

# NANOSTRUCTURED ADSORBENTS FOR ARSENIC COMPOUNDS REMOVAL



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### INTRODUCTION

Increasing of arsenic content in natural waters due to changes of groundwater level and acidic rains is the significant problem of drinking water treatment. Arsenic is one of the most dangerous elements in world.

According to European Commission, the maximum allowable level of arsenic in drinking water is 10 µg/l. High arsenic concentration in natural water is typical for India, China, Bangladesh, Taiwan, Vietnam, Hungary, USA, Mexico, Chile, Argentina, Hungary, Ghana, Iran, etc. [1-3].



According to Fig. 1, the probability of increased natural arsenic content in groundwater exists in many countries, which makes the arsenic compounds removal an urgent task in water treatment. In such areas, arsenic level in groundwater can often reach 40 mg/l, which is 4000 times higher than the maximum allowable arsenic content in drinking water [1, 5].

Chronic arsenic exposure provokes a lot of different health problems, including cancer of skin and internal organs, endocrine disorders, hyperkeratosis, melanosis, etc. [2,6].

There are different methods for arsenic removal from water, including chemical precipitation, ion exchange, adsorption and membrane methods, but adsorption is the most commonly used method [1].

Figure 1. Map of the probability of increased arsenic content in groundwater [4].

### **MATERIALS AND METHODS**

We synthesized nanostructured iron oxyhydroxide and iron oxyhydroxide/activated carbon adsorbents by homogeneous precipitation (Fig. 2-4). We used thermal hydrolysis of urea to precipitate nanostructured iron oxyhydroxide from iron(III) chloride solution:

#### $2(NH_2)2CO+FeCI_3+4H_2O\rightarrow FeOOH+3NH_4CI+NH_3+2CO_2.$



### **RESULTS AND DISCUSSION**





All iron oxyhydroxide/activated carbon adsorbents were effective against arsenic. The most effective was modified BAU-based sample, in which BAU was oxidized with potassium permanganate (Fig. 5). The arsenic removal using this sample was 89%, which was 51% more than unmodified carbon, and 2% and 3% more than other modified samples.



At high arsenic content (15000 µg/l) specific As(III) adsorption was high



**Figure 3.** Light microscopy of synthesized suspension of iron oxyhydroxide.

*Figure 4. Microscopy of iron* oxyhydroxide/activated carbon adsorbent.

For the sorption removal of arsenic-containing compounds, 0.05 g of powder, 0.1 g of activated carbon-based granular material and 0.01 g of suspension sorption material were weighed and placed in conical flasks together with 200 ml of arsenic-containing water. The flasks were placed on a shaker. At the end of the sorption, water samples were filtered and samples were prepared for photometric analysis.

This determination methodic is based on usage of ammonium molibdate and potassium antimony oxalate, formation of blue complex and photometric measurements at wavelength 880 nm.

(67.7 mg/g) (Fig. 6), but residual arsenic level at this sorbent dose (50 mg/l) was significantly higher (1463  $\mu$ g/l) than maximum allowable concentration for drinking water. Thus, dose 50 mg/l was not enough for effective treatment and it was recommended to use higher adsorbent doses for water with significant arsenic content.

## CONCLUSIONS

Obtained nanostructured adsorbents could be used for arsenic removal from water phase due to significant efficiency (the best sample efficiency is about 70 mg As/g). Modifying of activated carbon by iron oxyhydroxide improved the arsenic removal more than twice, but additional oxidation has a very insignificant effect on the sorption activity of the synthesized iron-containing sorption materials relative to As(V) compounds. So, these sorption materials are perspective for drinking water treatment.

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