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Phosphorus recovery as calcium phosphate by a pellet reactor pre-treating domestic wastewater before entering a constructed wetland

Rugaika, A. M.

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Phosphorus recovery as calcium phosphate by a pellet reactor pre-treating domestic wastewater before entering a constructed wetland

A. M. Rugaika, R. Van Deun, K. N. Njau and B. Van der Bruggen

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Abstract

Horizontal subsurface flow constructed wetlands poorly remove phosphorus from wastewater, resulting in phosphorus levels above the required limits in constructed wetland effluents. Since a pellet reactor can recover phosphorus through calcium phosphate precipitation/crystallization, using it as a pre-treatment system prior to horizontal subsurface flow constructed wetland could be a sustainable solution for phosphate scarcity. The operational conditions required for phosphate recovery in a pellet reactor were evaluated and compared with the Visual MINTEQ version 3.0 with the aim of checking its suitability to simulate the pellet reactor removal efficiencies. Such conditions include the initial phosphate concentration, pH, [Ca]/[P] molar ratio and hydraulic loading rate. The results showed an increase in phosphate removal efficiency with increased initial phosphate concentration, pH, [Ca]/[P] molar ratio and decreased hydraulic loading rate. However, the model calculation gave higher removal efficiencies than experimental results due to its inability to take into account the system kinetics which is an important component in pellet reactor operation and its assumption that precipitation reactions take place at constant pH. The effects of carbonate on phosphate precipitation were also investigated, and the removal efficiency of 61.9% without carbonate was improved to 63.2, 64.3 and 66.4% with a carbonate concentration of 0.25 mM, 0.5 mM and 2 mM, respectively, at pH 9, initial phosphate concentration of 1 mM, [Ca]/[P] molar ratio of 1.5 and hydraulic loading rate of 57 m/h. Thus, the presence of carbonates in domestic wastewater is advantageous as it promotes calcium phosphate precipitation in a pellet reactor.

Keywords

Horizontal subsurface flow constructed wetland, Phosphorus, Removal efficiency, Saturation index, Operational condition