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Influence of phosphorus precipitation on permeability and soluble microbial product concentration in a membrane bioreactor

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HIGHLIGHTS

- MBR pilot-plant with flat sheet membrane fed by raw municipal wastewater was monitored for 2 years.
- Impact of coagulant dosing on flux, nutrient removal, SMP and filtration cake was evaluated.
- Coagulant dosing resulted in a significant decline in carbohydrates and protein concentrations.
- High PO_4-P, COD and NH_4-N removal efficiency was achieved over periods with coagulant dosing.
- The main contributors to inorganic fouling were compounds of elements Ca, Si and Fe.

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ABSTRACT

Many articles have been published on coagulant dosing in membrane bioreactors, though few have been long-term studies examining the treatment of real wastewater. This study summarises the results of a membrane bioreactor pilot-plant (flat sheet membrane, nominal pore size 0.03 μm) that treated real municipal wastewater for two-years. Both influence of phosphorus precipitation by ferric sulphate on membrane permeability (flux decrease) and soluble microbial product concentration (especially on carbohydrates and proteins) were monitored. Flux decrease over work cycles lasting several months without phosphorus precipitation were compared to two periods with precipitation. X-ray elemental diffractometry of the filtration cake showed differences in the main contributors to inorganic fouling, with decreases in Ca and Si during operation with coagulant addition, and an increase in Fe.

1. Introduction

A membrane bioreactor (MBR) includes a membrane separation process into the standard activated sludge process. Inclusion of this process eliminates the weakest link in activated sludge wastewater treatment, making effluent quality independent of biomass settling characteristics. MBRs have several important advantages over conventional activated sludge systems, including high effluent quality, ease of operation and high bacteria removal efficiency.

MBR technology currently faces a number of research and development challenges, however, including membrane fouling, high membrane cost and the need for pretreatment. Membrane fouling increases operational costs and shortens membrane lifetime (Yang et al., 2006). Further, as the MBR mixed liquor includes both living organisms and their metabolites, the fouling is more complex than that of a simple membrane separation processes (Bae and Tak, 2005). Studies aimed at minimising membrane fouling can be divided into several groups: (i) those focused on the characteristics of the mixed liquor that affect membrane fouling, including its morphological characteristics (Lee et al., 2003; Gómez

Abbreviations: C, carbohydrates; COD, chemical oxygen demand; EPS, extracellular polymeric substances; F/M, food to microorganisms ratio; HS, humic substances; IR, internal recycle; L_p, permeability; MLSS, mixed liquor suspended solids; MLVSS, mixed liquor volatile suspended solids; MBR, membrane bioreactor; NH_4-N, ammonia nitrogen; NO_3-N, nitrate nitrogen; P, proteins; PES, polyethersulphon; PFS, polymeric ferric sulphate; PFC, polymeric ferric chloride; PO_4-P, phosphate phosphorus; SMP, soluble microbial products; SRT, sludge retention time; $Y_{obs.}$, observed biomass yield; $W_{org.}$, proportion of organic fraction; WWTP, wastewater treatment plant.

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