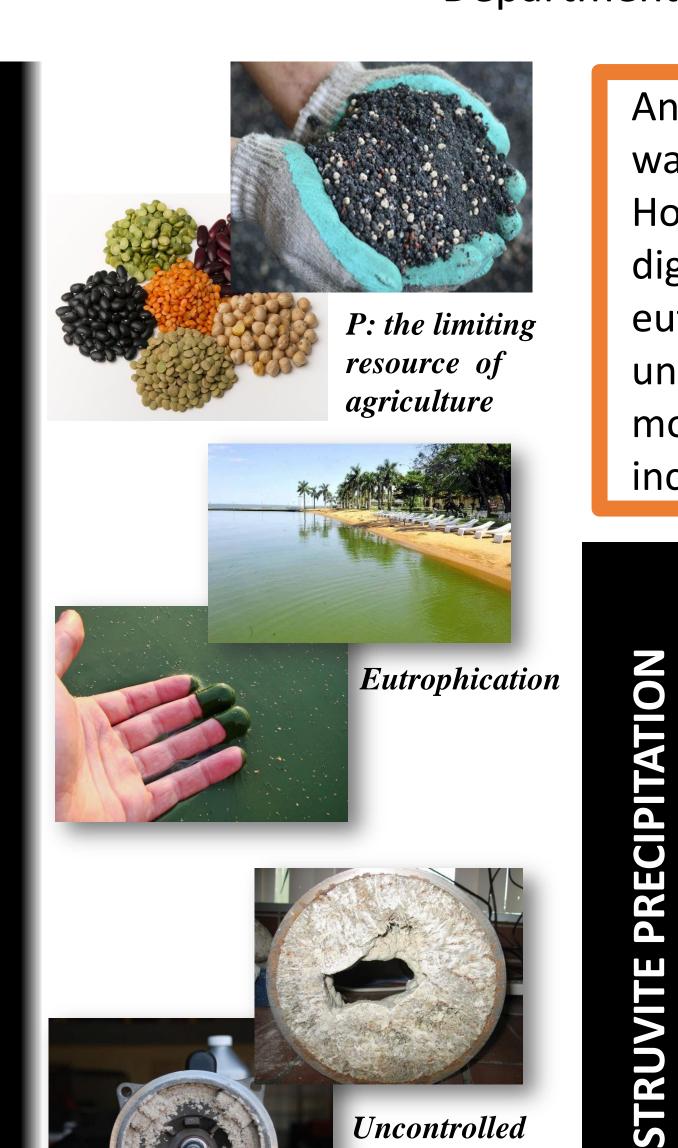


PROBLEM

A thermochemical model approach for struvite precipitation in anaerobically digested sludge dewatering liquid

C. Santiviago⁽¹⁾⁻⁽²⁾, L.I. Borges⁽²⁾, I. López⁽²⁾

(1) Department of Industrial Applications, Chemistry Faculty, Universidad Nacional de Asunción - Paraguay - csantiviago@qui.una.py (2) Department of Reactor Engineering, Faculty of Engineering, Universidad de la República - Uruguay



struvite

deposition

Anaerobic treatment of agroindustrial wastes -like slaughterhouse wastewater- is a powerfull technology to remove the organic content. However the nutrient content of the treated wastewater or the anaerobically digested dewatering liquid remains almost unchanged. Excess of nutrients may cause eutrophication of aquatic systems, difficulties for water supply and crystalline deposits by uncontrolled deposition of phosphate salts in the treatment systems. Nutrient recovery has become more important in recent years as demand increases. Recovery is particularly important for P, as it is becoming an increasingly limited resource.

