Applicability of Zirconium Loaded Okara in the Removal and Recovery of Phosphorus from Municipal Wastewater

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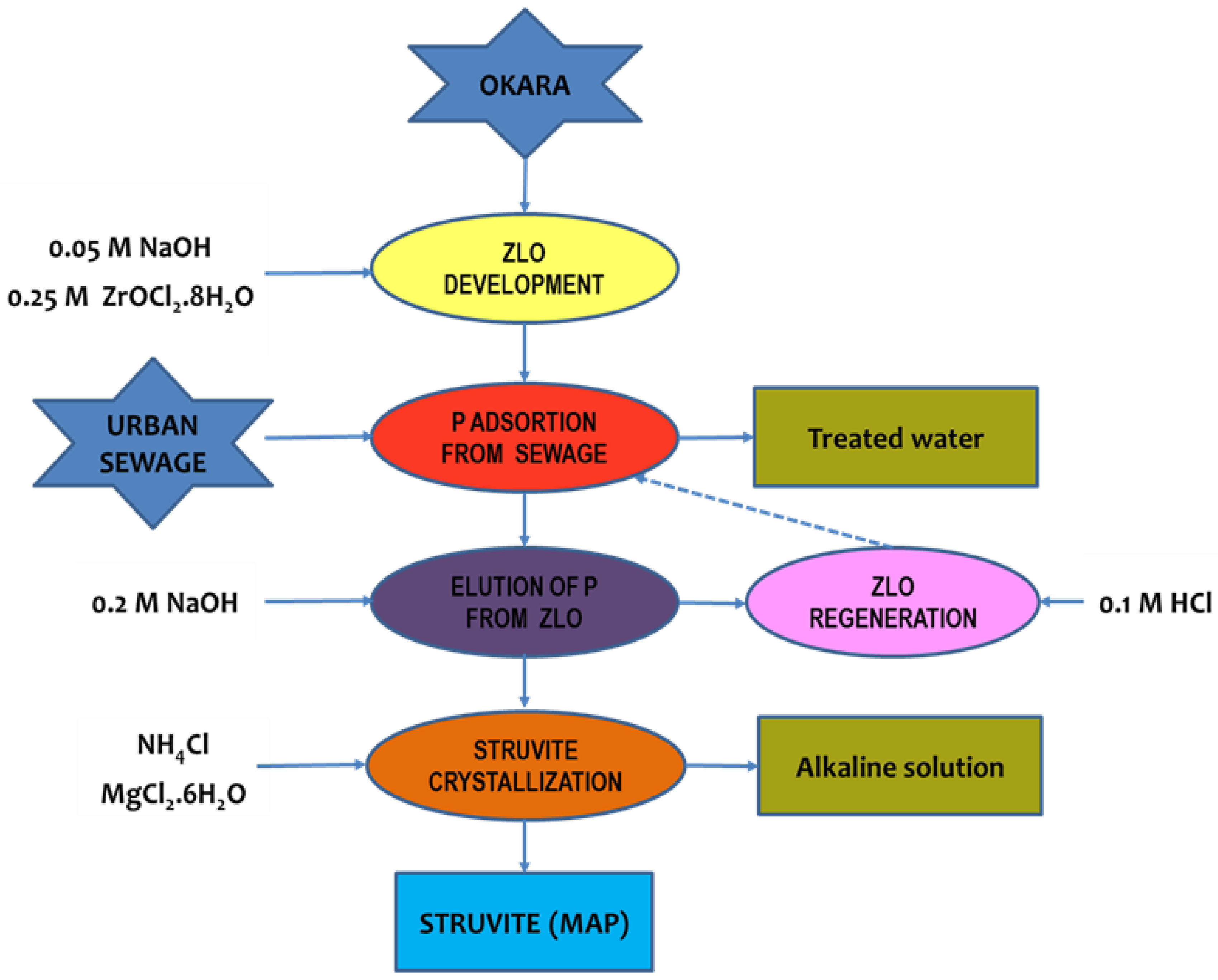
INTRODUCTION

