

Phosphorus Removal from Sewage with the Corrosion of Aluminum and Silver to Pilot-Plant

S I Park* · H I Choi · O J Jung · D Y Shin · K H Cheong

Division of Environmental Engineering, Chosun University

Abstract

The pilot scale experiment was performed to investigate phosphorus and nitrogen removal from sewage by intermittently activated sludge process combined with the electrochemical interaction (Localized Corrosion) of aluminum and silver. The average T-N removal rate for HRT of 24hr was 57.4%. It was possible to remove P in sewage to under 1 mg/L with a short HRT of 12 hr using Al and Ag plate but often required additional Al plate supplement during the operation.

Introduction

Most of the suggested phosphorus ($\text{PO}_4\text{-P}$) removal processes can be classified into physical/chemical and biological treatments. Recently, the electrochemical technique to elute metal ion such as aluminum or iron as precipitant and to form a precipitation with P has been developed for the small-scale domestic sewage treatment plant. However, due to high electrical cost during the electrolysis of iron or aluminum, a new approach to utilize the eluted aluminum through corrosion to interact with P in sewage was tried. Kondo et al. (1996) and Cheong et al. (1999) showed applicability of aluminum media to remove P in sewage applying the principle that when there are two kinds of metals having different ionization tendencies in the solution containing salts, pitting corrosion occurs. Therefore, in this study, the pilot scale experiment was performed to investigate phosphorus and nitrogen removal by intermittently activated sludge process combined with the corrosion of aluminum and silver.

Materials and Method

Pilot-scale test

A pilot-scale intermittent aeration activated sludge reactor with a working volume of 100 L and a subsequent reactor (50 L) for P removal were installed in the sewage treatment plant at Chosun University. Fig. 1 shows a schematic of pilot plant with Al plates ($12,500 \text{ cm}^2$) and Ag plates ($1,800 \text{ cm}^2$).

Wastewater

A feed wastewater was obtained from the effluent of the biological treatment plant (intermittent aeration) located at Chosun University. Table 1 shows the average composition of the influent.

Parameters measured

All parameters measured were in accordance with Standard Methods (1985). Characteristics of Al precipitation on the surface were determined using SEM (Scanning Electron Microscope, JSM 840-A, JEOL Co.), EDS (Energy Dispersive X-ray Spectrometer, AN ISIS 310) and ICP (Inductively Coupled Plasma Emission Spectrophotometer, France, Jobin Yvon Co. JY 70Plus).

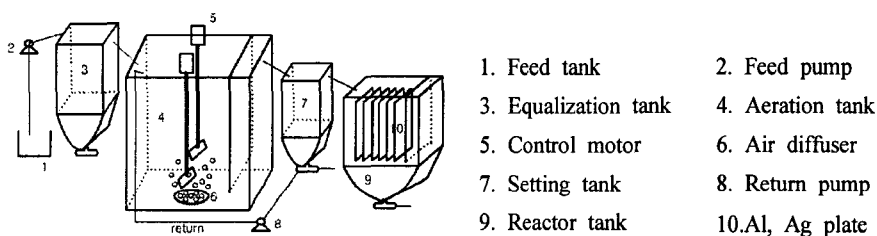


Fig. 1. Schematic diagram for the pilot scale reactor combined with aluminum corrosion.

Table 1. Characteristics of influent in this experiments

Item	Concentration (mg/L)	Item	Concentration (mg/L)
NaCl	0.08~0.10 %	PO ₄ -P	6.9~10.2 mg/L
pH	7.5~8.5	T-N	141.9~193.7 mg/L
TCOD	195.7~242.4 mg/L	NH ₄ -N	102.1~149.5 mg/L
SCOD	86.6~123.6 mg/L	NO ₃ -N	0.14~10.748 mg/L
T-P	12.8~18.8 mg/L		

Results and Discussion

Variation of SCOD

The average concentration of influent SCOD was 102.5 mg/L during the operation. Although influent SCOD was very various, the effluent SCOD kept constantly below 16.6 mg/L.

