



## USE OF MINERALS FORMED BY CHEMICAL PRECIPITATION IN LANDFILL LEACHATE SAMPLES AS AN AGRICULTURAL FERTILIZER

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### Abstract

The production of struvite is an option for macronutrients removal from leaching sanitary samples. In this work a mineral fertilizer known as struvite, as well as the possible formation of other minerals, was produced by chemical precipitation of leaching sanitary landfill samples. The best results yielding above 95% was obtained with reagent excess and a pH of 9.5. The struvite mineral could be applied as fertilizer in agriculture as an alternative for commercial fertilizers.

### Key words:

Struvite, fertilizer, agriculture, leachate, chemical precipitation.

### Introduction

The treatment of leachate from landfills with chemical precipitation a mineral ( $MgNH_4PO_4 \cdot 6H_2O$  - known as struvite) that contains macronutrients such as magnesium (Mg), nitrogen (N) and phosphorus (P) in its molecular structure and has the potential to be used in agriculture as a chemical fertilizer [1]. In this context, the present work evaluated the formation of minerals formed in the chemical precipitation of ammonia in landfill leachate by X-ray diffraction (XRD), as well as the possible use as agricultural fertilizer. For this, a leachate sample was collected from a landfill pilot system within the Laboratory of Prototypes Applied to the Treatment of Water and Effluents (LabPro). Then, the choice of the best sources of phosphate ions was established, with magnesium ions always coming from the addition of magnesium oxide (MgO). In this step it was determined that the best reagents among the tested were: phosphoric acid 85% ( $H_3PO_4$ ), potassium phosphate dibasic ( $KH_2PO_4$ ) and monobasic ( $K_2HPO_4$ ). The analysis of the precipitated material was performed by X-ray diffraction and scanning electron microscopy (SEM) coupled with dispersive energy spectroscopy (EDS).

### Results and Discussion

The precipitation pH (based on the removal of nitrogen and the mass of precipitate) was between 9 and 10. The influence of the addition of both phosphate and magnesium excess on the chemical precipitation was evaluated according to the proportions presented in Table 1.

Table 1. Efficiency of treatments employed

Reagents	Proportion	Mass of precipitate (g)	Removal of N-NH <sub>3</sub> (%)
MgO/H <sub>3</sub> PO <sub>4</sub>	1:1	1.655	80
	2:1.5	3.299	98
	2:2	3.350	98
MgO/KH <sub>2</sub> PO <sub>4</sub>	1:1	1.642	86
	2:1.5	2.983	98
	2:2	3.124	98
MgO/K <sub>2</sub> HPO <sub>4</sub>	1:1	1.514	67
	2:1.5	2.814	91
	2:2	3.080	90

The excess employed is efficient in the removal of the residual ammoniacal nitrogen because it is displaced in the precipitation equilibrium towards the formation of the product (Table 1). Removals above 90% were found for  $H_3PO_4$ ,  $KH_2PO_4$  and  $K_2HPO_4$ . The ideal combination ratio

was 2:1.5 (MgO/PO<sub>4</sub>). Adding more phosphate does not significantly improve the percentage of removal achieved (Table 1).

In the various treatment combinations evaluated, struvite was observed. However, in the SEM analysis coupled with EDS, it was verified the presence of elements such as calcium (Ca), potassium (K) and chlorine (Cl) (Figure 1A e B).

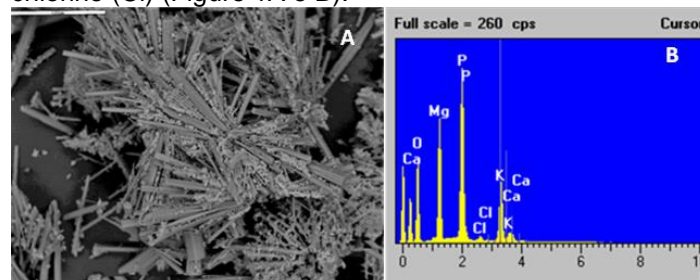


Figure 1. Backscattered electron image (A) Solid formed in the chemical precipitation with dibasic potassium phosphate; (B) Dispersive energy spectrum

### Conclusions

It is possible that other minerals, other than struvite, precipitated when the chemical treatment was applied. The presence of ions such as Ca and Cl indicates the formation of other compounds during precipitation.

The treatment performed in stoichiometric proportions was not enough to effectively remove ammonia present in the leachate and can be used as a pre-treatment step - removals around 75% are achieved in this proportion.

With excess of both Mg and P the efficiency of removal of ammonia is above 95%.

### Acknowledgement

CNPQ for promoting this research, Jerusa Schneider for guidance, Thiago Neves and Dailto Silva for collaboration in the development of activities.

\*RENOU, S.; GIVAUDANA, J.G.; POULAINA, S.; DIRASSOUYANB, F.; MOULINC, P. Landfill leachate treatment: Review and opportunity. Journal of Hazardous Materials, 150, 3, p. 468-493, 2008.