Study of the kinetics of sorption of heavy metal ions by dry biomass of cyanobacteria

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Key message. Sorption of copper (II), lead (II) and cadmium ions from a solution with a concentration of $1 \cdot 10^{-4}$ mol/L by dry biomass of cyanobacteria *Fischerella muscicola* occurred 1.4-1.9 times faster than *Nostoc paludosum*. The sorption rate of lead and copper ions was 1.9-2.6 times higher compared to cadmium ions.

Keywords: Cyanobacteria, sorption kinetics, sorption kinetics models, sorption capacity, sorption rate

Biosorption is one of the effective technologies for treating wastewater and soils contaminated with heavy metals (HM). Microorganisms are used as effective biosorbents, among which cyanobacteria (CB) have a rather high sorption potential in relation to HM.

The purpose of the study was to characterize the sorption ability of cyanobacteria *Fischerella muscicola* and *Nostoc paludosum* with respect to copper (II), lead (II) and cadmium ions.

CB was cultivated for 3 months on Gromov's medium without nitrogen, then CB biomass was thoroughly washed from the nutrient medium with distilled water, dried to constant weight, and ground. A 50 mL TM nitrate solution with a concentration of $1 \cdot 10^{-4}$ mol/L was poured into a glass, a magnet, an ion-selective electrode, a pH electrode and a two-key reference electrode were immersed in a solution, a magnetic stirrer was turned on, and then the data reception program for the ionomer "Expert-001". Quickly put in a glass with a solution a sample of dry biomass CB (average weight of 50.0 mg). In describing the kinetics of sorption, pseudo-first and pseudo-second-order models, a modified second-order model, and the Elovich's model were used. The values of the parameters of the kinetic models were found by the least squares method using the add-on "Solution Search" of the Microsoft Office Excel software package.

To describe the kinetics of sorption of HM ions, the most acceptable was a modified second-order model ($r^2 = 0.9305-0.9891$). This model assumes that the sorption process limits the ion exchange reaction. The sorbent capacity is characterized by the equilibrium specific gravity of the sorbate, which did not differ much for different ions and types of CB, varying from 93.57 to 108.66 $\mu\text{mol/g}$ of sorbent.

The kinetic coefficient of sorption, which characterizes the rate of sorption, varied over a wider range from 0.039 to 0.185 s⁻¹. The smallest coefficient values were calculated for cadmium ions; the rate of sorption of lead and copper ions was 1.9-2.6 times higher. The sorption rate of HM *F. muscicola* was 1.4-1.9 times higher than *N. paludosum*.

During sorption, along with a decrease in the concentration of HM ions in solution, a decrease in the concentration of protons ($r = 0.9234-0.9884$) occurred, i.e. an increase in the pH of the solution was noted. A more significant increase in pH (by 1.52-1.76 pH units) occurred during sorption of *F. muscicola* than during sorption of *N. paludosum* (by 0.58-0.80 units). This fact may be due to the ion-exchange mechanism of HM sorption not with protons, but with other cations, for example, potassium, magnesium or calcium ions, which are contained in the sorbent.

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