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RECOVERY OF SILICA GEL ADSORBENTS IN LABORATORY CONDITIONS AND DETERMINATION OF THEIR SORPTION PROPERTIES

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Abstract:
This article presents the methods of obtaining silica gel adsorbents and their industrial use. The methods of recovery of adsorbents produced after purification from heavy metals in wastewater are shown in laboratory conditions and in industry. Water vapor adsorption isotherms of regenerated silica gel adsorbents were measured in a sensitive quartz spiral apparatus of Mac-Behn.

Keywords: silica gel, adsorbent, Mc-Ben, π-complex, silicic acid.

Today, the demand for obtaining nanoporous, organophilic, thermal, and universally modified effective adsorbents for adsorption processes is to base scientific solutions on the thermodynamics of adsorption, first of all: to obtain suitable raw materials for adsorbers with selective absorption; study of thermodynamics of adsorption of organic vapors on modified bentonites; formation of ion-molecular and π-complexes in the pores of the adsorbent takes energy; study of processes of process cations influence on adsorption processes; it is necessary to study the full molecular adsorption mechanism.

Silica gel is a chemical compound obtained from silicic acid salts and dried. Silica gel adsorbents have the form of granules (grains), the diameter of which can be from 0.01 to 7 mm. This property has brought silica gel to the field of wide application [1].

It is used in the following areas:

Air drying and removal of vapors of various volatile substances (benzene, ether, etc.);

In refining oils and oil products;

Removal of dissolved mixtures of heavy metals from wastewater;

It is widely used in the areas of moisture protection of harvested crops, materials, equipment, and goods.

Features of regeneration of produced adsorbents.

In the process of absorbing water and gases, silica gel gradually loses its properties. At the same time, the destruction of the substance itself does not occur, which allows

it to be reused after the regeneration process (in addition, it is more economically profitable than constantly using new batches of the product).

Recovery of silica gel adsorbates includes the following technological processes:

Cleaning (not in all cases).

Desorption - removal of absorbed substances from silica gel.

Cooling.

Drying cabinets are used to regenerate silica gel in the laboratory. In this case, the heating temperature is 150-170 degrees, the processing time is 3 to 4 hours.

The choice of regeneration method in industry depends on the use of silica gel. Thus, when using a substance to absorb freons for preliminary cleaning of the surface of granules and pores, before heat treatment, blowing with inert gases (heated to 80-90 degrees) or cleaning of grains with a vacuum cleaner is carried out. If silica gel was used to remove impurities from oils and petroleum products, cleaning is carried out in the following ways:

Steam treatment; cleaning with non-flammable solvents.

If silica gel is used to remove moisture from the air, regeneration involves drying it. The main indicator for the efficiency of the process is temperature. In particular, when heat reaches 160 degrees, regeneration occurs regardless of the humidity of the environment. Modern drying cabinets have the ability to heat up to the specified parameters and higher [2].

Experimental part: For this purpose, as a research object, large porous granular silica gel (KG'DS) adsorbents used in the territory of our Republic were selected.

First, about 10-15 g of KG'DS adsorbents were added to 1 liter of wastewater, and the mixture was thoroughly mixed and left for 30 minutes, and the adsorbent was filtered. Silica gel adsorbents that absorbed heavy metals in wastewater were regenerated in laboratory conditions as shown in Figure 1.

Silica gel adsorbents were obtained by activating the wastewater content at thermal 100, 130, 160, 180oC for 3.5-4.0 hours in laboratory conditions. The process of regeneration of silica gel adsorbents under laboratory conditions is presented in Figure 1.

Figure 1.

