Nutrients recovery from toilet wastewater by struvite precipitation: Conditions influencing the process

By

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Order of Presentation

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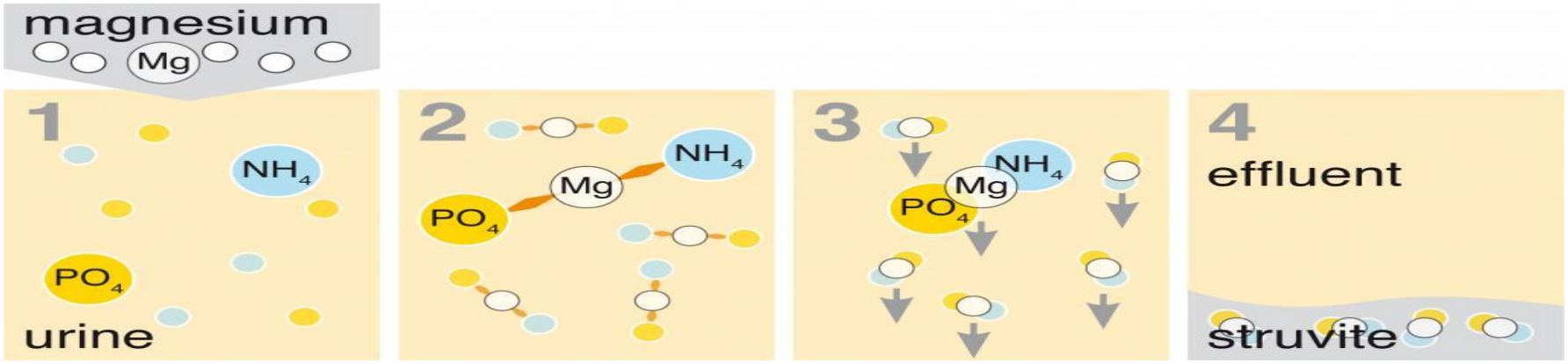
Introduction

- Industrialization and urbanization exerted pressure on depleting aqueous resources in different parts of the world
- Nutrients discharges to natural waters have contributed to an increase in eutrophication problems
- Nitrogen (N) and phosphorus (P): primary source of environmental eutrophication in surface waters
- The known reserves of phosphate rocks are limited
- 60 to 70 years the half the world's current economic phosphate resources will have been finished (Driver et al. 1999)
- 91/271CEE Directive about urban wastewater treatments
- Technologies for recovering N& P out of wastewater streams
- Struvite ($MgNH_4PO_4$-$6H_2O$) is a PO_4^{3-} and NH_4^+ fertilizer



- Toilet wastewater has been nowadays looked at more as a resource than as a waste
- The nutrients recovery from toilet wastewater: an alternative way of getting fertilizers for agricultural production and environmental pollution control means
- The formation of struvite in aqueous solutions: the result from the development of supersaturation which is a driving force to all precipitation processes (Adnan et al. 2004)
- Factors that influence struvite production include pH, T^0C, precipitant addition and mixing rate

Objectives

- Main objective: to study the removal and recovery of phosphorus and nitrogen nutrients from toilet wastewater by struvite production at the lab-scale through the precipitation
- Specific objectives:
- Evaluate the factors such as pH and temperature on the quality of struvite formation
- Evaluate the recovery of nutrients(N and P) through precipitation of struvite

Methodology

- The experimental work has been done at lab-scale and performed into five experiments
- Sample collection area: Kacyiru and Vision 2020 Estate Gaculiro treatment plants

- 1 L wastewater sample used for struvite production
- Studied parameters: Mg/P/N ratios, mixing rate, pH and T^0C effects on struvite production and nutrients recovery
- pH and T^0C were measured by using the electrochemical methods: pH-meter and thermometer devices
- Nutrients concentration were measured by titration method and spectrophotometric method respectively

- For struvite production:

- Determination of initial concentration of NH_4^+, PO_4^{3-} and Mg^{2+} content

-Determination of optimum pH and T^0C conditions for struvite precipitation with variation of pH and T^0C respectively

