PROCEEDINGS OF THE YEREVAN STATE UNIVERSITY

Chemistry and Biology 2016, № 2, p. 23–26

Chemistry

STUDY OF SORPTION PROPERTIES OF PEAT FOR REMOVING COPPER IONS FROM AQUEOUS SOLUTIONS IN DYNAMIC MODE

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The sorption of Cu(II) from aqueous solutions by peat containing sorbent was studied in a dynamic mode. Peat sample was taken from Lake Sevan (near Vardenis in Gegharkunik region of Armenia). The data obtained from sorption experiments were analyzed using Langmuir and Freundlich models. Langmuir equation describes sorption isotherm of Cu(II) with high correlation coefficients, better than Freundlich model. According to Langmuir model, the maximum uptake capacity of peat containing adsorbent for Cu(II) was obtained as about 15 *mg/g*. The sorption properties of peat were estimated by ICP-MS.

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

Introduction. Ions of heavy metals (e.g. Ni^{2+}, Cr^{3+}, Cu^{2+}, Pb^{2+}, Cd^{2+} and others) or ions of trace elements (for example, AsO_4^{3-}, AsO_4^{2-}) may often be detected in industrial wastewater and discharge into the environment, which is a serious threat, because of their acute toxicity. In acidic streams high content of heavy metals and radionuclides has a negative impact on the biodiversity [1].

Among physical and chemical methods of adsorption the most practical and highly efficient method that can provide cleaning prior to any desired level is using a multi-stage process. Much attention has been paid to water purification using natural adsorbents or adsorbents prepared on their basis, in recent years. Adsorbents based on peat can have a wide range of applications, in particular for removing heavy metal ions from water [2].

Peat is an inexpensive, available adsorbent for extracting a wide range of contaminants. It can be used either individually or as a component of combined composite adsorbents and complex materials [3, 4].

Recently a special technology has been developed, by means of which the converting of raw peat into powder of any size is provided, that retains its structure in water. Such systems can be easily adapted to existing technological cleaning systems [5].

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Peat is a natural biologically active medium and this activity is very important for its suitability as a filter medium. Any type of processing can affect the biological activity and moisture content. Water filtration with peat is known to provide a high level of wastewater treatment [6].

Due to the presence of organic compounds having polar functional groups such as alcohols, aldehydes, carboxylic acids, ketones and phenolic hydroxides, peat has a high complexing capacity [7, 8].

Based on the nature of origin, peats are divided into four groups, namely peat moss, herbaceous peat, wood and peat sediment. Over the last three decades various types of peat were used to obtain cost-effective adsorbents for municipal and industrial wastewater treatment [9–11].

The aim of this work is to study the sorption properties of the adsorbent obtained, based on peat with copper ions in dynamic mode.

Materials and Methods. Peat containing adsorbent was obtained by peat granulation with diatomite and bentonite. 30 *g* of diatomaceous soil and 10 *g* of bentonite were added to 300 *g* of peat (at 60% humidity). After mixing thoroughly the obtained mixture was granulated. Further sphere-like granules obtained were dried at room temperature and then in an oven at 105°*C* for 4 *h*. The ratio of peat : diatomaceous earth : bentonite in the final adsorbent was 12 : 3 : 1. 160 *g* of the adsorbent were obtained with a bulk weight of 400 kg/m^3 and a specific surface area of 12 m^2/g. The resulting adsorbent was fractionated by screening and was studied by selected fractions of 1–2 *mm*.

The specific surface area was obtained by BET method of determining the adsorbent on the Gemini-6 instrument ("Micromeritics", USA). The column with the size 300×10 *mm* ("Bio-Rad", USA) was used. The amount of adsorbent column was 8 *g*. The rate of flow of the solution through the column was installed within 1.0–1.25 *mL*/*min*. As an object of study, copper sulphate $CuSO_4{\cdot}5H_2O$ (200 *mg*/*L*) solution was used.

Results and Discussion. The amount of metal ions absorbed by the peat-containing adsorbent is calculated by formula

$$q = V\left(C_0 - C\right)/m,$$

where q is the number of copper ions adsorbed per unit mass of adsorbent at equilibrium, *mg*/*g*; C_0, C are the starting and residual concentrations of metal ions in solution respectively, *mg*/*L*; V is the volume of metal ion solution, *L*; m is the mass of dry adsorbent, *g*.

Fig. 1 shows the adsorption isotherm of copper ions on peat containing adsorbent. The amount of copper ions was calculated according to above formula.

