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# Optimization of struvite crystallization protocol for pretreating the swine wastewater and its impact on subsequent anaerobic biodegradation of pollutants

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ABSTRACT

Higher contents of $NH_4^+$ and SS in wastewater hamper the anaerobic digestion; necessitating its pretreatment to reduce them. This study reveals optimization of struvite/MAP precipitation protocol followed by anaerobic digestion of pretreated swine wastewater for pollutants removal. Levels of different treatments: stirring speeds, 400 and 160 rpm; pH values, 9.0, 9.5, 10.0, 10.5, 11.0 and 11.5; and P:Mg:N ratios, 1:1:1.2, 1:1:1.7, 1:1:2.2, 1:1:2.7, 1:1:4.0 and 1:1:5.0 were evaluated for MAP crystallization. Among various combinations, protocol comprising of initial 10 min stirring at 400 rpm followed by 160 rpm for 30 min, pH 10.0, and P:Mg:N ratio 1:1:1.2 rendered the best removal efficiency for $NH_4^+$, $PO_4^{3-}$, COD, TC and TOC. Subsequent anaerobic biodegradation revealed superiority of MAP supernatant over raw swine wastewater for methane yield and $NH_4^+$-N, $PO_4^{3-}$-P, COD, TC and TOC removals. It suggests that struvite precipitation as pretreatment to anaerobic digestion is highly effective and advantageous in wastewater treatment.



## 1. Introduction

Amount of agricultural non-point source pollutants originating principally from livestock farming is quite outstanding; contributing 96% COD, 38% total nitrogen (TN), 56% total phosphorus (TP) and large emission of greenhouse gases (Qiao et al., 2010; MEP, 2010). Traditional approach for treating the livestock wastes mostly relies on anaerobic fermentation with methane production due to low cost and energy saving (Labatut et al., 2011; Fantozzi and Buratti, 2011). Nevertheless, there are certain serious issues, e.g., longer hydraulic retention time ($\geqslant$5 days) that lowers down treatment efficiency (Masse et al., 2010), and higher contents of suspended solids (SS), lactic acid and $NH_4^+$-N that inhibit methane production (Xu et al., 2011). Further, anaerobic process plays little role in removing the $NH_4^+$-N, which often exceeds to 1000 mg $L^{-1}$ in the effluent (Rico et al., 2011). Hence, an apposite pretreatment protocol for separating the solids from liquid, and lowering of $NH_4^+$-N concentration is crucial in the success of anaerobic technology (Bernet and Béline, 2009). Addition of a starch based flocculant to integrated fluidized bed bioreactor as pretreatment of submerged microfiltration hybrid system could achieve higher organic and nutrient (total N and P) removal from the sewage effluent (Xing et al., 2012). However, use of polyacrylamides (PAM) as flocculant to pretreat the swine wastewater could not remove $NH_3$, while there was slight removal of P (González-Fernández et al., 2008). Therefore, in order to establish the anaerobic process very well and simultaneously to control $NH_3$ in the influent, it is crucial to find other protocols of pretreatment (Chen et al., 2012).

Currently, magnesium ammonium phosphate (MAP) precipitation technology of recycling N and P from all kinds of wastewater is receiving focus by the scientists and industrialists (Etter et al., 2011; Li et al., 2011). The MAP hexahydrate ($MgNH_4PO_4{\cdot}6H_2O$) called struvite, is a white inorganic crystalline mineral, density 1.71 g $cm^{-3}$, soluble in acid not in water, alkali and ethanol, and considered as a slow release fertilizer (Le Corre et al., 2009). Yetilmezsoy and Sapci-Zengin (2009) studied the feasibility of using MAP precipitation for removing N and P from the effluent of anaerobic process, tested the fertilizer efficiency of struvite, and got satisfactory results. Nonetheless, this technology prevails mostly for treating the effluent of anaerobic process (Pastor et al., 2010). Only a few scientists reported the MAP precipitation as pretreatment of the raw wastewater, even no detailed reports for the influence on the subsequent process (Ryu and Lee, 2010; Li et al., 2011). Particularly, there is no information regarding impact of MAP precipitation on the removal of carbon contents (TC and TOC) from swine wastewater.

Present study comprised of several batch experiments to determine the effectiveness of MAP precipitation as pretreatment

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