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# PROCESS OF SORPTION IN VERMICULITE-BASED SORBENTS MODIFIED WITH ORGANIC SUBSTANCES CONTAINING AMIN GROUP

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**Abstract:** The article covers vermiculite activated in strong acid, its pore formation, modification with hydrolyzed polyacrylonitrile. Also, experiments were carried out on the attachment of the obtained composite sorbent with monomers containing the amine group and the preparation of a highly selective sorbent for Cu(II) ion. The obtained results were tested by SEM and X-ray structural element analysis. Tests on absorption of benzene vapors by adsorption were carried out in the Mac-Ben-Bakr apparatus and appropriate adsorption and desorption isotherms were obtained, its surface area, monolayer capacity and pore sizes were given.

**Keywords:** Vermiculite, hydrochloric acid, copper, hydrolyzed polyacrylonitrile, diethanolamine, melamine, ethanolamine, adsorption.

In today's rapidly developing industrial production process, there is an obligation to use natural resources and local resources wisely. Treatment and reuse of waste water generated during the production process is an important factor [1].

Researches are being conducted in order to create ion-exchange sorbents for the purpose of extracting heavy metals from wastewater and selectively separating metals from metal solutions[2-3].

Pollutants in water are divided into different types according to their physical and chemical properties. Thus, several sorbents may be needed to remove them. Kinetic studies showed that a column packed with a mixture of ammonium and humic acid had a pore volume of 100 to remove ammonium at an initial concentration of 10 mg/l and a pore volume of 500 to remove humic acid at an initial concentration of 20 mg/l before effluent concentration. can clear the pore volume [4]. Against the background of water scarcity, scientists have conducted research on the creation of new adsorbents for collecting atmospheric water. A new composite adsorbent $MgCl_2$ / vermiculite was synthesized in order to increase the water collection capacity of the development. Positive results were obtained when $N_2$ adsorption test, adsorption performance test, desorption performance test, cyclic adsorption test and adsorption characteristic curve fitting were conducted on this new type of composite adsorbent. The composite adsorbent $MgCl_2$ /vermiculite is an excellent adsorbent material for water vapor, a conventional adsorbent[5].

**Experimental part.** Vermiculite in its natural state was expanded at a temperature of 800 ºC, that is, it was made porous.

For this, 50 g of vermiculite was placed in a 100 ml porcelain container and placed in the incinerator. Vermiculite is considered a natural sorbent mineral, and its composition consists of several different oxides and layers. Constitutive water between the layers begins to escape during intense heating, this process begins after the temperature rises to 150°C. As a result of evaporation of non-hygroscopic water contained in vermiculite under the influence of temperature, the interlayers opened up and acquired an accordion-like appearance. Porous vermiculite was placed in a 250 ml glass container, 36% hydrochloric acid solution was poured over it and left in a dark place for 48 hours. During this period, vermiculite undergoes a chemical activation process. Active $-OH^-$ groups are formed in vermiculite, which is considered an almost chemically inert substance in its natural state. The mixture with vemiculite was filtered and treated with ammonia water to neutralize acid residues. In the next step, it was decanted with boiling distilled water. The activated vermiculite was left in a drying oven at a temperature of 100 ºC and dried until all the hygroscopic water in it was removed.

Activated vermiculite and maleic anhydride were added to a 20% aqueous solution of hydrolyzed polyacrylonitrile in a mass ratio of 4:2.5:0.5 and stirred regularly in a magnetic stirrer at 7C for 60 minutes. The reaction was carried out with the reflux condenser connected. An initiator was added to the reaction medium and the viscosity of the mixture began to increase. After that, diethanolamine containing an amine group was added to the container. Our resin-like composite was taken out of the container and dried using air flow.