- 16 test tubes were used in each experiment: 9 for pH & T^0C variations

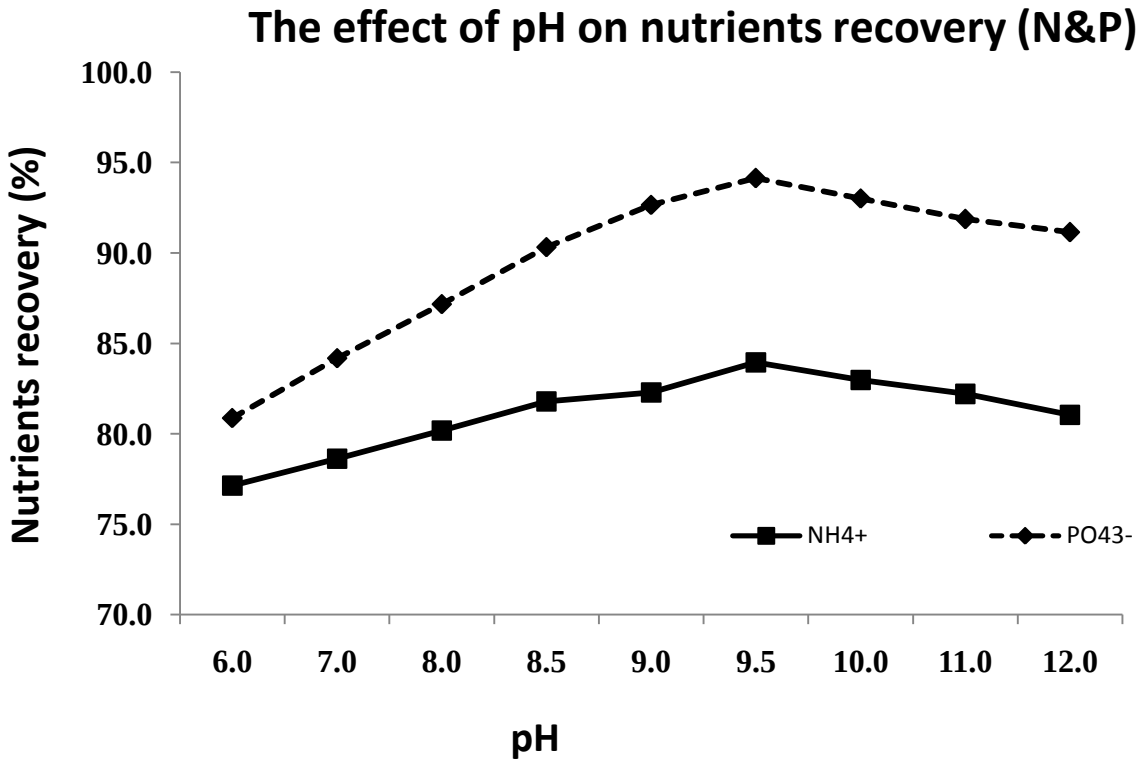
- A triplicate was done for each experiment to ensure the received results

- The precipitates made were collected from the reaction zone (test tubes), dried within 2 to 3 days and after weighed

