



DEMONSTRATING THE MAXIMUM EFFICIENCY OF REMOVING LEAD IONS FROM INDUSTRIAL WASTEWATER USING MAGNETITE OXIDE NANOMATERIAL



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ABSTRACT

Nowadays, nanotechnology is a researched way for wastewater treatment [2]. The aim of the article is to present a nonconventional method based on nanotechnology for efficient removal of lead ions from industrial wastewater. For this purpose, magnetite nanomaterial absorbent was used, being very easily separated from the wastewater at the end of the treatment due to its magnetic properties [1]. Iron oxide nanoparticles are widely used to remove heavy metal ions from water due to their special properties [3, 4]. Some advantages in using the adsorption process in order to remove heavy metal ions from wastewater using magnetic nanoparticles are that it does not produce secondary pollutants, has the capacity to treat in a decreased period of time large volumes of polluted water and the nanomaterials used could be regenerated and reused [5]. The accumulation of lead in the human body will conduct to serious health problems such as: memory problems, cancer, high blood pressure, brain damage, premature birth, kidney disease, low IQ of children or hearing loss [6-8]. The maximum limit of lead ions permitted in wastewater is 0.20 mg/L, according to NTPA 001/2002. Experimental results revealed the influence of pH and contact time on the process of adsorption of lead ions. The magnetite nanomaterial had the maximum efficiency in a short period of time when the wastewater had pH 6. At a lower pH the highest treatment efficiency was around 84% and the required contact time was longer. When the pH increases above 6 the precipitation process occurs. Langmuir and Freundlich models were used to describe the adsorption process.

MATERIALS AND METHODS

The nanomaterial used to remove lead ions from synthetic wastewater was magnetite (Fe_3O_4). This was obtained through the coprecipitation process [9]. The reagents that were used to determine the concentration of lead ions (hydroxylammonium chloride, ammonia solution and potassium cyanide) were purchased from Sigma Aldrich. The analysis of lead ion concentrations in synthetic wastewater was performed with the PhotoLab S12 photometer.

All experiments were performed at room temperature with the rotational speed of 300 rpm having different concentrations (0,70; 1,00; 1,20; 1,45; 1,64 mg/L), and the dose of adsorbent nanomaterial was 2.00 g/L. The pH values were set at 4 and 6 for each concentration using 0.1 M HCl.