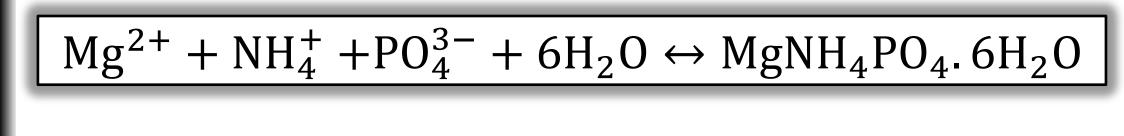
NH₄Cl

Mg/P = 1.0

 $N/P = 2.0 \text{ and } 8.3 | MgCl_2.6H_2O |$

"Struvite precipitation is a promising alternative to remove and recover P from nutrient rich wastewater, like anaerobically digested sludge dewatering liquid"

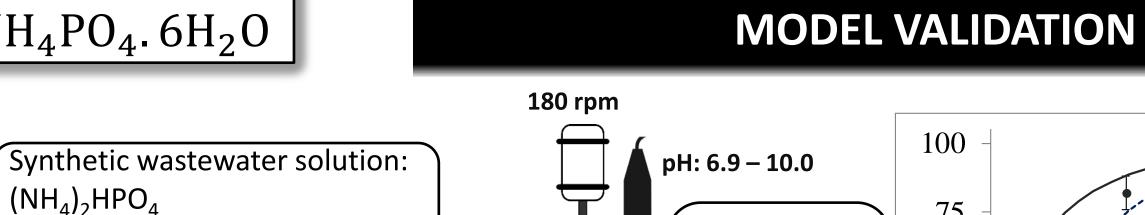
DISCUSSION

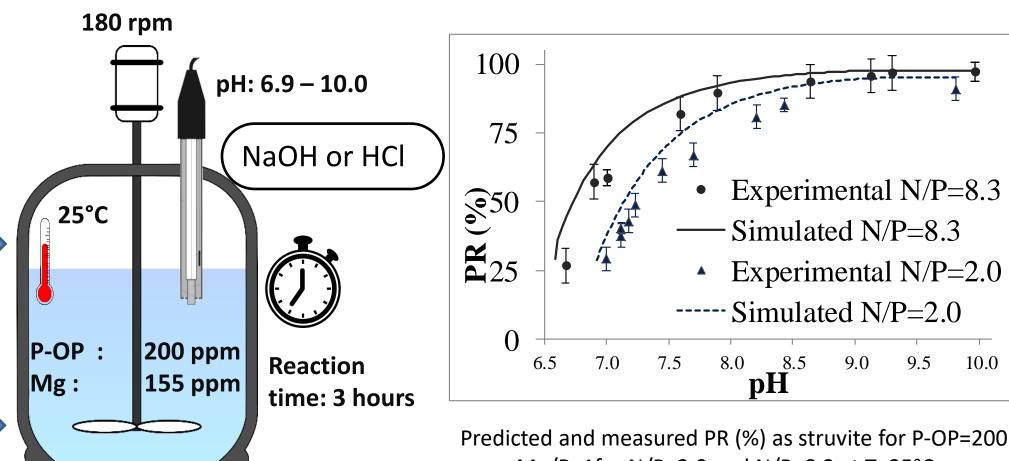


 $pK_{PS} = 13.26$

Ionization fraction:

