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EFFECT OF MODIFICATION OF PEAT SURFACE WITH CHITOSAN ON SORPTION OF COPPER IONS

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The sorption capacities of two peat samples were determined with AAS method. The first one is a natural peat and the second sample is modified with chitosan. The peat was used, was from fields of Vardenis (Gegharkunik Marz of RA). To evaluate the sorption capacity of the sorbents the models of Langmuir and Freundlich were applied. Application of chitosan to the surface of the peat was performed by 3% chitosan solution acidified with citric acid solution. The cross linking was performed by formaldehyde. Sorption processes carried out in static mode.

Keywords: peat, sorbent, copper sorption, Langmuir and Freundlich adsorption models.

Introduction. Heavy metals such as (Ni^{2+}, Cr^{3+}, Cu^{2+}, Pb^{2+}, Cd^{2+}, etc.) can often be found in industrial wastewater and discharged into the environment, which is a serious threat due to their acute toxicity. In acidic streams the high content of heavy metals and radionuclide has a negative impact on biodiversity of aquatic systems. Traces of these elements may be manifested in different ways from molecular dissolved state to colloidal sizes and micron size particles [1].

There are different methods (mechanical, physical-chemical, chemical and biological), which are currently used to remove heavy metals from water. Among the physical and chemical methods the adsorption method is the most effective one. Recently in water purification procedure much attention is paid to natural or prepared on their basis sorbents. Adsorbents based on composite peat–chitosan can be used for a wide range of applications, in particular for removing heavy metal ions from water [2].

Peat is inexpensive, available sorbent for extracting a wide range of contaminants. It can be used either individually or as a component of a combined composite sorbents and complex materials [3, 4]. It is a natural biologically active material and it is very important for its suitability as a filter medium. Water filtration with peat is known to provide a high level of wastewater treatment. Significant reduction of organic carbon, nitrogen, phosphorus and suspended solids, heavy metals and microorganisms can be achieved by using as a peat filter [5].

Due to the presence of organic compounds having polar functional groups such as alcohols, aldehydes, carboxylic acids, ketones, et al., peat has a high complexing capacity [6, 7]. The use of sorbents based on waste and natural materials has a great interest, because the resource saving and environmental protection are priorities in

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modern science and technology, and the use of waste in an industrial scale is economically feasible [8–10].

Chitosan is nontoxic, biodegradable, biocompatible polymer having inherent film forming and heat resistant properties [11]. Chemical modification of chitosan becomes feasible due to presence of amino and hydroxyl groups in it, which makes it attractive for preparing of hybrid materials [12–14]. Antimicrobial activity also enhances its application in various fields such as biomedical [15–17], waste water treatment [18], adsorption [19, 20], etc.

The aim of this work is to study the sorption properties of natural and composite peat–chitosan materials for sorption of copper from water in static mode.

Materials and Methods. Initially peat is dried at room temperature. To peat weight (about 100 *g*) was added 90 *mL* 3 *g*/*L* solution of chitosan in citric acid and dried at room temperature. Sorbent pH was 6–7.

To prevent leaching of humates, 100 *mL* NH_4OH solution with pH 9–8 was added to the peat–chitosan sorbent (pH 8–9). The sorbent was dried at room temperature.

The peat–chitosan sorbent with 75 *mL* of a 20% aqueous solution of formaldehyde was treated, after 2 *h* it was washed in 1000 *mL* of distilled water and then dried in the air and then in 105°*C*. Copper sulphate $CuSO_4{\cdot}5H_2O$ (2.0 *g*/*L*) solution was used, as an object of study. To 50 *mL* of the resulting solution was added respectively: 0.5, 1, 2, 4 *g* of sorbent. The same is done for natural peat. After 24 *h* the concentration of Cu has measured in each solution. The samples were held for 15, 60, 240 *min* and 24 *h*.

The measurements have done by AAS ((AA-7000, A30784800185), (ASC-7000, A30694801102)). Optics parameters: λ=324.8 *nm*, lamp mode BGC-D2.

Atomizer/Gas flow rate setup: Fuel gas flow rate (*L*/*min*) 1.8, flame type Air-C_2H_2, concentration unit is *ppm*.

Results and Discussion. The experimental data of copper ions adsorption from aqueous solution of copper sulfate with $[Cu^{2+}]$=629.32 *mg*/*L* are presented in Fig. 1. The maximum values of the adsorbed copper per 1 *g* of peat are about 40 *mg*/*g*. For modeling and more accurate assessment of sorption capacity of the peat sample, based on the data, the models of Langmuir and Freundlich were used (Fig. 2). It is obvious that the Langmuir model describes the specified experimental data better, than the Freundlich model. Based on Fig. 2, adsorption capacity of the given peat samples by copper is about 40 *mg*/*g*.

