PREPARATION OF MODIFIED SORBENTS BASED ON SILICA GEL AND KINETICS OF SORPTION OF GASES ON THEM

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Abstract: In the world, scientific and research work is being carried out aimed at quickly determining the amount of carbon dioxide in the mixture of gases, separating it by sorption, and creating a safe working atmosphere. In this regard, obtaining energy-saving, high-temperature-resistant, renewable, environmentally friendly, effective gas sorbents based on various modified polymers, carbon sorbents, minerals and modified silica gel, determining the composition and properties of sorbents used for industrial waste gas purification, sorption at high temperatures increasing efficiency, improving the mechanical properties of sorbents, the effect of various factors such as temperature and pressure on the sorption process, researching the sorption kinetics of gases under different conditions, and determining the mechanisms of physico-chemical processes that occur during the purification of the atmosphere from toxic gases.

Аннотация: В мире ведутся научно-исследовательские работы, направленные на оперативное определение количества углекислого газа в смеси газов, его сорбционное разделение, создание безопасной рабочей атмосферы. В связи с этим получение энергосберегающих, жаростойких, возобновляемых, экологически чистых, эффективных газовых сорбентов на основе различных модифицированных полимеров, углеродных сорбентов, минералов и модифицированного силикагеля, определяющих состав и свойства сорбентов, применяемых для очистки промышленных газов. очистка, сорбция при высоких температурах, повышение эффективности, улучшение механических свойств сорбентов, влияние различных факторов, таких как температура и давление, на процесс сорбции, исследование кинетики сорбции газов в различных условиях, определение механизмов физико-химических процессов которые возникают при очистке атмосферы от ядовитых газов.

Key words: sorbents, modified silica gel, SMEA, SDEA, Carbonic anhydride, porous layer, absorption rate, polygon gases, kinetics, sorption kinetics.

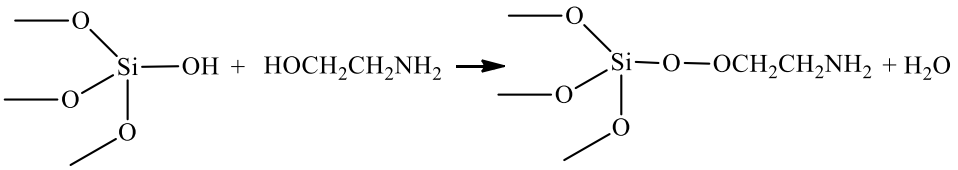
Introduction: Scientific research is being conducted in our republic on the production of chemical industry products, in particular, on the production of gas sorbents, which are used to purify the atmosphere from toxic gases with the help of sorbents, and certain results are being achieved. In the action strategy of the development of the Republic of Uzbekistan, "further modernization and diversification

of the industry by transferring high-tech processing industries to a qualitatively new stage aimed at the rapid development of high-tech processing industries, first of all, the production of finished products with high added value based on deep processing of local raw materials important tasks aimed at "mastering fundamentally new types of products and technologies" and "further strengthening the country's food security, expanding the production of ecologically clean products" have been defined. In this regard, in the development of the leading sectors of the national economy, including the chemical industry, it is important to obtain selective gas sorbents and use them to purify the atmosphere from toxic gases, and to develop fast, highly effective methods for determining the concentration of gases in the air.

Experimental part: Preparation of polysilicic acid (silica gel). The synthesis of silicic acid is based on the reaction of sodium silicate with acids. A solution of sodium orthosilicate (liquid glass) [1], which is commercially used as a building material, was used for the reaction. A synthesis was carried out according to the method given in the literature [2]. The sodium silicate solution was diluted with distilled water until its density was 1.2 g/ml. 75 g of 15% sulfuric acid solution was taken in a beaker, and sodium silicate solution was added dropwise until the solution medium became pH=3 [3]. Then the resulting solution was heated at a gelation temperature of 90°C and washed 3 times with sulfuric acid solution with pH=4. Each time the mixture was filtered. The last precipitate was dried at room temperature for 1 day[4]. The next day, the product was heated to a constant mass at 110°C. It is a polysilicic acid or silica gel obtained in laboratory conditions, the degree of porosity of which directly depends on the pH level of the point at which the neutralization process of the solution is completed and the gelation temperature of the solution. The mass of the product obtained by the above method is 16.14 gr.

$$nNa_4SiO_4+nH_2SO_4 \rightarrow nNa_2SO_4+(H_4SiO_4)_n$$

Modification with monoethanolamine. For reactions with monoethanolamine, technical monoethanolamine was purified by driving in an inert medium. Then 10, 20, 30% solutions in absolute ethanol were prepared according to mass percentage. 10.0 g of the resulting solution was taken and soaked in 5.0 g of polysilicic acid for 5 hours. In this case, in the second method, the mixture was stirred at 150°C for 5 hours in a closed atmosphere. At the end of the process, the product was heated under reduced pressure at 80°C to evaporate the solvent and excess ethanolamine. The approximate reaction of the process is as follows[5]:



The amount of products obtained is shown in Table 1 below.

