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TECHNICAL NOTE

Characterization of Zeolite at Chorrillo Deposit, Camagüey, Cuba, for Use in Conceptual Test Ammonia Capture

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INTRODUCTION

Ions of ammonia are toxic residues of animal metabolism. Some animals excrete them directly into the environment, whereas others turn them into urea or uric acid to decrease their toxicity until they are disposed of by the organism in the stools. They are present in many residuals. Controlling ammonia levels in aquaculture is fundamental to fish vitality (Forrest, 2005).

Moreover, ammonia-N charged zeolite has been used so far to increase crop yields. Experiments in maize, such as Obregón-Portocarrero *et al*. (2016), where the plants that received zeolite applications were observed to have a more efficient use of N ammonia, are numerous.

Based on developments in porous materials worldwide, including zeolite and activated coal, their uses, properties, and technologies leading to a more viable use of technological alternatives to address pollution issues are being studied in residual waters (Rodríguez *et al.*, 2018).

The Geo-mining Company of Camagüey is a supplier of clinoptilolite zeolite from San Jose Chorrillo deposit, municipality of Najasa, Camagüey province. A characterization study for possible ammonia capture used a representative compound sample extracted from that deposit.

DEVELOPMENT

Three different sieving diameters were established (0.75, 1.75, and 3.25 mm), based on the sieving set used. The balance tests included a multifactorial design, taking into account two types of zeolite: natural (Nat) or incinerated (Inc) at 500 °C, the three previously mentioned diameters, and five concentrations of ammonia (20, 50, 100, 150, and 200 mg/L). The ammonia concentration before and after the treatments underwent colorimetric measurements using the Nessler reagent, adapted from AOAC (1995). The graphs and math were done using MS Excel®, and MATLAB®. Below, the results from the regression analysis.

Table 1. Results from the regression analysis. The retention capacity was used as dependent variable

	Coefficients	Typical error	Probability
Intercept	3.9027	0.3552	< 0.001
Type (1 - Nat; 2 – Inc)	-0.7134	0.1610	< 0.001
Diameter	-0.8737	0.0782	< 0.001
Concentration	0.0272	0.0012	< 0.001

The coefficient sign denotes that, as expected, there is more retention in the most concentrated solutions, the best being produced by the smallest particle diameters.

The results recommend it is better not to incinerate zeolite, which leads to thinking that exchange predominates over absorption, since incinerating must enhance (activate) the latter by disposing of the organic matter present in the pores.

Fig. 1 shows the behavior of the two forms of presentation of zeolite (Natural and Sodium), by dipping in 3% NaCl solution for 72 h. The two smallest diameters (lowest capacity, according to the previous paragraph) were in contact until achieving saturation with 200 mg/L of ammonia solution. To perform the experiment, the greatest diameter was not considered necessary, so it was removed.