$$lpha_{ion^{ch \, {
m arg} \, e}} = rac{C_{free_ion}}{C_{T,free+combined}}$$





ppm, Mg/P=1for N/P=2.0 and N/P=8.3 at T=25°C. 3000 2400 **—**pH=10.0

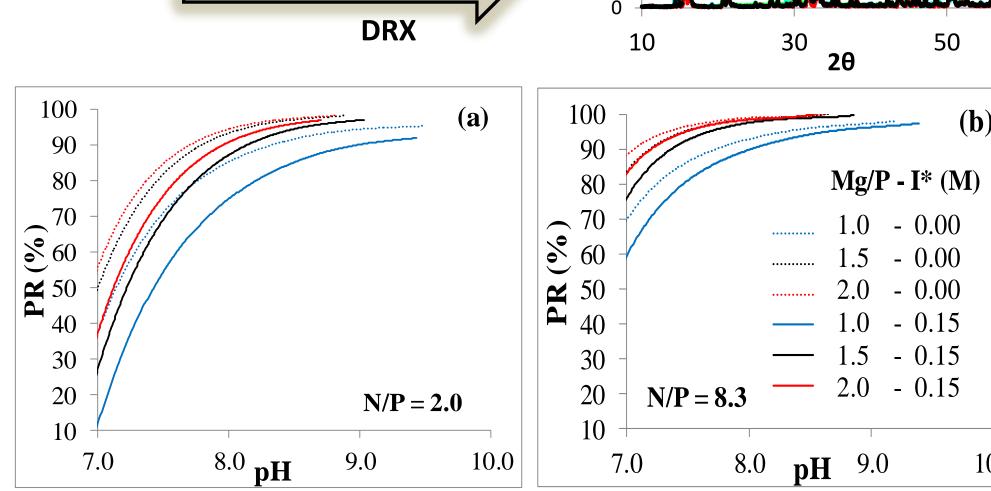
1200 1200

600

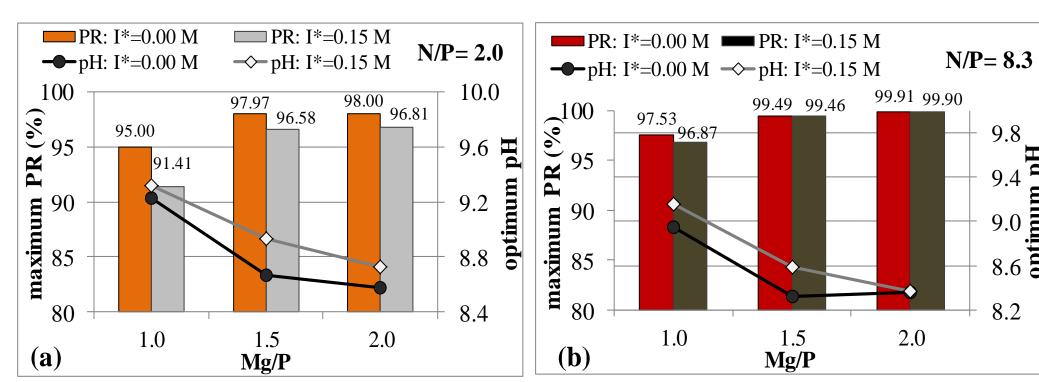
→pH=7.6

→pH=7.3

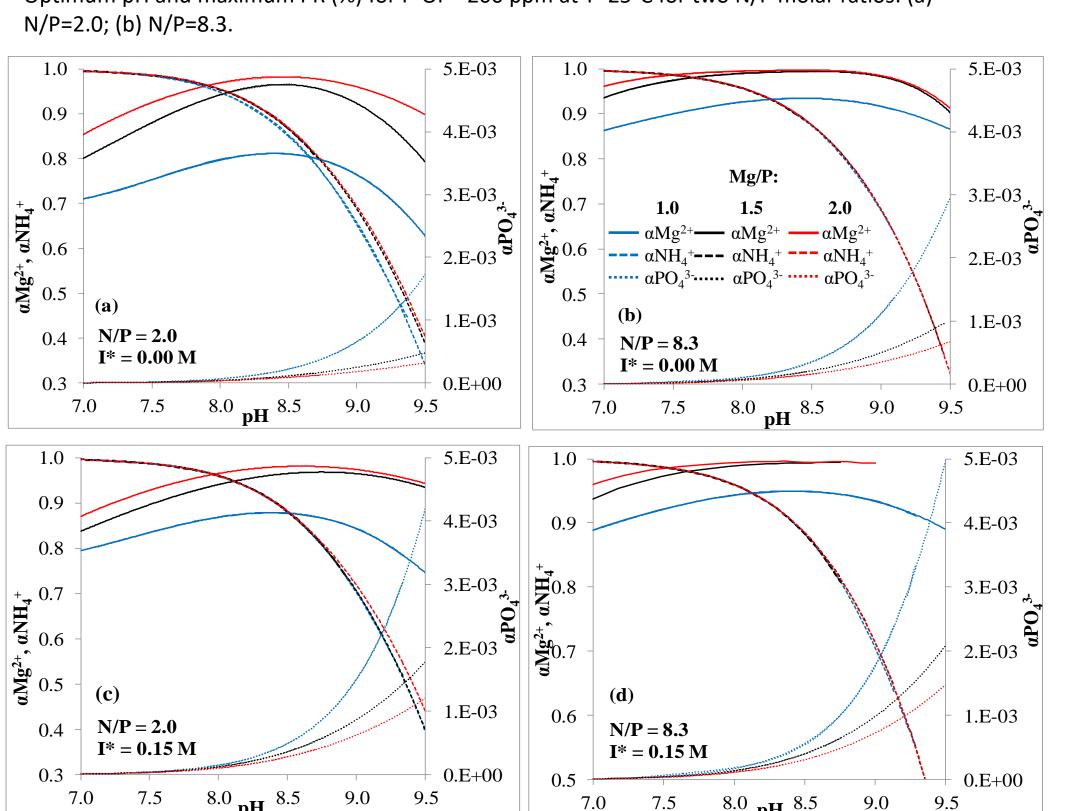
→pH=8.5



Influence of molar ratios Mg/P (1.0, 1.5 and 2.0), pH (7.0–10.0) and I* (0.00 M, 0.15 