Recovery of phosphorus as struvite (MAP - $MgNH_4PO_4.6H_2O$) has recently become a matter of interest to researchers. However, the MAP recovery from municipal wastewater is still a challenge, due to low concentration of phosphorus and high volume of wastewater to be treated. This study investigates the potential of reclaiming MAP from municipal wastewater by adsorption coupled with crystallization. The results prove that it is viable to recover MAP from municipal wastewater by adsorption followed by crystallization. This paves the way for mining phosphorus from municipal wastewater together with reducing soybean waste in a green way.

OBJECTIVES

The goal of this study was to investigate the feasibility of recovering phosphorus as MAP from municipal wastewater using adsorption followed by crystallization.

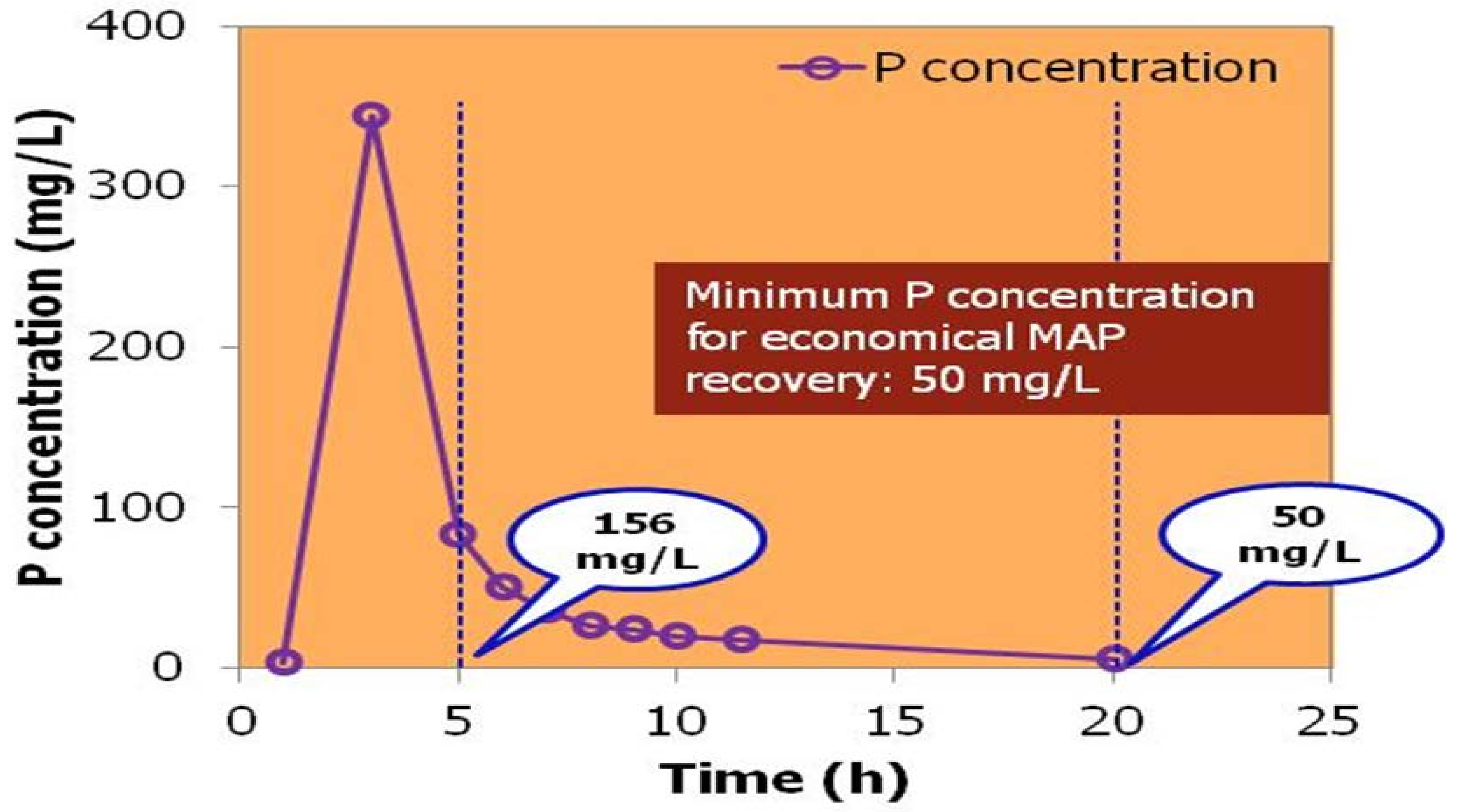
RESEARCH METHODS



Experimental set-up