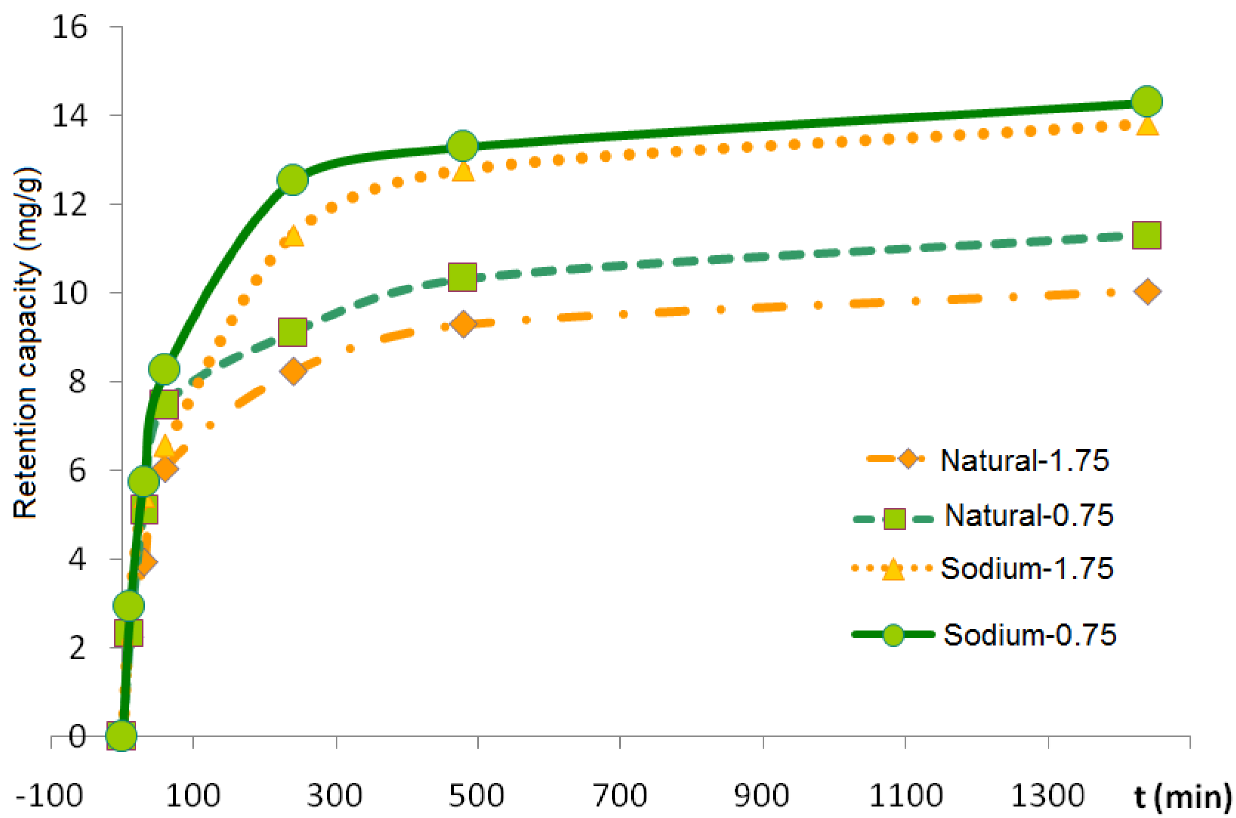

Fig. 1. Dynamics in the ammonia retention capacity per g of the two types of zeolite (Natural and Sodium), and two average diameters.

The particle sizes of sodium zeolite was greater ($P<0.05$) than the natural in terms of retention capacity, which, in addition, allowed for possible recovery after use by dipping in NaCl solution, a common practice with exchangers.

The thermodynamic characterization was done by data adjustment to the nonlinear models of Lagmuir and Freundlich, similar to the works done by Chuan-Hsia and Kwang (2001).

Lagmuir $$q_{(e)} = q_{Máx}\frac{kC_e}{1+kC_e}$$

Freundlich $$q_{(e)} = k_F C_e^{1/n}$$

Where q(e) is the amount absorbed and Ce is the concentration. Qmax, k, kf, and n are the model's parameters.

Table 2 shows the adjustment results of each equation.

Table 2. Minimal square adjustment results of the equations of Lagmuir and Freudlich

Model	Parameter	Nat-Na-0.5-1	Nat-0.5-1
Langmuir	Qmax	14.2478	12.4790
	K	0.0065	0.0058
	Error	0.0312	0.0259
Freundlich	Kf	1.5703	1.5246
	N	0.2846	0.2136
	Error	0.0684	0.0554

The model of Lagmuir was more representative of the retention process (minimum error). The parameters achieved were comparable to the reports made in the literature regarding other zeolite types (Chuan-Hsia and Kwang, 2001; Milovanovic *et al.*, 2013; Kalil *et al.*, 2018). The capacity was between 12 and 14 mg of ammonia captured by g of zeolite, which enables it for possible use in a effort to dispose of animal production residuals and/or the incorporation to the soil after being charged.

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AUTHOR CONTRIBUTION

Author participation included the following: Conception and design of research: SJMS, ADMAG, data analysis and interpretation: LBRS, SJMS, redaction of the manuscript: SJMS

CONFLICTS OF INTEREST

None