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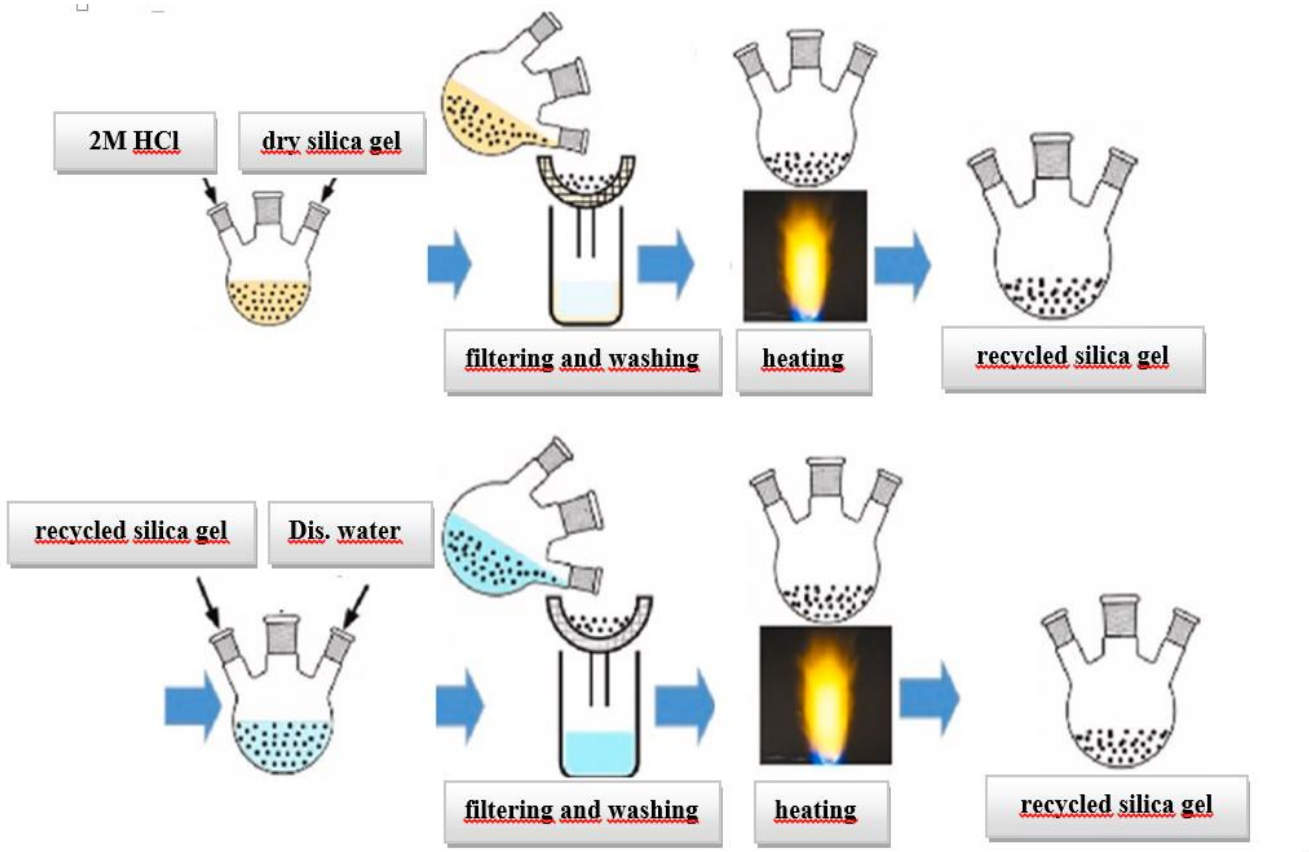

Figure 1. The scheme of recovery of silica gel adsorbents purified from heavy metals in wastewater in laboratory conditions

Silica gel adsorbents purified from heavy metals.
Adsorption of the obtained adsorbents with water vapor was studied.
It is important to study the structural porosity and adsorption parameters of silica gel adsorbents when conducting experiments and determining the mechanisms of surface properties. Adsorption of obtained silica gel adsorbents with polar molecule water vapor was studied.
Water vapor adsorption isotherms of silica gel adsorbents were measured in McBean's sensitive quartz spiral device [3]. Before measuring the adsorption of water molecules in the sample, the system was vacuumed until the residual pressure was 1.33×10^{-3}Pa, heated for 8 hours, and then adsorption isotherms were obtained. A scheme of the high-vacuum Mc-Ben-Bakra apparatus for adsorption research is shown in Fig. 2.
Figure 2.