Table 1.

Results of modification with monoethanolamine

Initial silica gel mass, g	The composition of the solution for modification	Sample received	The last mass	Mass increase, %
5,0	10% MEA 90% ethanol	SMEA-10	5,48	9,6
5,0	20% MEA 80% ethanol	SMEA-20	6,76	35,2
5,0	30% MEA 70% ethanol	SMEA-30	7,54	50,8
5,0	40% MEA 60% ethanol	SMEA-40	7,72	54,4

In order to determine the optimal conditions for the modification process with monoethanolamine, it was performed at different temperatures and different reaction times. The degree of modification was evaluated according to the increase in the mass of the final product compared to the initial silica gel [6]. As a result, it was determined that the reaction lasting 5 hours at 150°C had the best yield (Figures 1-2).

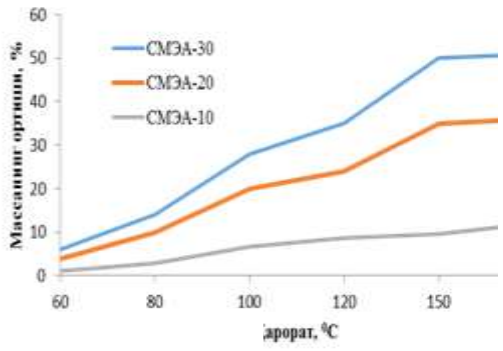


Figure 1. Temperature dependence of modification of polysilicic acid with monoethanolamine

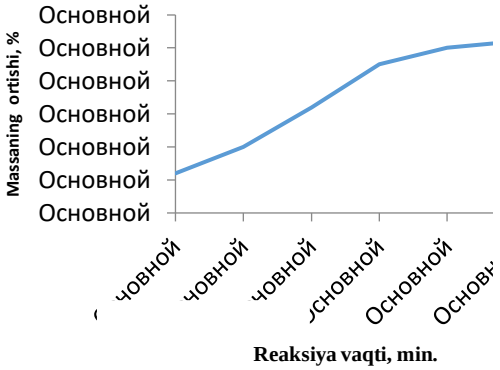


Figure 2. Dependence of reaction time of modification of polysilicic acid with monoethanolamine

Analysis of results: The apparatus shown in Figure 3.1 was assembled to study the sorption process under laboratory conditions. The sorption process was performed in a U-shaped tube with one end connected to a vacuum pump and the other end to a CO_2 cylinder. 1.00 g of sorbent is placed in the tube and kept under 0.8 vacuum for 20 minutes. The pump is then turned off and CO_2 is released from the cylinder. The pressure is controlled by a cylinder monometer ([7]. The sorption process is studied at different temperatures by thermostating the tube in a water bath. The degree of sorption is determined by weighing the sorbent mass at the end of the process.

The sorption properties of modified sorbents at normal atmospheric pressure are studied by thermogravimetric method. The essence of this method is to determine the change of the mass of sorbents in the environment of different gases due to the increase in temperature. Thermogravimetric analysis was carried out on a Shimadzu TG600 device manufactured in Japan[8].

At the first stage, the samples are heated to 110°C in an argon atmosphere in an aluminum crucible. The gas flow rate is 100 ml/min. By keeping it at this temperature for 30 minutes, solvent residues, absorbed atmospheric gases and moisture were removed from the sorbent composition.

In the second stage, the temperature is lowered to the required level to measure the sorption capacity. Then, carbon dioxide gas was injected at a rate of 100 ml/min. During the process, thermogravimetric and differential thermal measurements are performed. The maximum sorption capacity at the appropriate temperature is determined using the mass change compared to the initial mass.

In the third stage, the sorbent is heated again at a rate of 10°C/min in a flow of 100 ml/min argon and brought to 100°C. The desorption process is studied from the mass change. It is heated at 110°C for 30 min in an argon atmosphere until the end of desorption. Further measurements are carried out in this order.

The sorption/desorption cycle is repeated 5-6 times. These results are very important for evaluating the change in sorbent efficiency with increasing cycles.

At the end of the work, the maximum and average sorption rates, maximum sorption capacity, maximum and average desorption rates at 30°C, 50°C and 80°C are studied for each sorbent. .

The maximum sorption rate is selected from the 1 min interval with the highest mass gain and is calculated using the following equation:

$$v_{max} = \frac{m_1 - m}{m_1}$$

here,v_{max} – maximum sorption rate, m-initial sorbent mass mg, m_1- the maximum mass at the time of the fastest mass change is mg.

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