RESULTS The pH effect

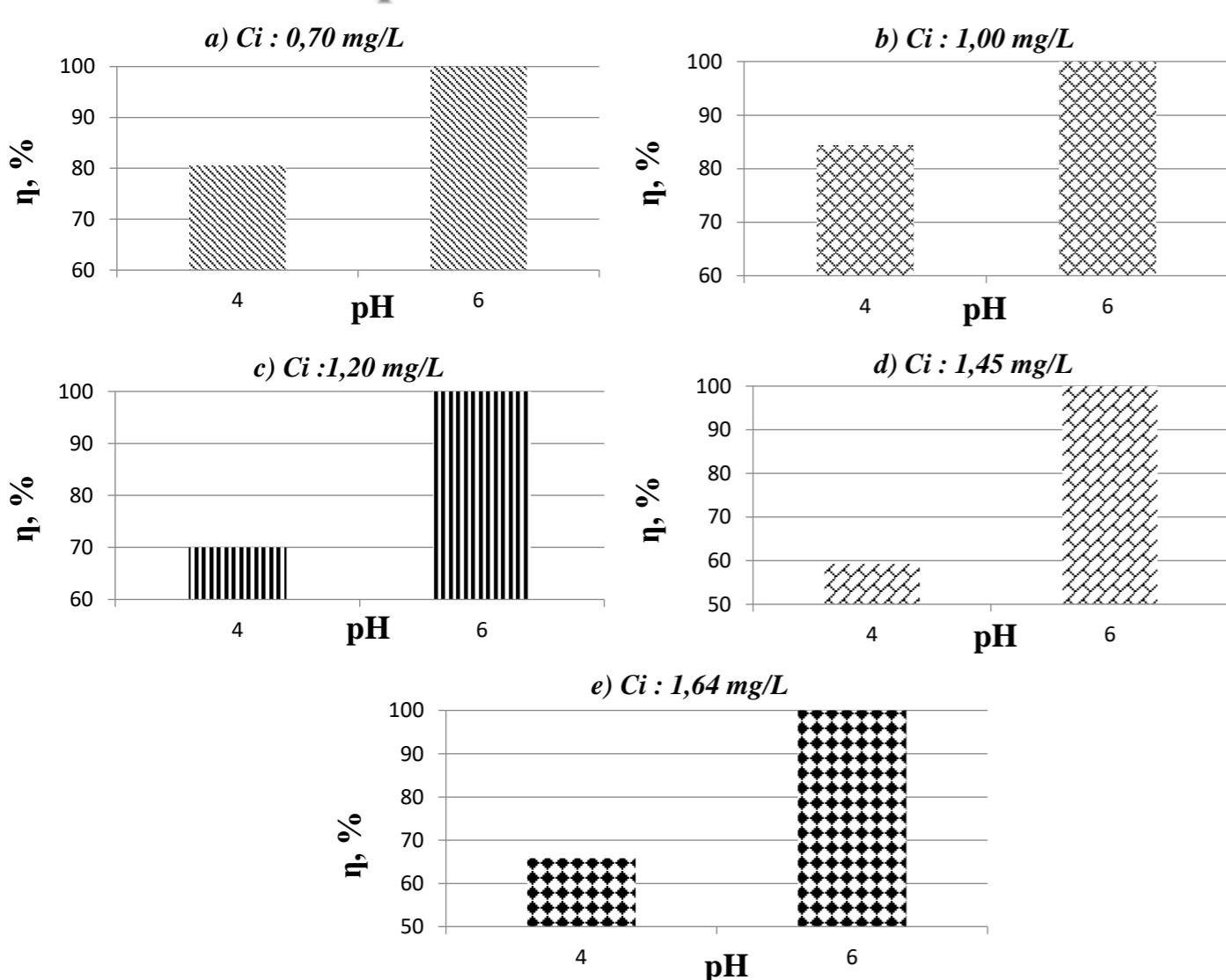


Fig. 1. The pH effect on the removal process of Pb (II) ions (conditions: metal ions concentration 0.70 (a); 1.00 (b); 1.20 (c); 1.45 (d); 1.64 (e) mg/L)

Contact time effect

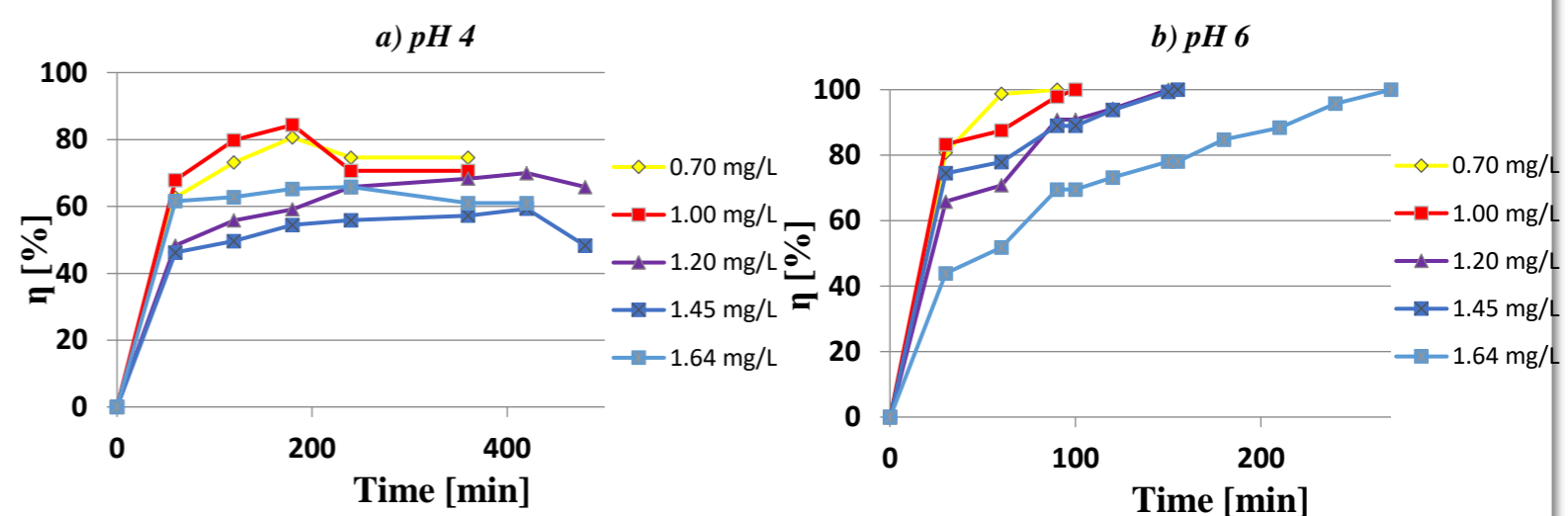


Fig. 2. Treatment efficiencies of wastewater versus time at pH 4 (a) and pH 6 (b)