Two models were used to describe the experimental data of adsorption: Langmuir model and Freundlich model. Langmuir equation was chosen to estimate the maximum adsorption capacity, corresponding to surface saturation of peat containing adsorbent:

$$q = q_0 K_L \frac{C}{1 + K_L C}.$$

The linearized form of the Langmuir equation after a permutation has a form

$$\frac{C}{q} = \frac{1}{q_0} K_L + \frac{C}{q_0},$$

where K_L is a constant related to the adsorption/desorption energy, *L*/*mg*; q_0 is the adsorption maximum at full saturation of peat containing adsorbent surface, *mg*/*g*. These constants were determined by curve fitting C/q vs C.

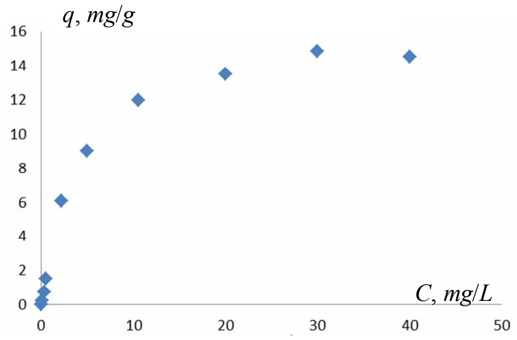

Fig. 1. Experimental points of copper ions sorption obtained on peat containing adsorbent.

Freundlich model was chosen to assess the intensity of adsorption of metal ions on the surface of the adsorbent:

$$q = K_F C^{1/n},$$

and the linearized form of Freundlich equation takes the form:

$$\log q = \log K_F + 1/n \log C,$$

where K_F is the Freundlich constant and is an indicator of sorption capacity; n is the constant characterizing the affinity of the metal ion to the adsorbent. From direct relationship of $\log q$ to $\log C$ defined constants K_F, where $\log K_F$ is the point of intersection of the curve with the y-axis and $1/n$ is its slope (Fig. 2).

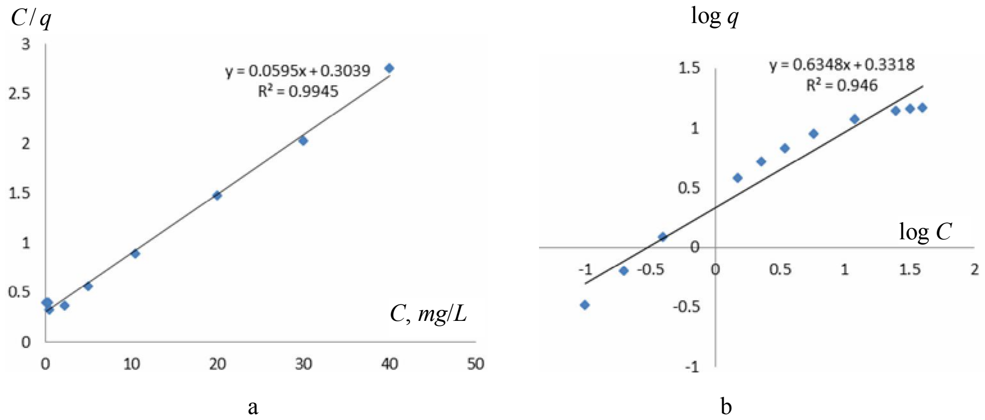

Fig. 2. Linearized forms of Langmuir (a) and Freundlich (b) equations.

K_F higher values indicate a greater adsorption capacity of the adsorbent. From Fig. 3 follows that Langmuir model more accurately describes the experimental data of sorption displayed in Fig. 1. According to Langmuir isotherm, the maximum sorption capacity of peat containing adsorbent for copper is about 15 *mg* per 1 *g* of adsorbent.

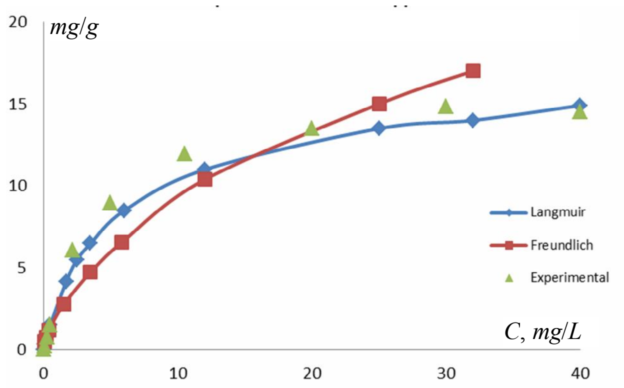

Fig. 3. Langmuir and Freundlich isotherms.

Conclusion. It is shown that Langmuir model more accurately describes the experimental copper sorption data on peat containing adsorbent in dynamic mode and, therefore, this model has been taken to assess the maximum sorption capacity of the adsorbent. According to this model, the maximum sorption capacity of peat containing adsorbent is about 15 *mg* of Cu per 1 *g* of adsorbent.

Received 03.03.2016

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