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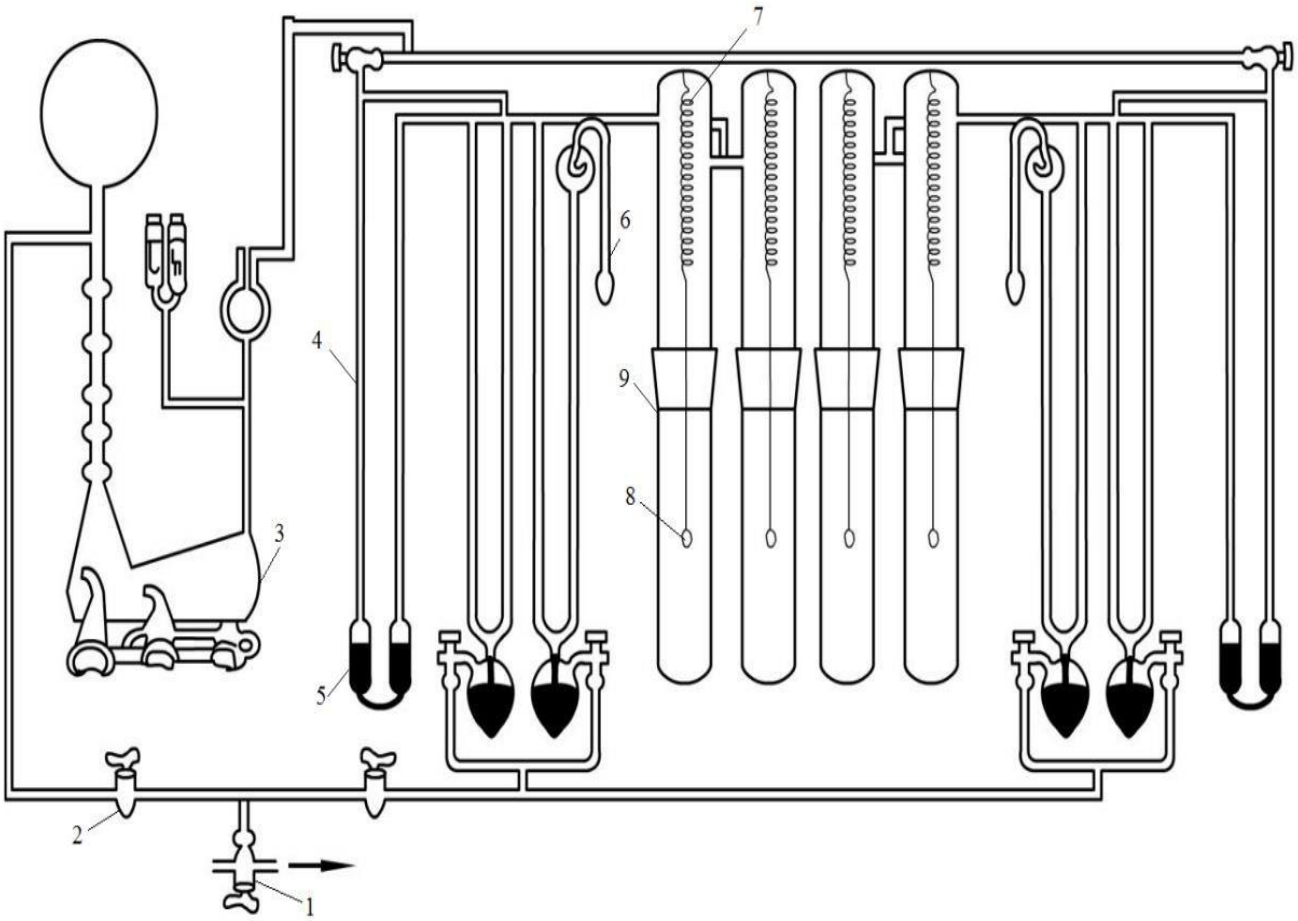

