学 位 論 文 概 要

Biological Phosphorus Recovery From Municipal Wastewater Using UASB-DHS System

(UASB-DHS システムを用いた廃水からの生物学的リン回収)

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The goal of this research was to evaluate whether UASB-DHS system could be applicable for biological phosphorus recovery from real wastewater. The assessment of UASB-DHS system involved investigation on various aspects of biological phosphorus recovery process especially on the microbiology of Accumulibacter and the technical operation of pilot scale UASB-DHS system

Effect of phosphate concentration on Accumulibacter diversity (Chapter 3).

The results of the present study revealed that phosphate concentration is a significant factor influencing dominant PAOs (Accumulibacter) type and population size in enriched biomass. In which the phosphate removal activity of a bioreactor increasing with increasing phosphate concentration. However, it found that excessive phosphate levels inhibited Accumulibacter activity, that this inhibitory effect was greater for Type II. In addition, the affinity of Type II for phosphate was higher than that of Type I. Type IIA-B dominated at a phosphate concentration below 5 mg P L^{-1}, while Type IA was dominant at 50 and 500 mg P L^{-1}, and these patterns of enrichment could be explained by an inhibition kinetics model.

Phosphate recovery from sewage in a pilot scale UASB-DHS (Chapter 4)

The combined UASB-DHS system could achieve good organic removal efficiencies accounted for 87%, 84% and 90% for BOD, COD, and SS respectively. Under the optimum operational condition, the P-DHS reactor was able to concentrate phosphate up to 120 mg P L^{-1} in the recovery solution even from real sewage. Nevertheless, high phosphate concentration could not be easily maintained over the years. It started to worsen when the pH in F-DHS effluent dropped until below 6, but then slightly increased when the pH is being controlled in a range of 7-8. Moreover, High phosphate concentration only achieved temporally during spring ($16 < T < 20$°C) and further become deteriorated as temperature rise in summer ($T > 30$°C).

Troubleshooting the pilot scale operation of UASB-DHS reactor (Chapter 5)

The reactor problems include wastewater distribution, sewage pump, reactor hydraulic, and disfunction in some mechanical and electrical parts of the reactor. Other reactor operational problems like excess biomass in P-DHS that interfere the COD removal performance, and UASB biomass wash out that assumed causing pH drop in F-DHS effluent. Most of those mentioned problem have been tackled and could be controlled during the operation. However, an attempt to reveal the roots of problem behind the pH drop by UASB biomass washout have produced unsatisfied results.

Preferable saline environment for enrichment different type of Accumulibacter (Chapter 6)

DHS reactors inoculated with tidal flat sediment and activated sludge was applied for PAOs enrichment process. The biological phosphorus (BPR) activity of PAOs was investigated under different level of salinity environment including: fresh water, brackish water, and seawater. The result showed that BPR activity could be observed in all salinity level, which suggesting that PAOs was successfully enriched. On the other hand, some enriched PAOs still could perform a substantial BPR activity even when the operation conditions were switched reversibly into fresh or seawater, implying the existence of saline tolerant PAOs. Results of 16S rRNA and *ppk1* gene analysis revealed that Accumulibacter Type IIA, IIB, and IIC could be categorized as saline tolerant (halophile) since it always detected from the seawater, Type IB slightly halophile enriched from brackish water, while Type IA and ID are non saline tolerant as it not possible to be enriched under seawater.