RECOVERY OF AMMONIUM, PHOSPHATE AND MAGNESIUM IONS FROM STRUVITE

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1. Introduction

This research project investigated the recovery of ammonium, phosphate and magnesium ions from struvite. Struvite forms in environments with a high percentage of decomposing organic matter, primarily wastewater treatment plants (WWTPs) that utilise anaerobic digestion. Firstly, an explorative investigation into the solubility of struvite in carbonic acid was undertaken. This was followed by experiments which utilised the recovered ions in the formation of fertilisers, the synthesis of ammonium bentonite and magnesium iron layered double hydroxides (LDHs).

2. Why Struvite?

- Source of ammonium ions
- Transforming waste products into useful materials
- Struvite formation decreases efficiency of WWTPs
- Source of magnesium 2+ ions
- Source of phosphate ions

3. Methodology and Materials

Experiment 1 and its counterparts were an initial explorative study into the solubility of struvite in carbonic acid. Carbonic acid was chosen as the main solvent to explore as carbon dioxide is one of the main gases produced as a product of anaerobic digestion in WWTPs.

Experiment 2 endeavoured to separate the ammonium cations from struvite dissolved in a 1 M HCl solution by reacting the solution with sodium bentonite, a clay mineral, potentially forming ammonium bentonite, a multi-purpose clay and fertiliser.

Experiment 3 aimed to form a magnesium, iron LDH with the phosphate ions contained in the layered double hydroxide lattice structure.

4. Results

The dissolution of struvite in carbonic acid was successful. Figure 2 and 3 depict synthetic struvite crystals, by comparison, Figure 4 is the carbonated struvite sample which elude to the dissolution of struvite and its reprecipitation as smaller struvite crystals.

The product formed in Experiment 2 was confirmed as ammonium bentonite: the interlayer spacing of the bentonite layers decreasing in comparison to the product, the new peak at 11.7° 2θ and the lack of a peak with intensity 22.04° 2θ seen in the XRD, seen in figure 1.

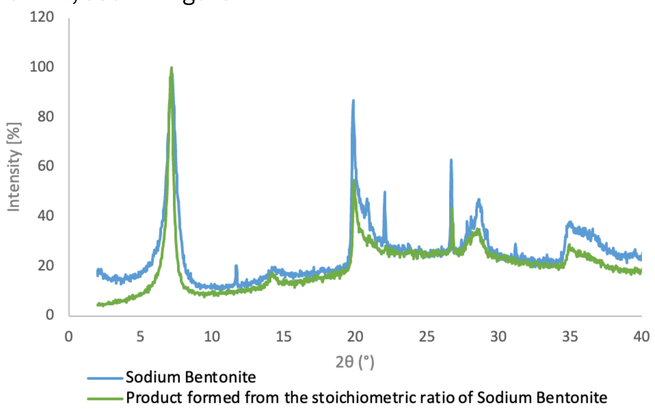

Figure 1. X-ray diffraction of sodium bentonite versus product from exp 2

The co-precipitation reaction (experiment 3) formed a deep orange powder. The XRD analysis of the co-precipitation product was analogous to the XRD analysis of sodium chloride. This means that as well as the co-precipitation product, sodium chloride crystallised and was picked up by the XRD rather than the MgFeLDH. Further adjustment of the methodology for the synthesis of MgFeLDH's and the washing technique utilised is required to increase product yield and purity.

5. Scanning Electron Microscope (SEM) Images

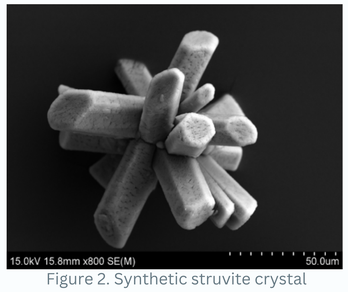

Figure 2. Synthetic struvite crystal

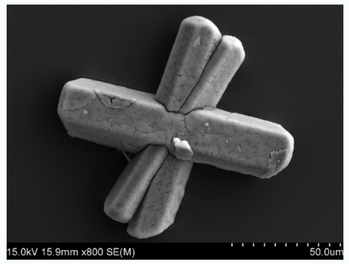

Figure 3. Synthetic struvite crystal

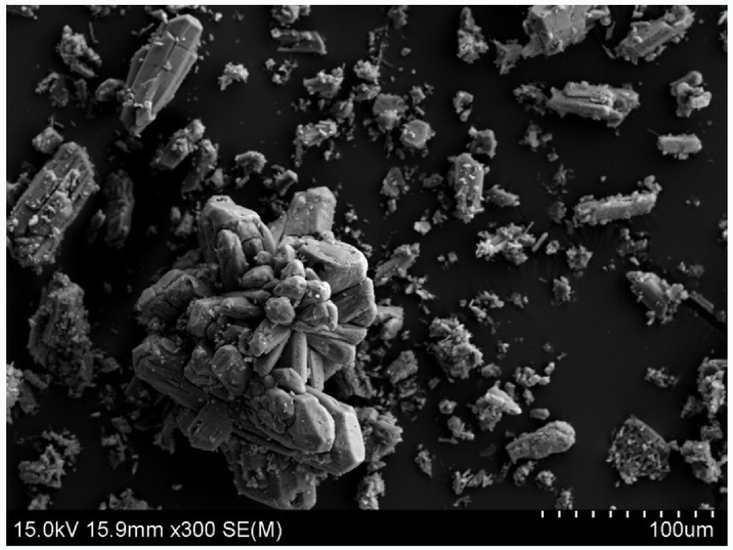

Figure 5. Struvite crystals after dissolution in carbonic acid

6. Futher Research

1. Optimisation of the methodology and materials for the dissolution reaction of struvite in carbonic acid.
2. Implementation processes of these methodologies in WWTPs in collaboration with chemical Engineers
3. An investigation of how the present legislation is affecting the implementation of waste repurposing schemes
4. An exploration of the supply chain processes to redistribute the recovered ions to other sectors and industries.
5. Exploring different uses for the recovered ions notwithstanding their significant use in the fertiliser industry.

Acknowledgements & QR Code to Research Report

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