RESEARCH RESULTS

Desorption profile of ZLO packed bed column



A semi pilot-scale ZLO column could pre-concentrate P from municipal wastewater more than 28 times, providing a sufficiently high P concentration for MAP recovery.

Factors affecting MAP recovery

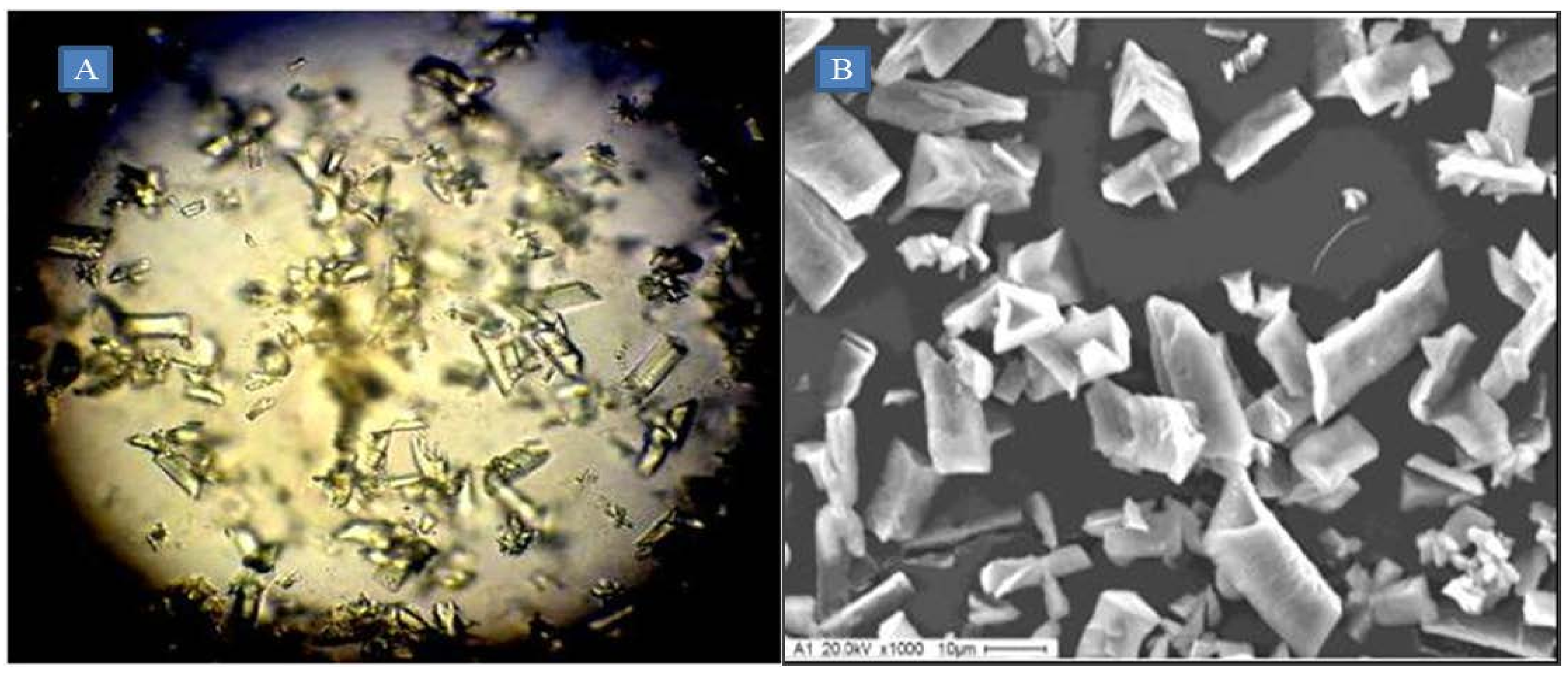
Crystallization condition	% P recovery	% P	% Mg	%N	% MAP	P:Mg:N molar ratio
pH 9	88.70	12.19	9.0	6.97	91.88	0.80:0.76:1.01
pH 9.5	91.28	11.89	8.51	6.47	86.87	0.82:0.76:0.99
pH10	93.73	11.89	8.56	6.97	87.38	0.84:0.78:1.09
1:1:1	51.50	12.53	9.00	6.97	91.88	0.52:0.48:0.64
1:1.5:1.5	88.69	12.48	9.74	7.49	98.63	0.89:0.9:1.19
1:2:2	95.19	11.96	9.07	5.48	92.59	0.96:0.94:0.97
$NH_4Cl+MgCl_2.6H_2O$	91.64	13.23	8.03	6.48	81.97	1.12:0.88:1.21
$(NH_4)_2SO_4+MgSO_4.7H_2O$	94.87	12.14	7.62	6.48	77.79	1.16:0.94:1.37
22 °C	75	13.48	7.7	6.25	78.60	0.83:0.61:0.85
8 °C	85.84	13.31	7.76	5.47	79.22	0.95:0.72:0.86