Adsorption isotherms

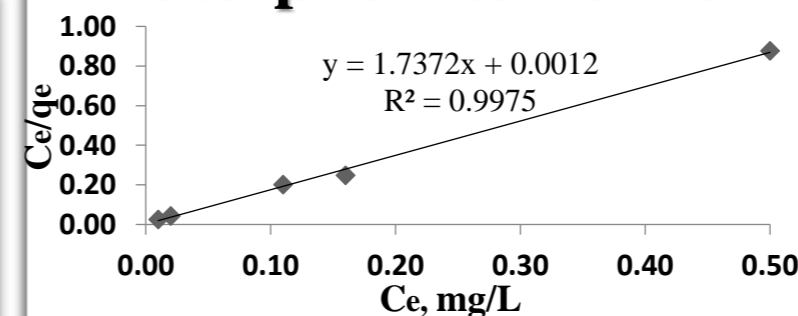


Fig. 3. Experimental isotherm for different concentrations of lead ions (0.70; 1.00; 1.20; 1.45; 1.64 mg/L)

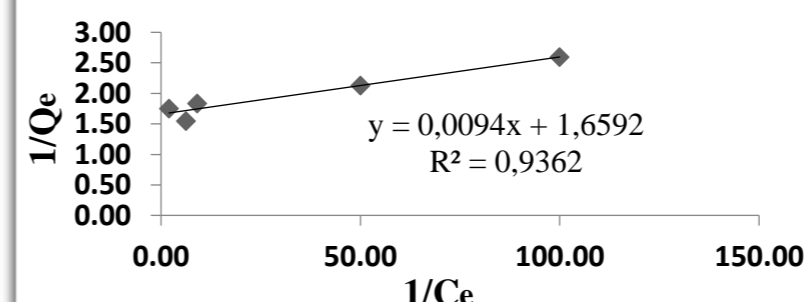


Fig. 4. Langmuir model for the adsorption of lead ions from wastewater

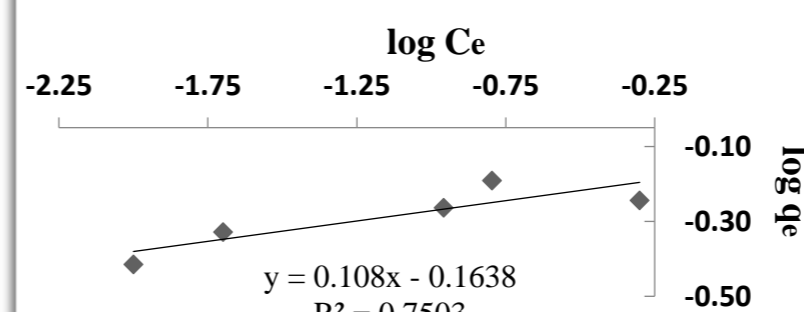


Fig. 5. Freundlich model for the adsorption of lead ions from wastewater

Conclusions

In the case of wastewater with pH 6, the treatment efficiency reached 100% at all studied concentrations. The highest treatment efficiency in case of removal lead ions from wastewater at pH 4 was 84.40% at the initial concentration of 1.00 mg/L. The required contact time is longer in the case of pH 4 than in the case of pH 6. The minimum contact time at which the maximum treatment efficiency was reached was 90 minutes and 180 minutes in the case of wastewater with pH 6 (100%) and pH 4 (84.40%), respectively. There is also the phenomenon of desorption (reversible adsorption).

As the pH of the wastewater increases (up to pH 6), the adsorption of lead ions on the Fe_3O_4 surface is facilitated. On the other hand, if the pH rises above 6, the removal of lead ions can be achieved through the adsorption process, but precipitation can also occur due to the metallic hydrolysis of lead hydroxide.

Acknowledgement

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