 mg/L. As a result, the effluent concentration of NH_3-N and NO_3-N was 2.96 mg/L and 3.07 mg/L respectively.

At the AST(anaerobic sludge tank), NO_3-N concentration of 3.07 mg/L was decreased to 1.35 mg/L(Therefore, the optimal condition for phosphate release was achieved by endogenous denitrification in AST). The average TN concentration of in AST was 27.19 mg/L. and the removal efficiency of whole system was average 76.5 percent, Especially, the most of TN removal was achieved by AST and anoxic reactor.

Figure 7 illustrates the experimental profiles of TP and PO_4-P in ASA system. The concentration was increased to 2.96 mg/L in anaerobic reactor because of the phosphate release. The average removal efficiency of TP in whole system was 81.4 percent. Especially the most of TP was removed in aerobic and reaerobic reaerobic reactor because of phosphate uptake.



Parameter	T-N	NH_3-N	NO_3-N
Influent	27.19	15.92	0.11
AST	4.24	2.33	1.53
Anaerobic	18.20	14.04	1.76
Aerobic	16.64	4.28	11.86
Anoxic	7.92	3.85	2.61
Reaerobic	6.96	2.62	3.78
Effluent	6.48	2.96	3.07

Figure 6. Experimental profiles of TN, NH3-N and NO_3-N in the ASA system.

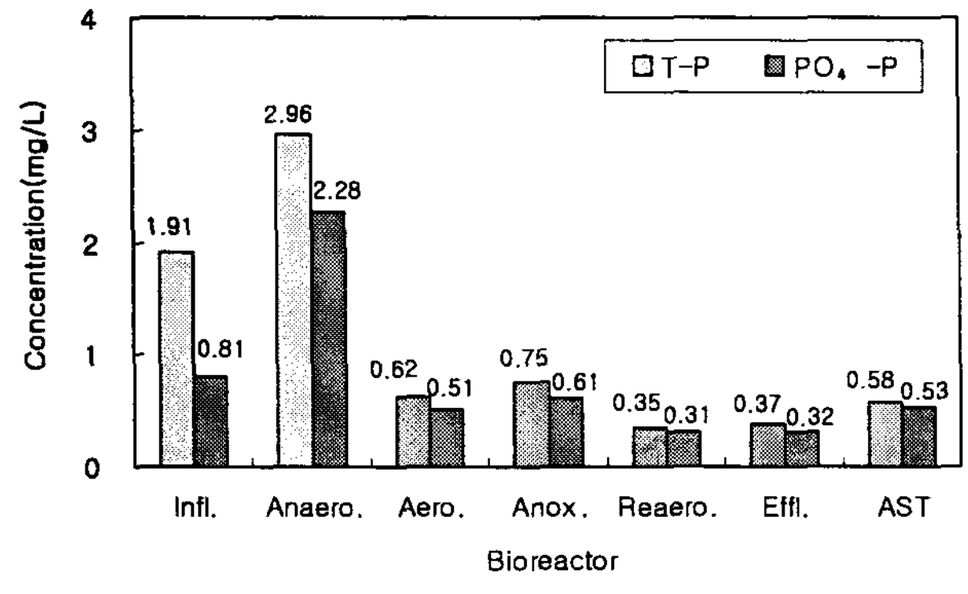


Figure 6. Experimental profiles of TP and PO_4-P in the ASA system.

4. CONCLUSIONS

The following is summarized as a result of the study.

1. The results from ASA system indicated that the removal efficiency of BOD, COD and SS was 89.9%, 74.5% and 89.0% respectively. On the other hand, the removal efficiency of CAS system was 89.9%, 71.7%, 89.5% respectively.

2. The TN removal efficiency of each system was about 76.5% in ASA system and 32.7% in CAS system when the influent TN concentration was ranged 13.86-59.75 mg/L. The TN removal efficiency of ASA system was approximately 44% higher than CAS system. Also the TP removal efficiency was about 81.4% in ASA system and 25.2% in CAS system respectively. It means that more than 56% TP removal was achieved in ASA system comparing to CAS system.

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