

Studies Regarding the Possibilities of Ammonium Ions Removal from Underground Waters

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Abstract: Nitrogen is one of the most important elements for the sustaining of life, interfering in different phases of plants and animal life. The forms in which the nitrogen appears in water are: molecular nitrogen – N_2 , nitrogen bounded in various organic combinations, ammonia – NH_3 , ammonium – NH_4^+ , nitrites – NO_2^- , nitrates – NO_3^- . The ammonia nitrogen can result from a high number of sources. Its presence in the drinking water is limited by the legislation (<0.5 mg/L – recommended by the World Organization of Health) because of its noxious effects on the consumers. In the present paper were carried out studies regarding the possibilities of ammonium removal from underground water using the ion exchange method. For the establishment of the optimum conditions of ammonium removal from underground waters it was determined the dependence of the residual concentration of ammonium upon the initial concentration of ammonium in water, the quantity of ion exchanger and the stirring time.

Keywords: drinking water, ammonium removal, ion exchange method

1. Introduction

Water has a primordial role in the apparition and maintaining of life and also in the development of human communities along history. This is proven by the fact that the first life forms appeared in the aquatic medium, the first human settlements were established in the vicinity of rivers in order to provide the water needed for drinking and household activities, water represents the medium where all metabolic processes take place, the tissues and organs of all living beings have high content of water [1-3].

At present days, as sources for drinking water are used the surface waters and the underground waters.

Surface waters have various compositions which are also variable in time. The parameters which influence their composition are: the nature of the rocks from the bed, the affluents, precipitations, current or accidental overflow of waste waters, the physical, chemical and biological phenomena which are taking place in water.

Underground waters have relatively constant parameters. They are characterized by a high content of minerals, high content of carbon dioxide and low content of oxygen.

In a general definition, water pollution represents the direct or indirect change of its normal composition, as result of human activity, in such extent that is affecting all other possibilities to use the water in its natural state. Water pollution implies the biological, physical and chemical pollution and causes, finally, the alteration of the environmental balance [4-7].

Underground waters may contain some chemical species (iron, manganese, calcium, magnesium, hydrogen sulphide, fluoride, carbonate, hydrogen carbonate,

ammonium, nitrite, nitrate) having concentrations which are higher than the values admitted by the legislation for drinking waters or industrial waters. In this situation it is necessary to use a system for water treatment, especially when the water is destined for human consumption.

Taking into account the importance of this purpose, the present paper is integrated with the complex matter of the inorganic nitrogen compounds which are present in water (ammonia, nitrites and nitrates). In the paper are presented practical aspects referring to the separation process of ammonium ions from underground waters using the ion exchange method [8-10].

2. Experimental

The studies for the separation of ammonium ions from water were carried out on solutions having various initial concentrations: 4, 6, 8, 10 and 20 mg NH_4^+ /L.

Volumes of 50 mL from the initial solutions were treated with various quantities of AMBERJET 1400 ion exchanger (4; 8; 12; 16 and 20 g/L), using various stirring time (5, 15, 30, 45 and 60 minutes). The samples were stirred with a MTA KUTESZ 609/A shaker bath.

The concentrations of the ammonium ions in the solutions were determined by spectrophotometric method, at 425 nm, using a Varian Cary 50 spectrophotometer [11].

3. Results and discussion

In order to determine the optimum conditions for the removal of ammonium ions from water, we studied the influence of the ammonium ions initial concentration,

quantity of ion exchanger and stirring time on the residual concentration of ammonium ions.

3.1. Influence of the quantity of ion exchanger and ammonium ions initial concentration, at a certain stirring time

The experimental data regarding the dependence of the residual concentration of ammonium ions upon the ammonium ions initial concentration and the used quantity of ion exchanger, for a certain stirring time, are presented in Figures 1-5 (for 5, 15, 30, 45 and 60 minutes stirring time respectively).

One may notice that the ammonium ions residual concentration decreases as the quantity of ion exchanger increases; the ammonium ions residual concentration increases with the ammonium ions initial concentration.

Following the analysis of the experimental data, an optimum quantity of ion exchanger can be taken into account the quantity of 12 g/L. However, we decided to consider that the optimum quantity of ion exchanger is 20 g/L, because only for this quantity the ammonium ions residual concentration was smaller than the maximum admitted value for drinking water ($0.5 \text{ mg NH}_4^+/\text{L}$) [12], but only for ammonium ions initial concentrations of 4 and respectively 6 mg/L.

