The Inhibitory Effects of Free Nitrous Acid and Free Ammonia on the Aerobic Phosphorous Utilization Rate

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Abstract: Laboratory scale experiments were conducted to study the inhibitory effects of free ammonia (FA) and free nitrous acid (FNA) on the enhanced biological removal (EBPR) process. The aerobic phosphorous utilization rate (PUR) was found to be inhibited by 50% under a FNA concentration of approximately 0.0015 mg/L and was fully inhibited at the FNA concentration of 0.013 mg/L. FA was also found to inhibit phosphorous removal with an observed 50% inhibition of the aerobic PUR under the FA concentration of approximately 8 mg/L.

Keywords: Free Nitrous Acid; Free Ammonia; Phosphorous Utilization Rate

INTRODUCTION

The effective removal of phosphorus and nitrogen from wastewater is necessary to prevent eutrophication phenomena and the decline of water quality. During the processing of sewage sludge, reject water containing high nutrient concentrations is produced and it's recirculation to the inlet of the wastewater treatment plant (WWTP) may increase nutrient loading by up to 30%. In light of this, the side treatment of reject water has emerged as an attractive option over the past years. Due to the high ammonium nitrogen concentrations of the reject water, nitrogen removal via conventional nitrification/denitrification is implausible as free ammonia will most likely fully inhibit nitrite oxidizing bacteria (NOB). Still, nitrogen removal via nitritation/denitritation may be achieved with the added advantage of lower COD and oxygen requirements. As for the removal of phosphorous, the EBPR process is considered an economical and effective method and is widely applied in WWTPs. However the application of EBPR in the treatment of reject water may be problematic as nitrite, and more specifically FNA, has been reported to inhibit EBPR (Zhou et al., 2012). To a lesser extent, some studies have also reported on the inhibitory effects of FA on the EBPR process. Therefore the study of the inhibitory effects of FNA and FA on EBPR is crucial in determining the feasibility of this method in the treatment of reject water.

MATERIALS AND METHODS

A 10L laboratory-scale sequencing batch reactor (SBR) was used to cultivate polyphosphate accumulated organisms (PAOs)-enriched sludge. Once stable

conditions were achieved, a series of ex-situ batch experiments focused on the aerobic PUR were conducted on sludge retrieved from the SBR. During each experiment the removal of phosphorous under a specific nitrite or ammonium concentration was examined over a 4 hour aeration period following a 1 hour anaerobic phase, under stable pH. The COD source was acetic acid. The parameters measured were temperature, pH, DO, ORP, TSS, VSS, MLSS, MLVSS, PO_4-P, NH_4-N and NO_2-N. All analyses of SBR unit and batch assays were performed in accordance with Standard Methods(APHA, 2012).

RESULTS AND DISCUSSION

The inhibitory effect of various nitrite and ammonium concentrations on the aerobic PUR was studied for the pH values of 7, 7.5 and 8. Figure 1 illustrates the effects of FNA and FA on the observed inhibition of PUR.

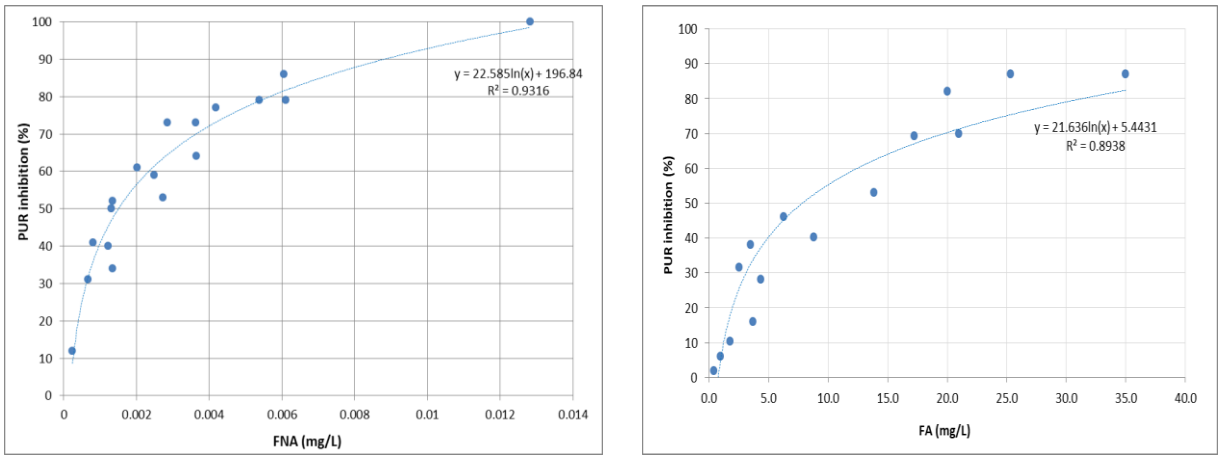

Figure 1.1 The effect of FNA and FA on PUR inhibition

PUR was inhibited by 50% under nitrite concentrations to the order of 10—50 mg/L under the pH values studied. The respective FNA concentration is around 1.5 μg/L. Yoshida et al. (2006) reported that 0.7 μg HNO_2-N/L inhibit non FNA-adapted PAO by 72% and FNA-adapted PAO by 20%. Thus, the results seem more consistent in describing the effects on a FNA-adapted biomass. The Phosphorus utilization rate is inhibited by 50% under a FA concentration of approximately 8 mg/L. Over the duration of the experiments the control's PUR varied from 3.8 to 10.9 mgP/grVSS.hr.

ACKNOWLEDGEMENTS

This work was carried out thanks to the funding from the European Union's Horizon 2020 research and innovation programme under the SMART-Plant Innovation Action (www.smart-plant.eu grant agreement No 690323).

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