M) on the PR for P-OP= 200 ppm at T=25°C for (a) N/P=2.0; (b) N/P=8.3.



Optimum pH and maximum PR (%) for P-OP =200 ppm at T=25°C for two N/P molar ratios: (a)



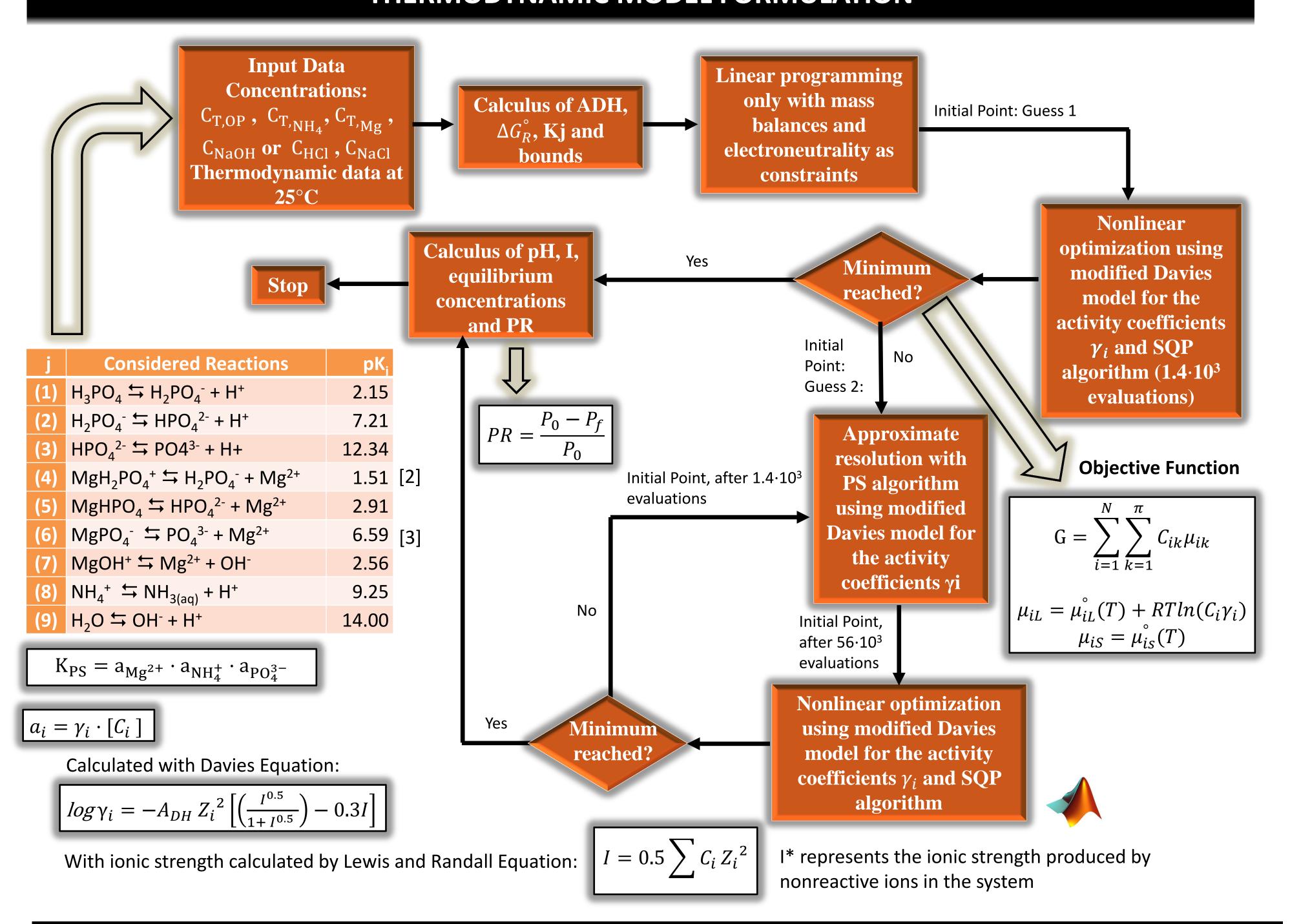
Ionization fraction at different equilibrium pH and Mg/P molar ratios for P-OP=200 ppm and T=25°C with (a) N/P=2.0, I*=0.00 M; (b) N/P=8.3, I*=0.00 M; (c) N/P=2.0, I*=0.15 M; (d) N/P=8.3, I*=0.15 M.