Variation of nitrogen

Figure 2 shows total nitrogen removal in the pilot scale reactor. Influent T-N concentration ranged various from 141.9 mg/L to 194.3 mg/L, averaging 168.6 mg/L. The average concentration of influent $\text{NH}_3\text{-N}$ and $\text{NO}_3\text{-N}$ were 125.1 mg/L and 11.7 mg/L, respectively. The effluent T-N concentration in intermittent aeration reactor was significantly decreased at HRT of 48hr, however, the effluent T-N concentration gradually increased at HRT of 24hr. The average T-N removal rate for HRT of 24hr was 57.4%.

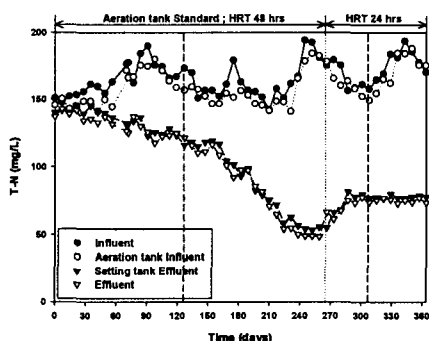


Figure 2. Variation of nitrogen in continuous treatment.

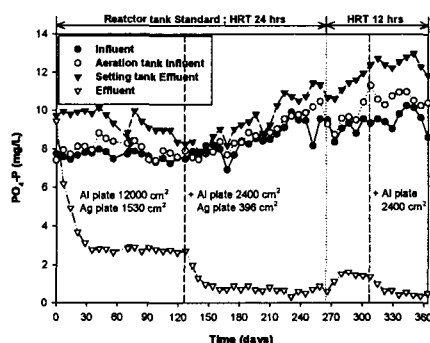


Figure 3. Variation of phosphorus in continuous treatment

Variation of phosphorus

Figure 3 shows the temporal variation of P concentration in the pilot plant for 365 days. At the beginning of the operation, Al plate and Ag plate with the surface area of 12,500 cm^2 and 1,800 cm^2 , respectively, were facilitated in the corrosion reactor. The HRT was maintained to 24 hr for 266 days and reduced to 12 hr after that. The initial P concentration of 9.5 mg/L was decreased to 2.75 mg/L and sustained to about 3mg/L for 126 days. To improve the water quality, Al plate of 2,400 cm^2 and Ag plate 396 cm^2 were supplemented and the average P concentration the in effluent was decreased to 0.96 mg/L for 140 days. As the reduced HRT of 12hr from 266 days caused the gradual increase of P concentration Al plate of 2,400 cm^2 was added again. After that the average P concentration in effluent was maintained to 0.5 mg/L by supplementing Al plate. As the result, it was found that even the high concentration of P in sewage, Al plate of 16,800 cm^2 and Ag plate of 1,926 cm^2 permitted the desirable P concentration under 1 mg/L.

Conclusion

The removal of P from sewage was demonstrated successfully on a continuous flow operation with electrochemical interaction (Localized Corrosion) between aluminum and silver

plate. The experiment results are summarized below:

1. SCOD concentration of effluent kept 16.6-5.4 mg/L.
2. Average removal rates of T-N and NH₃-N were 57.4% and 78.5%, respectively.
3. It was possible to remove P in sewage to under 1 mg/L with a short HRT of 12 hr using Al and Ag plate but often required additional Al plate supplement during the operation.

References

- CHEONG K H and JUNG O J : Phosphorus removal by aluminium ion generated with the pitting corrosion of aluminium. J of Korean Environmental Sciences Society 8(6) 705-710, 1999.
- KONDO M, YAMAMOTO J, ITADANI T, MATSUNAGA K and MORI T : Simultaneous removal of BOD, T-N and T-P using a contact aerator packed with used aluminium cans in the aeration tanks by circulated return system. Johkasou Kenkyu 8(2) 3-13, 1996.
- STANDARD METHODS : Standard Methods for the Examination of Water and Wastewater (16th edn.), American Public Health Association, Washington, DC, 1985.
- JONES D A : Principles and Prevention of Corrosion (2nd edn.). Prentice Hall, Inc, Toronto 168-171, 1996.