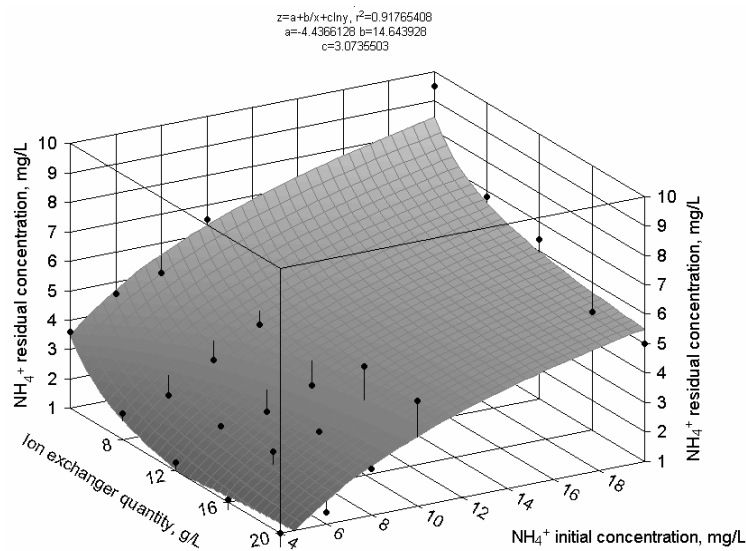


Figure 1. Influence of the initial concentration of ammonium ions and quantity of ion exchanger on the residual concentration of ammonium ions, at a stirring time of 5 minutes

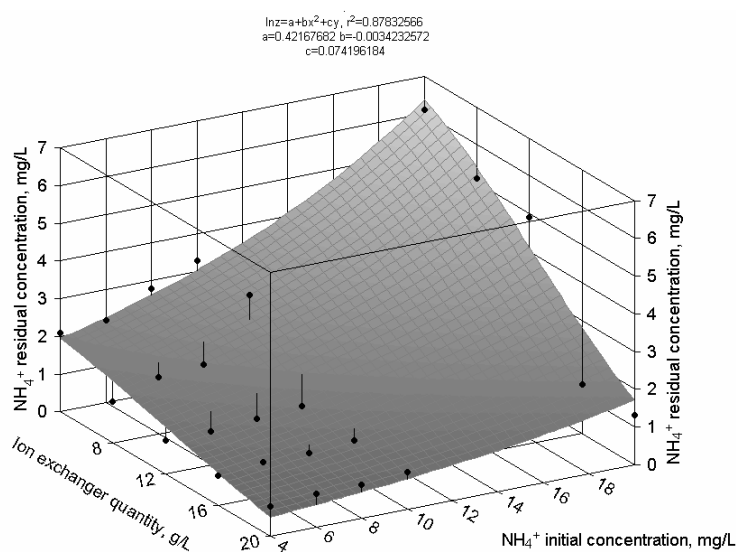


Figure 2. Influence of the initial concentration of ammonium ions and quantity of ion exchanger on the residual concentration of ammonium ions, at a stirring time of 15 minutes

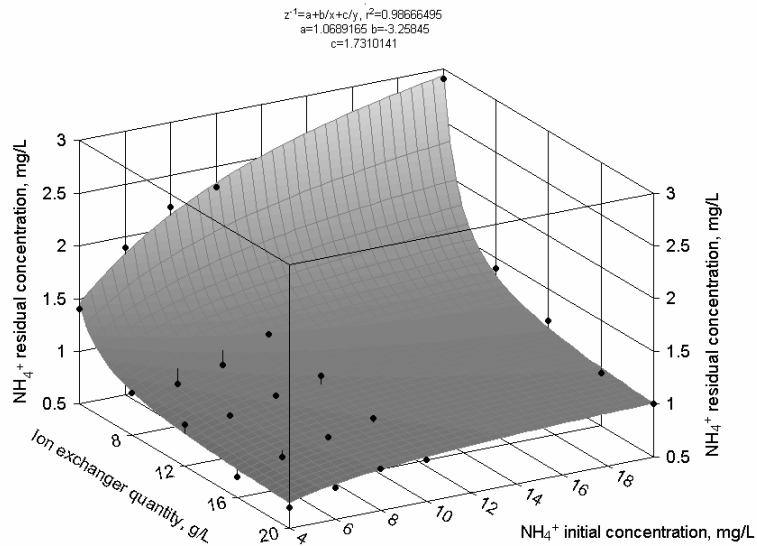


Figure 3. Influence of the initial concentration of ammonium ions and quantity of ion exchanger on the residual concentration of ammonium ions, at a stirring time of 30 minutes

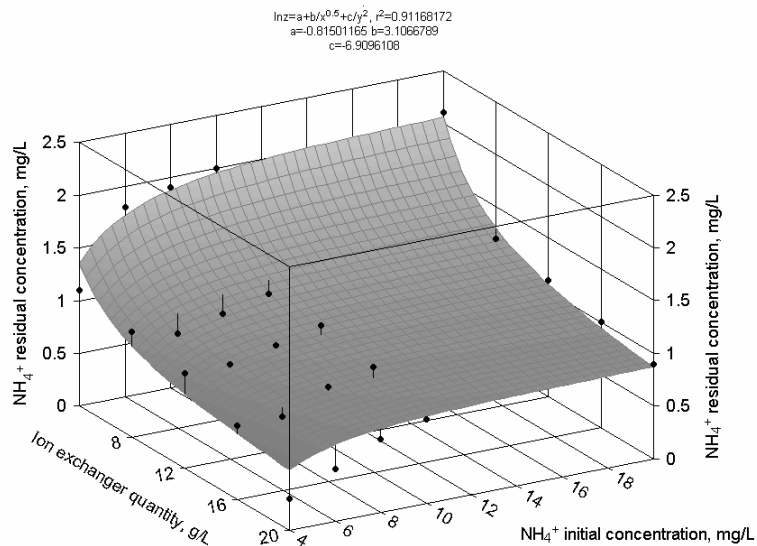


Figure 4. Influence of the initial concentration of ammonium ions and quantity of ion exchanger on the residual concentration of ammonium ions, at a stirring time of 45 minutes

