

# PRODUCTION OF STRUVITE AS AN ALTERNATIVE TO REDUCE THE CONTENT OF NITROGEN AND PHOSPHORUS FROM SWINE WASTEWATER

E.L. FOLETTO<sup>†\*</sup>, W.R.B. dos SANTOS<sup>†</sup>, S.L. JAHN<sup>†</sup>, M.A. MAZUTTI<sup>†</sup>,  
R. HOFFMANN<sup>‡</sup>, A. CANCELIER<sup>†</sup> and E. MÜLLER<sup>‡</sup>

<sup>†</sup> Department of Chemical Engineering,

<sup>‡</sup> Department of Chemistry, Federal University of Santa Maria, Santa Maria-RS, 97105-900, Brazil.

\* E-mail: efoletto@gmail.com

**Abstract** - This work is focused on the production of struvite as an alternative to reduce the concentration of phosphorus and nitrogen from swine wastewater. The effect of Mg source (MgO and MgCl<sub>2</sub>·6H<sub>2</sub>O) and pH on nitrogen and phosphorus removal was investigated. From the results was seen that N and P were efficiently removed from swine wastewater. Data of X-ray diffraction (XRD) revealed that the production of struvite in the crystalline form is dependent of pH, which was obtained only in the runs carried out at pH 9.5, independent of Mg source employed. The production of struvite showed to be effective for adding value to swine wastewater.

**Keywords** - Struvite, wastewater, nitrogen, phosphorous.

## I. INTRODUCTION

Swine wastewater contains high concentration of phosphorus (P) and nitrogen (N), and the removal of these nutrients from wastewater is important to maintain the water quality, avoiding the eutrophication (Haddrill *et al.*, 1983; O'Hare *et al.*, 2010). Ammonia in swine wastewater is usually removed by biological methods such as autotrophic nitrification (conversion of NH<sub>4</sub><sup>+</sup> to NO<sub>3</sub><sup>-</sup>) (Furtado *et al.*, 1998; Iliuta *et al.*, 2002; Queiroz *et al.*, 2011) and heterotrophic denitrification (conversion of NO<sub>3</sub><sup>-</sup> to gaseous nitrogen) (Reginatto *et al.*, 2005; Garbossa *et al.*, 2005; Canto *et al.*, 2008). However, the struvite precipitation method is interesting because it simultaneously removes and recovers P and N from wastewater (Liu *et al.*, 2011). Struvite is a crystalline solid with equal molar concentrations of magnesium, ammonium and phosphorus (MgNH<sub>4</sub>PO<sub>4</sub>·6H<sub>2</sub>O). The formation of struvite normally occurs in alkaline medium. The optimal pH value for struvite crystallization was considered to be 8.0-11.0 (Laridi *et al.*, 2005; Hanhoun *et al.*, 2011). Struvite is used as a slow-release fertilizer (Bridger *et al.*, 1962). Therefore, the production of struvite is an alternative for adding value to swine wastewater, besides to decrease the impact caused by its disposal into the environment (Nelson *et al.*, 2003).

Struvite has been obtained from industrial wastewater (Diwani *et al.*, 2007), leather tanning wastewater (Tunay *et al.*, 1997), waste sludge (Jaffer *et*

*al.*, 2002), poultry wastewater (Yetilmezsoy and Zengin, 2009), swine wastewater (Song *et al.*, 2011; Rahman *et al.*, 2011) and municipal landfill leachate (Kim *et al.*, 2007). Although there are many works in literature reporting the phosphorus and nitrogen removal by struvite precipitation method from swine, it is difficult to found studies reporting/comparing different sources of Mg on the formation of struvite (Li *et al.*, 1999; Li and Zhao, 2003; Demirer *et al.*, 2005; Huang *et al.*, 2011), since the characteristic of material formed as well as the recovering efficiency can be influenced by this variable.

In this sense, the effect of the magnesium source and pH on the removal of phosphorus and nitrogen by struvite crystallization method from swine wastewater was investigated. The struvite obtained was analyzed by X-ray diffraction (XRD) and infrared spectroscopy (IR).

## II. METHODS

The swine wastewater sample used in this work was collected from a local farm. The sample was stored and maintained at 4°C until analysis. The sample was centrifuged at 3000 rpm for 15 min to separate the solids, and the supernatant was used for chemical analysis. The characteristics of the swine wastewater are summarized in Table 1.

The system consisted of a glass-batch reactor (Jar test) (11x11x17 cm) with a total volume of 2.0 L, constituted of a paddle of diameter 7.5 cm and height of 2.5 cm. The working volume of the reactor was 1.0 L. The reactor was operated under agitation of 200 rpm, at room temperature (25°C). Analytical grade chemicals (MgO, MgCl<sub>2</sub>·6H<sub>2</sub>O, H<sub>3</sub>PO<sub>4</sub> (85%), KH<sub>2</sub>PO<sub>4</sub> and NaOH) were used in the experiments. It was evaluated the synthesis of struvite using two different Mg sources (MgO and MgCl<sub>2</sub>·6H<sub>2</sub>O) and at two different pH (9.0 and 9.5). In addition, two combinations of chemicals, MgO + H<sub>3</sub>PO<sub>4</sub> (4M) and MgCl<sub>2</sub>·6H<sub>2</sub>O + KH<sub>2</sub>PO<sub>4</sub>, were used in the experiments. The pH of solutions was adjusted by adding NaOH 4M. The amounts of MgO + H<sub>3</sub>PO<sub>4</sub> (4M) and MgCl<sub>2</sub>·6H<sub>2</sub>O+KH<sub>2</sub>PO<sub>4</sub> used in the tests were calculated according to the concentration of nitrogen and phosphorous of the swine wastewater sample (see Table 1) in a molar ratio of 1:1:1 (Mg<sup>+2</sup>:NH<sub>4</sub><sup>+</sup>:PO<sub>4</sub><sup>-3</sup>). All runs were carried out by 10 min, and then kept at rest for 30 min. The suspensions were filtered and the