Figure 2. Scheme of the Mc-Ben-Bakra vacuum device for measuring adsorption isotherms. 1,2-cranes; 3-oil diffusion pump; 4-mercury U-shaped monometer; 5th mercury; 6 ampoule for liquid adsorbent; 7-quartz spring; 8- adsorbent cup; 9-column where adsorption processes go;

The water obtained as adsorbate was purified and dried under vacuum conditions before being used in sorption, its vapor pressure was first frozen and then heated until its vapor pressure was equal to the data of vapor pressure given in the tables for pure water [3] . The obtained adsorption isotherms are presented in Figure 3.

3 - picture

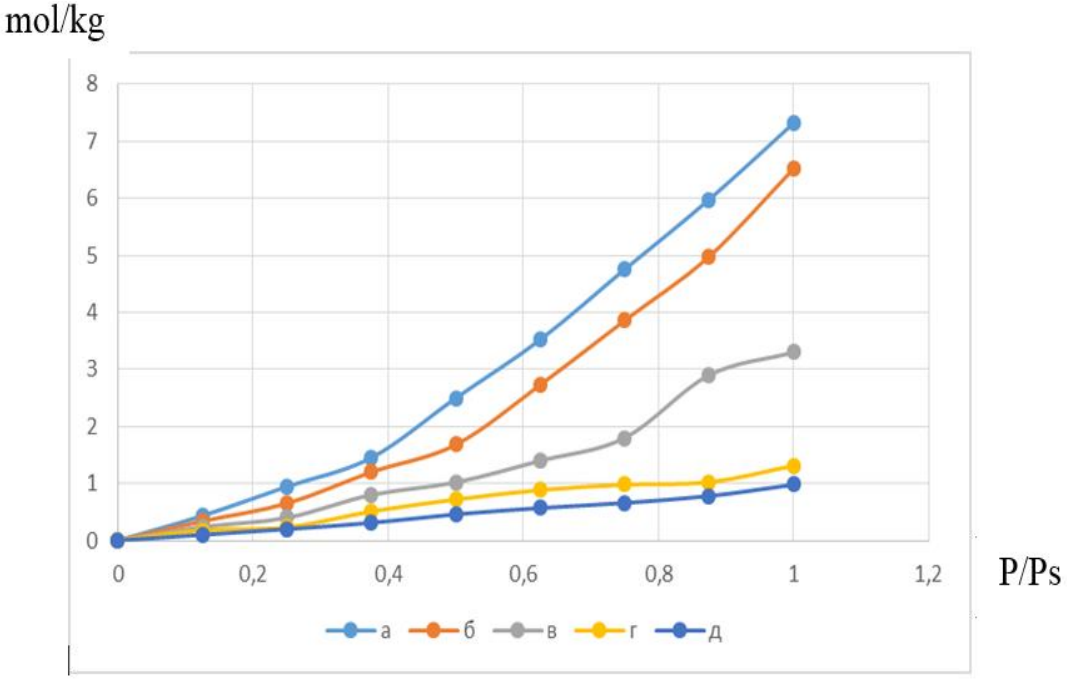

Figure 3. Adsorption isotherms of silica gel adsorbents with water vapor. а - initial, б - 100 °С, в - 130 °С, г -160 °С, д - 180 °С

The results of the adsorption isotherm showed that with the increase in temperature, we can see that the adsorption of water vapor on the adsorbents decreases. One of the main reasons for this can be explained by the decrease of polar functional, i.e., OH- groups in the adsorbent as the temperature increases.

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