Fate of Phosphorus Concentration in a SBR Designed for Nitrogen Removal

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Keywords: *Sequencing batch reactor, phosphorus, nitrification, denitrification.*

This work concerns the fate of phosphorus concentration during the operation of a SBR designed for nitrogen removal from a brewery wastewater with an anaerobic pre-treatment. The aim was to assess if an operational strategy directed towards nitrification-denitrification could be set up integrating simultaneously a biological phosphorus removal process.
The SBR was seeded with a grab sample of mixed liquor from a municipal activated sludge wastewater treatment plant and was operated over a 10 months period. In order to remove the nitrogen from the wastewater, six operational strategies were tested, as depicted in Table 1. Accordingly, Figure 1 presents, in each operational strategy, the soluble phosphorus concentration as determined in distinct periods of the SBR operating cycle.

Table 1. Experimental conditions.

Operating strategy	**1**	**2**	**3**	**4**	**5**	**6**
Reaction sequence	Aerobic/Anoxic			Anoxic/Aerobic/ /Anoxic		
Cycle time (Hrs)	36	24	24	8	8	8
Maximum working volume (L)	2.9	2.9	2.9	1.7	1.7	2.9
Filling ratio	0.6	0.6	0.6	0.3	0.3	0.2
HRT (days)	2.7	1.9	1.6	1.2	2.3	2.3

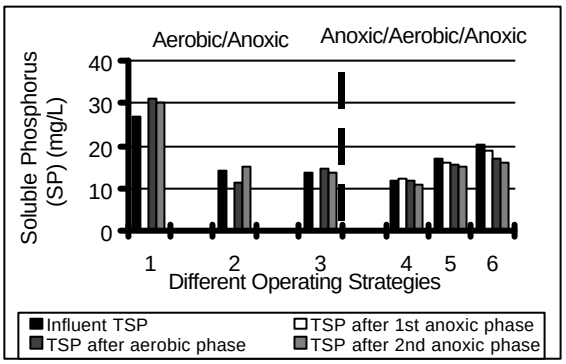

Figure 1. Soluble phosphorus concentration in distinct periods of the SBR operating cycle, using different operational strategies.

As can be seen in Figure 1, in all operational conditions that were tested phosphorus concentration in the liquid phase remained at a similar level. This result was expected since there was a lack of available organic carbon in the anaerobic effluent. Indeed, the ratio sCOD/TP was lower than 10, which is less than the minimum required according to reaction stoichiometry. Furthermore, is known that denitrifying microorganisms may outcompete phosphorus removal organisms regarding the carbon source. For that reason, the presence of a nitrate concentration above 6 $mgNO_3^-$-$N.L^{-1}$ was also detrimental because the available organic carbon was mostly utilised as an electron donor in the nitrate reduction, affecting the substrate available for polyP organisms. On the other hand, the reduction of the filling ratio from 0.6 to 0.3 and 0.2, and the reduction of the cycle time to 8 hours resulted in a slight decrease of the soluble phosphorus concentration.
The results clearly show that a SBR operation optimised for nitrogen removal can restrain the development of polyP organisms when the available carbon source is limited. Therefore, if a phosporus removal is necessary due to legal discharge guidelines, the SBR operation should incorporate “ab initio” the appropriate design.