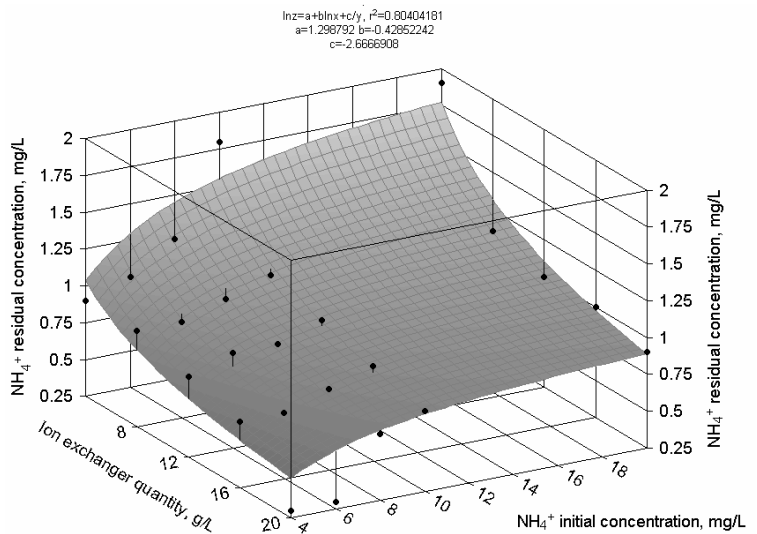


Figure 5. Influence of the initial concentration of ammonium ions and quantity of ion exchanger on the residual concentration of ammonium ions, at a stirring time of 60 minutes

3.2. The influence of the stirring time and ammonium ions initial concentration

Figure 6 illustrates the experimental results regarding the dependence of the ammonium ions residual concentration upon the ammonium ions initial

concentration and the stirring time, when a quantity of 20 g/L ion exchanger was used.

The experimental data show that the ammonium ions residual concentration decreases as the stirring time increases, but the decrease is not significant for a stirring time higher as 45 minutes. We consider that the optimum stirring time is of 45 minutes.

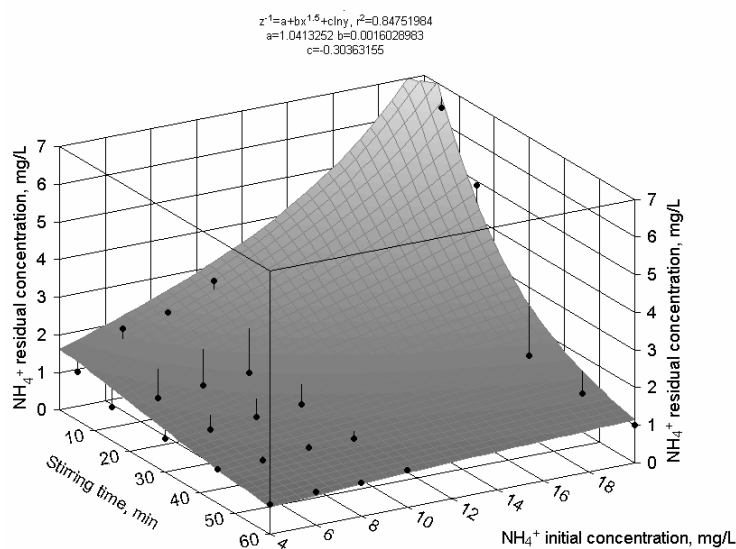


Figure 6. Influence of the initial concentration of ammonium ions and stirring time on the residual concentration of ammonium ions, using a quantity of 20 g/L ion exchanger

4. Conclusions

The present paper presents studies regarding the removal of ammonium ions from underground water, using the ion exchange method.

In order to determine the optimum conditions for the removal of ammonium ions from water, it was studied the dependence of the ammonium ions residual concentration upon the ammonium ions initial concentration, the quantity of ion exchanger and the stirring time.

The analysis of the experimental data let us to conclude that:

- as the quantity of ion exchanger increases, the ammonium ions residual concentration decreases;
- the ammonium ions residual concentration increases with the ammonium ions initial concentration;
- the ammonium ions residual concentration decreases with the stirring time; since the decrease is not significant for a stirring time higher as 45 minutes, we concluded that the optimum stirring time is of 45 minutes;
- we consider that the optimum quantity of ion exchanger is of 20 g/L because only in this situation, for initial concentrations of 4 and respectively 6 mg NH_4^+ /L, we

reached residual concentrations smaller than the maximum admitted value in the legislation (0.5 mg NH_4^+ /L).

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