Nanostructured Iron-based Sorption Materials

Anna Gusak, **Marta Litynska**, **Tetiana Dontsova**
m.litynska-2017@kpi.ua, maril91@ukr.net, dontsova@ua.fm
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute“

INTRODUCTION AND THEORETICAL BACKGROUND

Iron-based sorption materials are effective sorbents for arsenic compounds removal. But these materials can also be used for remediation of As-polluted soils, phosphate and humate removal in drinking water and wastewater treatment [1-3].

Low arsenic bioaccessibility by fixation in nanostructured iron-based materials is one of the significant advantages of this sorbents[4].

Figure 1 demonstrates, that a solubility of iron(III) arsenate is significantly lower than in case of aluminum, calcium and manganese. Phosphates show the same tendency.

Thus, synthesis and application of novel nanostructured iron-based sorbents and nanocomposites are the areas of current interest due to the high toxicity of arsenic compounds and the widespread occurrence of these pollutants in natural water.

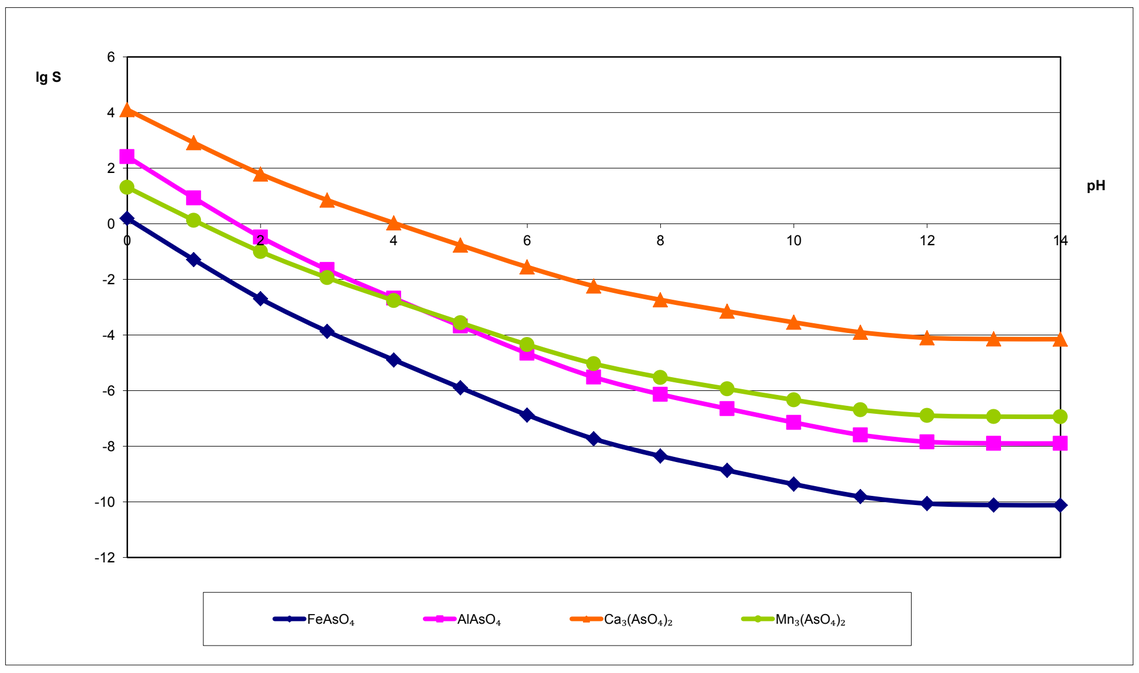

Figure 1. *Influence of pH on the solubility of some arsenates [5].*

MATHERIALS AND METHODS

We synthesized nanostructured iron oxyhydroxide by homogeneous precipitation. Iron(III) chloride was used as a source of iron and urea (ammonia from thermal hydrolysis of urea) was a precipitator:

$$2(NH_2)2CO+FeCl_3+4H_2O \rightarrow FeOOH+3NH_4Cl+NH_3+2CO_2.$$

The basic synthesis conditions: 150 g of urea was dissolved in 200 ml of distilled water, iron(III) chloride solution with concentration of 0.6 mol/l was added. The obtained mixture was heated with constant stirring to temperature of about 95 °C and boiled at this temperature.

The ratio of urea and $FeCl_3$ was varied from 5 to 15, and the heat treatment time was varied from 15 to 60 minutes.

For adsorption experiments conical flasks with volume of 250 ml were filled with 200 ml of the prepared solution with different concentrations for each of arsenic-containing substances. The adsorbent (0.005 g) was dosed into the prepared solutions. After achieving equilibrium, the contents of the flasks were filtered and analyzed for arsenic content by photometry using Systea EasyChem (Italy).

RESULTS AND DISSCUSIONS

Synthesized materials demonstrated high efficiency in removal of As(III) and As(V) (about 70 mg/g) (Figure 2) and humates (more than 98% removal) (Figure 3). Also these adsorbents are suitable for hybrid adsorption-membrane filtration treatment method due to its particle size and filtration properties.