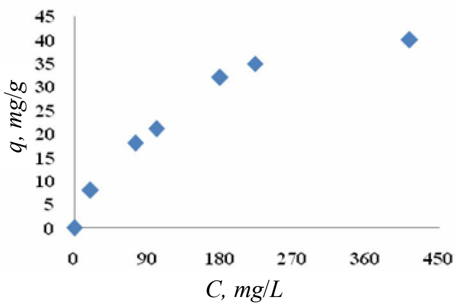

Fig. 1. Experimental data on the adsorption of copper ions on peat.

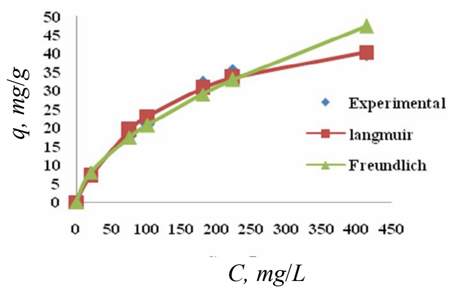

Fig. 2. Langmuir and Freundlich isotherms for Cu sorption on the peat.

Fig. 3 shows the experimental data by the adsorption of Cu^{2+} on the modified chitosan peat from an aqueous solution of copper sulfate with $[Cu^{2+}]$=669.32 *mg/L*. From Fig. 3 follows, that the maximum value of the adsorbed Cu per 1 *g* of peat is about 60 *mg/g*. To evaluate the sorptive capacity of this sample on the basis of appropriate experimental data were also used Langmuir and Freundlich models. In Fig. 4 shows the results of these models. As for peat sorbent was shown in this case Langmuir model better describes the specified experimental data, than the Freundlich model, also. Due to Fig. 4, sorption capacity of samples by copper is about 60 *mg/g*.

Fig. 5 shows that after the inoculation of peat with chitosan the sorption capacity of such composite increases nearly 1.5 times compared with baseline peat.

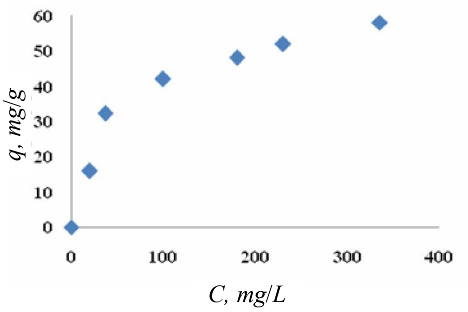

Fig. 3. The experimental data on adsorption of copper ions on peat modified by chitosan.

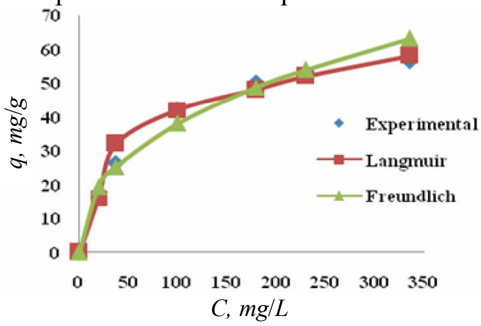

Fig. 4. Langmuir and Freundlich isotherms for Cu sorption on the peat–chitosan composite.

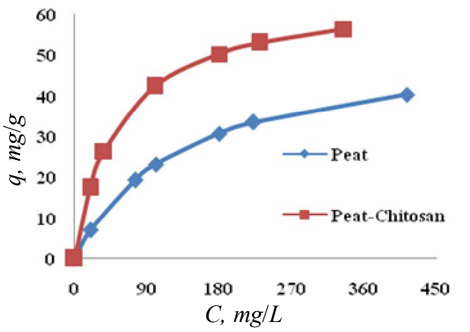

Fig. 5. Comparison of sorption capacities of peat and peat–chitosan.

Apparently, here in the sorption processes the adsorption mechanisms inherent both peat and chitosan are involved. The mechanisms in fact are very deferent since on the surface of the peat various functional groups exist that may be involved in adsorption processes in varying degrees. From that angle chitosan is a more simple system. Here NH_2 groups are responsible for the sorption.

Conclusion. Modification of peat surface with chitosan leads to a significant increase in the adsorption capacity of the sorbent. The optimal amount for removing copper from aqueous solution is 1 *g* of sorbent in a 50 *mL* solution. And the optimal time for removing of copper from water solution is 24 *h*.

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