Consequences of an occasional secondary phosphorus release on enhanced biological phosphorus removal

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Abstract

Laboratory experiments were performed to determine the conditions for an occasional secondary release of phosphates (release in the absence of any exogenous carbon input), and its consequences on the enhanced biological phosphorus removal process.

Phosphorus accumulating sludge from two extended aeration waste-water plants was subjected, in an Erlenmeyer flask, to successive sequences of anaerobiosis, with or without the addition of raw water, and of aeration. Secondary release occurred between 1 and 3 h after decanting the sludge. It would appear that this phenomenon is linked to the low nitrate concentration in the aqueous phase of sludge (NO_3-N < 0.5 mg/l). This release occurs at very low rates (0.2 and 0.4 mg P/g VSS-h) over an oxidation reduction potential range between +100 and +250 mV/NHE. This secondary release does not lead to any excess accumulation of phosphorus in the course of later aeration. It would not appear that the occasional secondary release affects the enhanced biological phosphorus removal process. On the one hand, the phosphorus released without COD is completely reabsorbed even after a long period of anaerobiosis (20 h), and, on the other hand, this secondary release has no effect on the further release in the presence of COD, nor on the good reabsorption of phosphorus.

Nomenclature

BOD - biochemical oxygen demand
COD - chemical oxygen demand
mV - millivolt
NHE - normal hydrogen electrode
ORP - oxidation reduction potential
p.e. - population equivalent
VSS - volatile suspended solids

Introduction

Enhanced biological phosphorus removalisbased on the alternation of the anaerobic-aeration phases. In the presence of COD, the sludge releases phosphates in the anaerobic phase, then, in the aeration phase reabsorbs a greater quantity than was initially released to give enhanced phosphorus uptake (Marais et al., 1982; Ekama and Marais, 1985; Wentzel et al., 1985; Meganck, 1987; Meganck and Faup, 1988; Somiya, 1988; Randall, 1991). As the quantity of phosphates reabsorbed in the aeration phase is proportional to the quantity of phosphates released in the anaerobic phase (Wentzel et al., 1985; Meganck, 1987; Wouters-Wasiak, 1994), the anaerobic phosphate release must be optimised.

For this purpose, certain authors (Paepcke, 1982; Kerdachi and Roberts, 1983; Gerber and Winter, 1984; Brodisch and Joyner, 1982) recommended a long anaerobic residence time to maximise the release. Other authors (Barnard, 1984; Tracy and Flammino, 1987; Nicholls et al., 1987) have indicated that long anaerobic residence times will lead to excessive phosphate release without uptake of organic matter and that this is detrimental to the biological dephosphatation efficiency, and accordingly recommending short anaerobic residence times (Barnard, 1974, 1976; Krichten et al.. 1987; Pitman, 1991).

The phosphorus release in the presence of exogenous COD has been well documented. In contrast the secondary phosphate release (release in the absence of any exogenous carbon input), has few bibliographical references, and still remains somewhat obscure. Such a release can occur in the clarifier or in an anaerobic zone with a low input of raw water, or with very long residence times, as is often the case overnight.

The purpose ofthis study was to determine (from batch tests on activated sludge from two urban sewage works) the conditions which stimulate phosphorus release in the absence of exogenous COD and its consequences on the biological dephosphatation efficiency.

Material and methods

Methodology

Two types of experiments were performed :

- Monitoring of a secondary phosphorus release from sludge collected at the end of an aeration cycle and left to decant in an Erlenmeyer flask to simulate residence in the clarifier. The medium was agitated one minute prior to the collection of each sample. This was followed by monitoring the reabsorption of the phosphates during subsequent aeration of the sludge.
- Monitoring of a secondary release, then of a release with the anaerobic input of exogenous carbon, and of the final reabsorption by aeration of the sludge. Two trials were performed concomiiantly with the same sludge, collected at the same time. In the first Erlenmeyer flask, the sludge was left to decant for 4 h so as to produce a "secondary" phosphorus release. The raw water was then added, and a second 3 h release period started, but in the presence of added COD. The aerator was then started. In the second Erlenmeyer flask, for the first 4 h the sludge was subjected to continuous agitation and aeration to prevent any phosphorus release. The raw water was then added, the rest of the experiment being identical to the first.

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