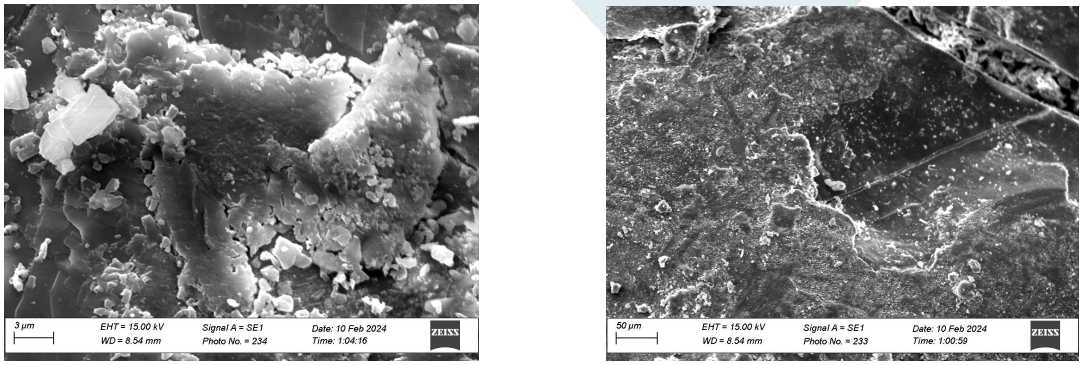
Various tests were conducted to check the sorbent properties of the obtained composite material. For this, a 0.1N solution of Cu (II) valence salt was prepared. 10 ml of saline solution and 30 mg of sorbent pieces were placed in glass ampoules. The vessels were left closed for 24 hours, and the concentration of $Cu^{2+}$ ions remaining in the solution was determined using a UV device (SHIMADZU, Japan). Also, a standard solution without an ion exchanger was also tested and determined using the following formula based on the difference in concentrations.

$$q_e = \frac{(C_0 - C_M) \cdot V}{m}$$

Here: $q_e$ is the amount of ion absorbed by the ionizer, mg-eq/g
**V**– solution volume, in l
Initial concentration of $\mathbf{C_M}$-solution, mmol/l
$\mathbf{C_0}$-equilibrium concentration mmol/l
**m**- ionite mass, g

According to the results calculated on the basis of this formula, it was calculated that the static exchange volume of the hydrolyzed polyacrylonitrile and vermiculite composite modified with diethanolamine is equal to 7.8 mg.ek/g.

**Analysis of results.**




a) b)

**Figure 1. SEM images of W/GIPAN/DEA composite: a) 3 µm resolution and b) 50 µm resolution**

Based on the SEM images of the obtained sorbent, it is possible to observe the intact form of vermiculite layers on the surface of the substance and other substances attached to it. On the surface of the sample, the presence of mesopores is reflected, the remains of unreacted initial substances are not observed. The mass fractions of the elements in the sorbent are presented in Table 1. According to the analysis, the highest mass fraction is 42.34% -C. This is due to the presence of C in the organic matter that modified the vermiculite. The second highest index belongs to O, i.e. it is 32.84% of the mass of the sample. The rest of the elements correspond to the oxides contained in vermiculite mineral.

**Table 1. Elemental analysis results of W/GIPAN/DEA composite ( %)**

| element | C | O | Na | Si | Cl | Mg | Al | S |
|---|---|---|---|---|---|---|---|---|
| Atomic number | 6 | 8 | 11 | 14 | 17 | 12 | 13 | 16 |
| Mass fraction [%] | 42.34 | 32.84 | 10.79 | 5.34 | 2.57 | 2.49 | 2.29 | 1.34 |
| Sigma mass (%) | 1.52 | 1.11 | 0.87 | 0.37 | 0.16 | 0.23 | 0.20 | 0.11 |