The MAP crystallization from phosphorus desorption solution was most favored at the following operating conditions: pH = 9, Mg: N: P molar ratio = 2:2:1, the chemical combination of $MgCl_2.6H_2O$ and NH_4Cl, and room temperature.

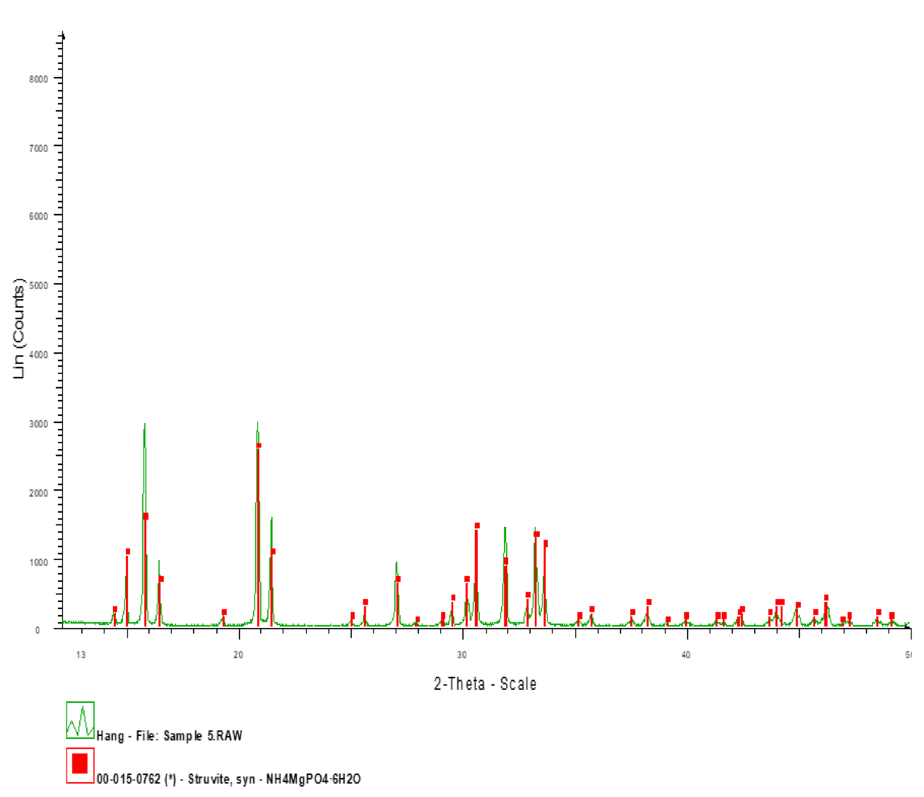
Characterization of recovered MAP

Elemental composition of MAP recovered from desorption solution at the optimal condition

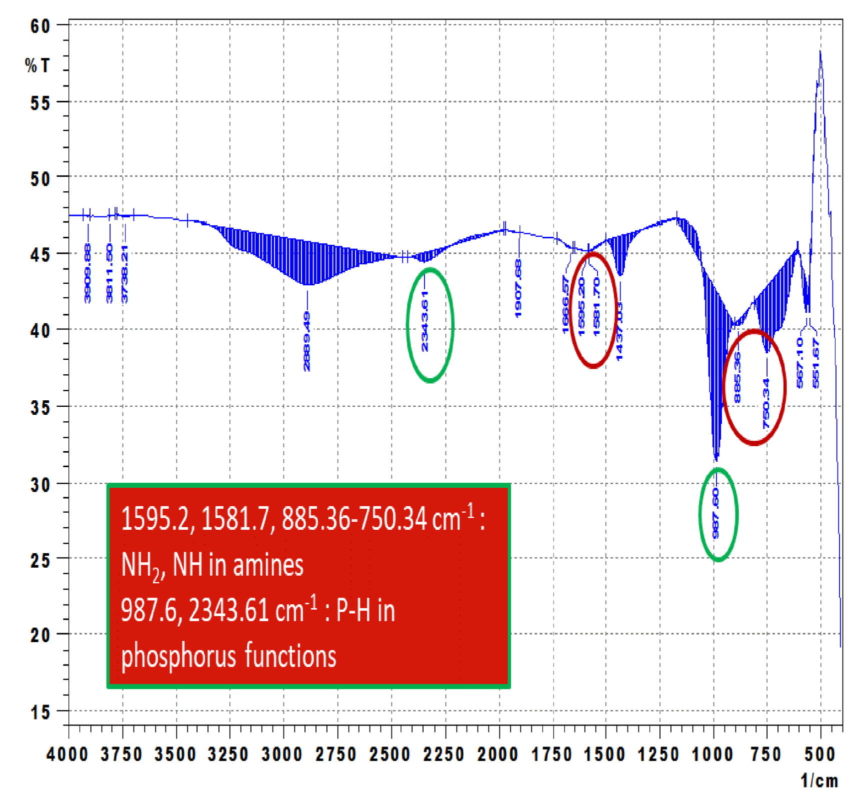
Element	Weight (%)	
	MAP recovered from desorption solution	Standard MAP (Sigma)
Phosphorus	11.96	12.65
Magnesium	9.07	9.80
Nitrogen	5.48	5.71



SEM image of MAP recovered from commercial MAP (A) and desorption solution (B)



XRD pattern of MAP recovered from P desorption solution at the optimal conditions



FTIR of MAP recovered from desorption solution

The results of XRD, SEM, FTIR, elemental analyses verified that the optimum crystallization conditions resulted in high-quality MAP crystals, with the MAP purity of 92.59%, and the P-availability of 89% by mass.

CONCLUSION

The combination between adsorption onto ZLO and crystallization as MAP can be a good solution for the phosphorus recovery from municipal wastewater.

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