Initially 1 pH produces 1 PR likely due to 1 of free PO₄ as a consequence of the successive deprotonation of HPO_4^{2-} , $H_2PO_4^{-}$ and H_3PO_4 . This 1 in PR is **counteracted** by **!** in the free NH₄+ which is transformed to NH₃.

1 Mg/P **1**PR, due to a **1** of free Mg²⁺. At higher pH, the **1** in PR is less sensitive to Mg/P, because the negative effect produced by ↓ NH₄⁺ prevails.

counteract the 1 in γ of struvite components produced by the high charges Z from these ions.

THERMODYNAMIC MODEL FORMULATION



CONCLUSIONS

- \triangleright PR decreases with the N-NH₄⁺ concentration. The relative percentage reduction is more pronounced at low pH, low Mg/P and high I*.
- > The increase in I* produces a decrease in the achieved PR for the same operational conditions. This **negative impact** is **more relevant** at **low pH**, **N/P** and **Mg/P** molar ratios.
- > For the conditions considered typical of anaerobically digested sludge dewatering liquid (N-NH₄⁺= 750 ppm and P-OP=200 ppm with I*=0.15 M) the highest relative improve in PR respect to Mg/P stoichiometric relations is achieved at a molar ratio Mg/P=1.5. The maximum **PR obtained** was **99.46%** at **pH=8.56**.

ACKNOWLEDGEMENTS

REFERENCES

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> A hybrid optimization procedure combining

from a wastewater stream.

at lower N/P and higher I*.

Pattern Search (PS) + Sequential Quadratic

Programming (SQP) algorithm has been developed

to predict the potential P-OP removal as struvite

Stoichiometric excess of Mg improve the achieved

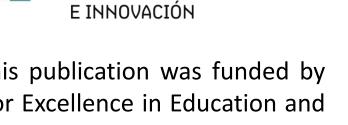
PR although this improvement is least significant

produced by increase in Mg/P is more significant

as Mg/P increases. The positive impact in PR

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