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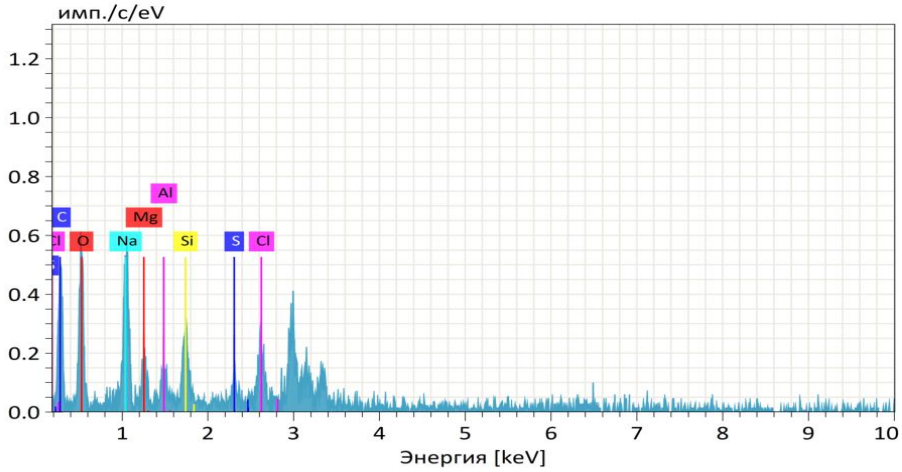


**Figure 2. X-ray spectroscopic analysis of elements contained in W/GIPAN/DEA sorbent.**

Adsorption of the composite sorbent in benzene vapor was studied and isotherms obtained in the high-vacuum Mc-Ben-Bakra adsorption device. According to the obtained results, the density of the sample in water is 10.8 g/cm3 and 40 g/cm3 in benzene vapor. Consumption of benzene vapor per mass of the analyzed substance was equal to 0.532 mol/kg.

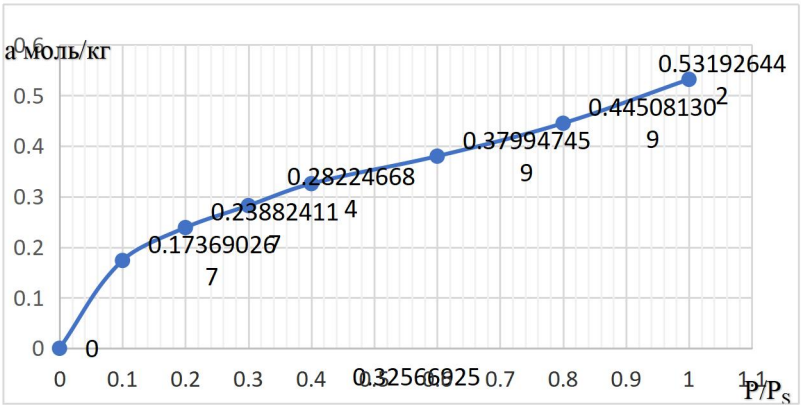


**Figure 3. Benzene vapor adsorption isotherm of W/GIPAN/DEA sorbent**

Regeneration process was carried out using hydrochloric acid and nitric acid in the metal ion sorbed sample.

In this case, the metal ions contained in the sorbent were transferred to the acidic solution. Effective adsorption disappeared when the sample was washed in distilled water, cleaned of acid residue and re-immersed in salt solution.

**Conclusion.** The clay mineral vermiculite, which is a natural sorbent, was expanded and made porous. A composite sorbent of porous vermiculite with GIPAN, maleic anhydride binder was obtained. The sorbent was modified with diethanolamine. The adsorbent properties of the obtained sorbent were studied. Cu(II) was sorbed from saline solution. The amount and conditions of sorption were studied. SEM images, elemental analysis and adsorption of the obtained organic-inorganic, composite sorbent with respect to water vapor were examined in a high vacuum in the Mak-Ben-Bakr device and adsorption isotherms were obtained. Based on the analysis and

calculations, it was found that the sorbent mainly consists of mesopores and micropores, and the surface area is relatively large.

The fact that the sorbent is regenerating increases the possibility of its exploitation. In the presence of acids, the desorption process takes place almost completely. It was found that the difference between the results of the sorption process after desorption was small. The fact that the sorbent is regenerating increases the possibility of its exploitation. In the presence of acids, the desorption process takes place almost completely. It was found that the difference between the results of the sorption process after desorption was small.

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