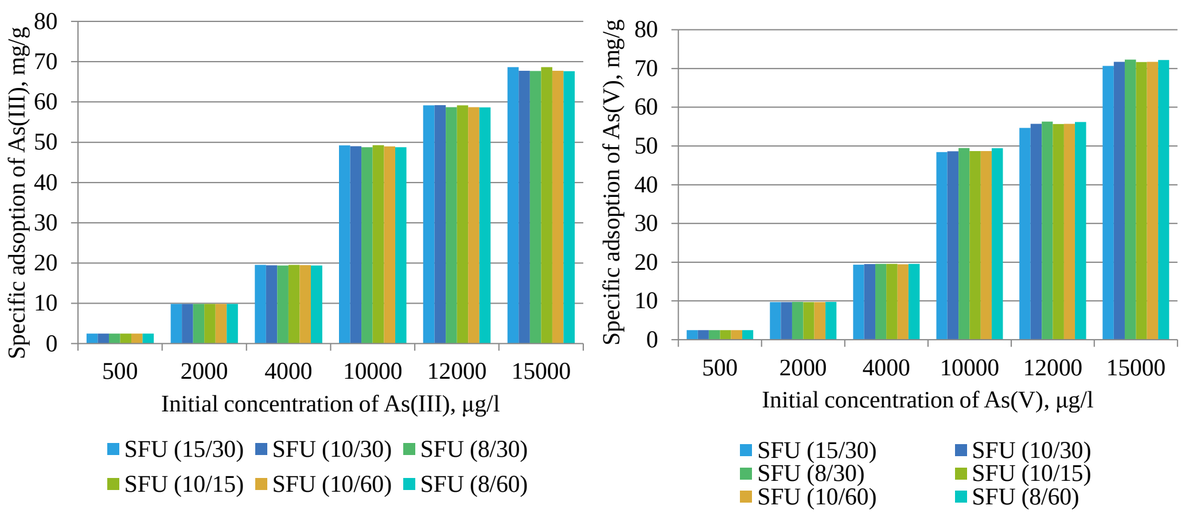

Figure 2. *Adsorption of arsenic compounds by* nanostructured iron oxyhydroxide.

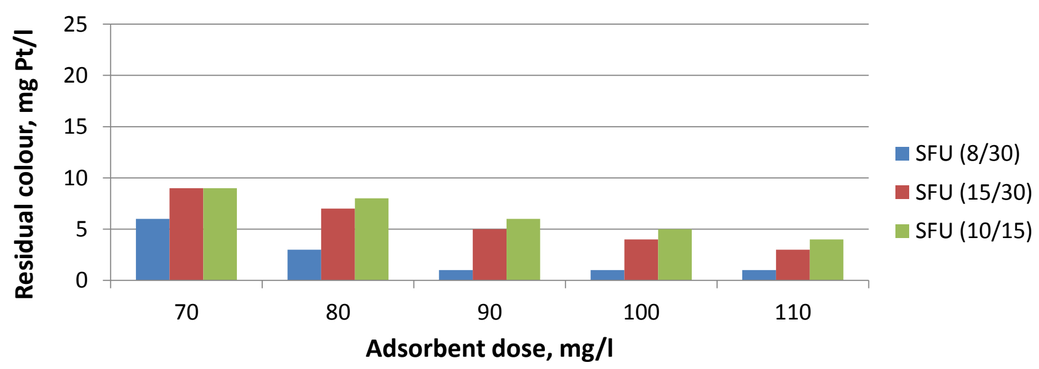

Figure 3. *Humates adsorption.*

References

1. Baragaño D., Alonso J., Gallego J.R., Lobo M.C., Gil-Díaz M. Zero valent iron and goethite nanoparticles as new promising remediation techniques for As-polluted soils // Chemosphere.-2020.-238.

2. Litynska M., Dontsova T., Yanushevska O., Tarabaka V. Development of iron-containing sorption materials for water treatment from arsenic compounds // East.-Eur. J. Enterp. Technol..-2021.-10 (110).-P. 35-42.

3. Moreira R.F.P.M., Vandresen S., Luiz D.B., José H.J., Puma G.L. Adsorption of arsenate, phosphate and humic acids onto acicular goethite nanoparticles recovered from acid mine drainage // J. Environ. Chem. Eng.-2017.-5, N 1.-P. 652-659.

4. Ciminelli V.S.T., Antônio D.C., Caldeira C.L., Freitas E.T.F., Delbem I.D., Fernandes M.M., Gasparon M., Ng J.C. Low arsenic bioaccessibility by fixation in nanostructured iron (Hydr)oxides: Quantitative identification of As-bearing phases // J. Hazard. Mater.-2018.-353.-P. 261-270.

5. Litynska M., Tolstopalova N., Astrelin I. Neutralization of arsenic pollutants, contained in natural waters: The theoretical analysis of solubility of some arsenates and optimization of the processes // J. Water Environ. Nanotechnol. -2017. 2(1).-P. 1-8.