Characterisation of the Ammonium Zinc Chloride Obtained from Zinc Chloride Residual Solution

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INTRODUCTION

The development of a modern and intensive agriculture requires using fertilizers of superior quality that contain macro-elements, such as Ca, K, Mg, N, P and S, and microelements, such as B, Co, Cu, Fe, Mn, Mo and Zn. Microelements are important for plant growth and development. Among the microelements, Zn has a special role in plant and animals metabolism. Zinc deficiency is a problem, especially for fruits trees, grape and maize. In this paper, we studied obtaining ammonium zinc chloride from residual solutions that contained $ZnCl_2$.

METHODS

The residual $ZnCl_2$ solutions containing $FeCl_3$ were neutralized with NH_3 to obtain ammonium zinc chloride. We followed the dependence of the reaction-mass pH on the ratio of NH_3 : (Zn^{2+} + Fe^{3+}) and the establishment of the condition for the optimum separation degrees of Zn and Fe.

The obtained product was analyzed to determine its chemical composition. Diffraction X-ray pattern, IR spectrum and thermo-gravimetric and differential-thermal analysis were used to characterize the obtained product. We used solutions with 528 g L^{-1} $ZnCl_2$ and 1.8 g Fe^{3+} L^{-1}. Solutions were neutralized with NH_3 at room temperature.

RESULTS AND DISCUSSION

The experimental data regarding the dependence of the mass reaction pH on the molar ratio of NH_3 : (Zn^{2+} + Fe^{3+}) revealed a well defined dependence of the mass reaction pH on the ratio NH_3 : (Zn^{2+} + Fe^{3+}). The graphic presented three inflexions at pH 5.0, 5.3 and 6.0.

The experimental data regarding the dependence of the Zn separation degree on the mass reaction pH and on the molar NH_3 : (Zn^{2+} + Fe^{3+}) ratio shows that a maximum separation degree (α=95%) was obtained at pH 6.5 – 6.6. The optimum pH range can be considered to be pH 6.2 – 6.8.

The product, obtained under optimum conditions, was analyzed to establish what complex was formed. The experimental data regarding the chemical composition of products obtained at different pHs are presented in Table 1.

Table 1. The chemical composition of the obtained product versus mass reaction pH.

No.	pH	Content, %		Molar ratio NH_3:Zn
		N	Zn	
1.	5.7	16.79	37.74	5.7
2.	6.0	16.76	38.17	6.0
3.	6.7	16.24	38.22	6.7
4.	7.0	16.21	38.40	1.95

The obtained product contained approx. 16% N and 38% Zn, thus, it had a molar NH_3 : Zn^2 ratio of 1 : 2. The ratio corresponds to the formation of $ZnCl_2 \cdot 2NH_3$. This was confirmed by diffraction X-ray pattern, IR spectrum and thermo-gravimetric and differential-thermal analysis (Fig. 1 and 2).

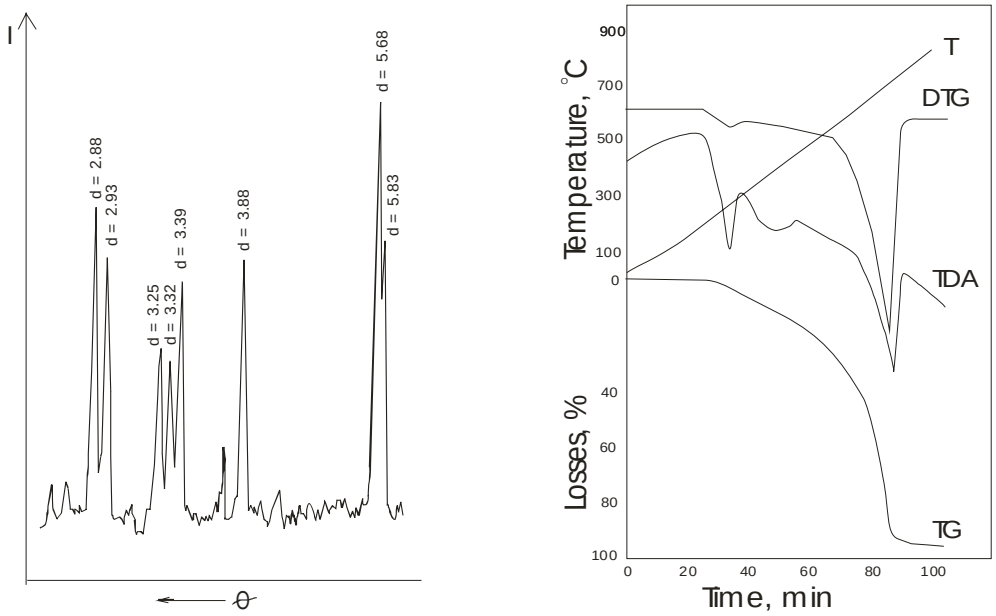

Fig. 1. (a) Diffraction X-ray pattern and (b) T, TG TDA and DTG curves for the product obtained at pH 6.7.

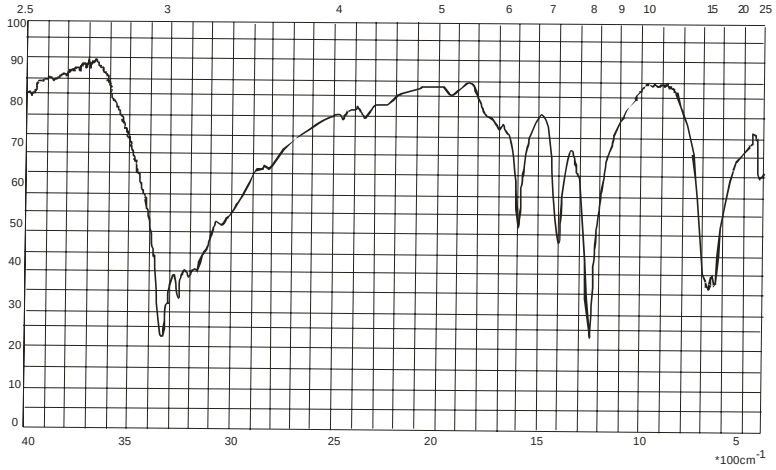

Fig. 2. The IR spectrum for the product obtained at pH 6.7.

CONCLUSIONS

The treatment of residual solutions high in $ZnCl_2$ with NH_3 can be used as a method of prime purification. The progress of the process under optimum conditions led to an advanced purification of the residual solution and formed ammonium zinc chloride, an important product for the fertiliser industry with microelements.

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