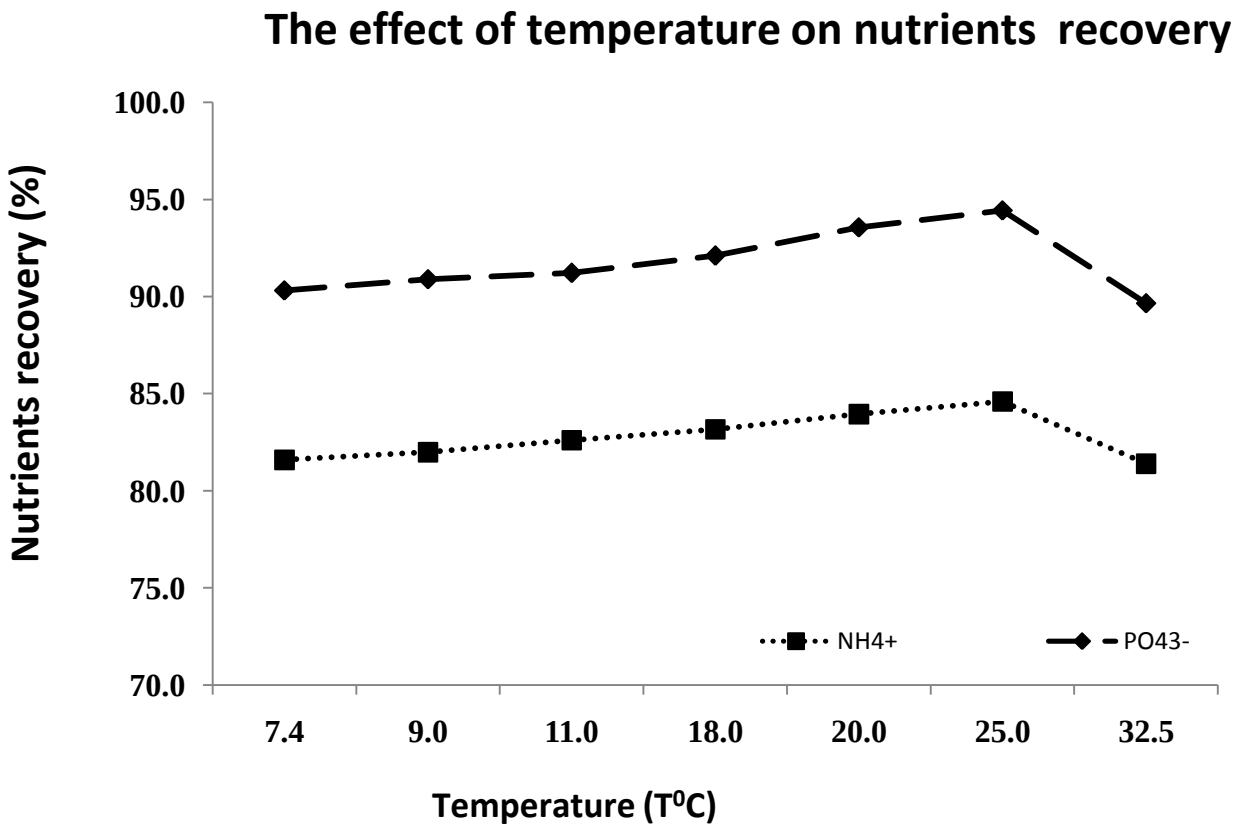
Results and Discussions

Table 1: Physico-chemical characteristics of the raw wastewater samples

Parameters	Kacyiru treatment plant			Gaculiro treatment plant	
	Experiment 1	Experiment 2	Experiment3	Experiment 4	Experiment5
Temperature [^{0}C]	26	18	22.5	20.8	13
pH	7.6	8.2	7.9	8.4	7.2
Ca Hardness [mg/L]	24	22	39	30	45
Total Hardness[mg/L]	87	75	111	90	100
Ca [mg/L]	8	15	20	12	18
Mg[mg/L]	33	19	24	15	13
NH_3-N[mg/L]	17	14	18	18	15
NH_4^+[mg/L]	21	16	21	23	18
Total nitrogen [mg/L]	1432	1372	1478	1673	1623
PO_4 [mg/L]	14	9	12	14	8
Total phosphorus [mg/L]	122	54	89	42	24



- Precipitate started to develop at pH around 7 and subsequently appeared well at pH 9.5
- N and P removal efficiencies increased linearly from pH 6.00 to the pH 9.50



- Nutrients (N& P) removal efficiencies slightly increased with temperature up to 25^0C and then decreased at high temperatures greater than 25^0C

Struvite precipitate after drying

- About 83% of N and 95% of P were recovered as struvite
- About 0.6-0.8 gr of struvite was formed per 1 L of wastewater sample

Conclusion and recommendations

- It has been shown that struvite precipitation is an ecofriendly process that removes and recovers nitrogen and phosphorus from wastewaters
- The optimum pH and T^0C for struvite precipitation and nutrients recovery was shown to be 9.50 and 25^0C, respectively
- About 83% of N and 95% of P were recovered as struvite
- Struvite would be the principal P fertilizer after exhaustion of all mined P rock in near future
- It is a slow release valuable fertilizer that can reduce the cost of production in agriculture (to be proved in near future)
- Consequently, there is a need to develop optimum conditions for small-scale and added value of struvite product.

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THANK YOU