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Deravatographic analysis of bentonite-coal sorbent samples and regeneration process

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ABSTRACT: As in the rest of the world, industry is one of the main sectors of our country's economy. Because the industry is fundamentally different from other sectors and sectors with its added value creation, its role in meeting the needs of the population and its high-level production locomotive. The development of industrial sectors leads to the steady growth of the national economy. Processing of all resources in the field of industry, production of new products from them, diversification processes will improve due to increase in assortment and nomenclature.

Taking into account the low price of local raw materials in the process of launching the production of activated bentonite-coal sorbents in the industrial sectors of our republic, the price of the produced sorbents should be significantly lower and provide the economy of our republic with an import substitute product [1].

KEYWORDS: coal, bentonite, sorbent, enrichment, activation, flotation, modification, granule, incineration, muffle furnace, temperature, decarbonization, industry, chemical regeneration, thermal regeneration.

I. INTRODUCTION

In today's age of rapidly developing technology, the need for water is increasing year by year. A large share of water consumption in the Republic of Uzbekistan is accounted for by industrial enterprises. Treatment of technological water of most industrial enterprises is one of the most urgent problems today. In order to solve this problem, it is necessary to create and put into practice the technology of developing sorbents from cheap local raw materials that can replace imported sorbents. The demand for sorbents that meet the requirements of world standards and do not have a negative impact on human health is increasing day by day.

II. SIGNIFICANCE OF THE SYSTEM

As in the rest of the world, industry is one of the main sectors of our country's economy. The study of methodology is explained in section III, section IV covers the experimental results of the study, and section V discusses the future study and conclusion.

III. METHODOLOGY

To obtain samples of bentonite-charcoal sorbent, a large amount of electricity is spent on its activation in muffle furnaces. Samples of sorbents taken in order to cover the costs of heat treatment must meet a number of requirements: first of all, they must be resistant to various environmental influences in the production of sorbents, they must be regenerated, and they must be used several times in technological processes. [2]

In the preparation of the sorbent, raw coal and bentonite samples were first derivatographically analyzed.

Derivatography is a method of studying chemical and physico-chemical processes in a substance in the study of temperature changes. One of its tasks is to determine the amount of evaporated structural water, hydroxides and minerals. In addition, derivatography also determines the structure of thin aqueous films in minerals, including coal. Derivatography is based on the combination of differential thermal analysis with physical or physico-chemical methods, such as thermogravimetry, dilatometry, mass spectrometry, and emonomy-thermal analysis. Under the influence of the heat effect, along with the change of the substance, a change in the mass of the sample occurs (liquid or solid).

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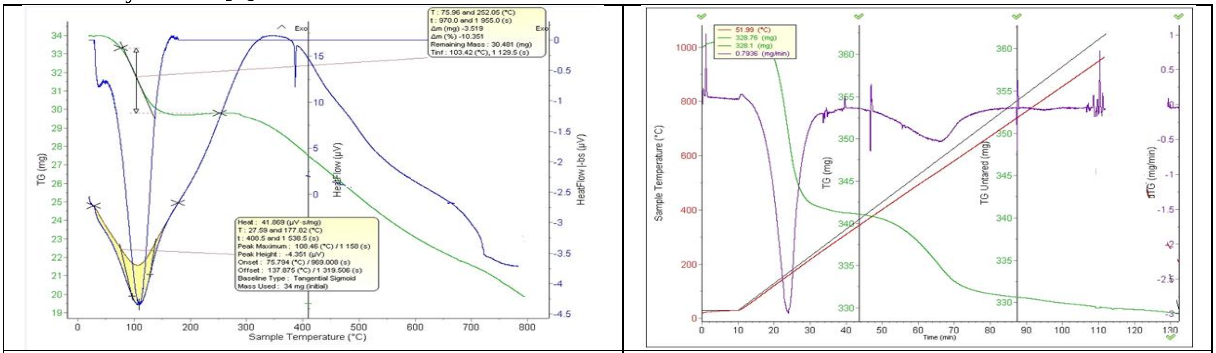
IV. EXPERIMENTAL RESULTS

Determining the content of functional substances in an unknown sample can lead to the determination of its derivatographic and endothermic peak area, and subsequently, the determination of the content of functional substances by the standard curve given for the derivatograph. Each step can be characterized by kinetic parameters determined by derivative analysis data [3].



a) b)

Figure 1. Derivatographic images: a) coal; b) bentonite

Thus, the derivatogram lines of coal and bentonite turned out to be almost the same. In the first peak of the endothermic reaction, the evaporation of structural water and volatile organic compounds was observed in the temperature range from 70°C to 300°C. The second peak was mainly observed after 300°C, after the coal was completely burned, leaving stable metal oxides and clay-bentonite in the bentonite. In the derivatographic analysis of coal and bentonite, the optimal parameters of decarbonization were established at 600°C for 40 minutes and activation at 950°C for 45 minutes. The main parameters of the subsequent quality control of the obtained granules are then calculated for use in order to create opportunities for reabsorption, strength and regeneration [4].

Derivatographic analysis results showed the practical possibilities of using coal and bentonite as starting materials for obtaining sorbents.

The speed of the sorption process and the reverse desorption process depend on the concentration of the substance in the solution and the surface of the sorbent. At the initial stage of the process, the concentration of the substance in the solution is maximum, so the level of sorption is also maximum. As the concentration of the substance on the surface of the sorbent increases, the number of molecules returning from the sorbent to the solution also increases [5].

Due to the increased consumption of electricity in the production of thermally activated sorbents from bentonite and coal, the obtained sorbents should have the ability to be used repeatedly in technological processes for their effective use. That is, used sorbents must be regenerated.

The simplest method of sorbent regeneration is to heat it in a certain volume of treated water. This leads to an increase in the degree of dissociation and solubility of sorbate and, as a result, desorption of sorbate particles. 20-30% of sorbate is desorbed at 90°C [6].

Chemical regeneration usually means sorbent processing with liquid or gaseous organic or inorganic reagents at a temperature not higher than 110°C.

Thermal and electrothermal regeneration is based on sequential thermal degradation of sorbate to volatile products and condensable intermediates, followed by reactivation and combustion of all volatile products [7].

Results and discussion. During the research, samples of bentonite-coal sorbent in the form of granules were taken, and their sorption capacity, degree of consistency, and bulk density were checked.

In order to increase the porosity of the sorbents, several modifying agents were added, and it was found that the sorption capacity of the sorbents modified with sodium salts increased.

Also, a number of parameters of sorbent samples were determined based on the theories of BET and Langmuir adsorption isotherms [8-9]. The results are presented in the table below.

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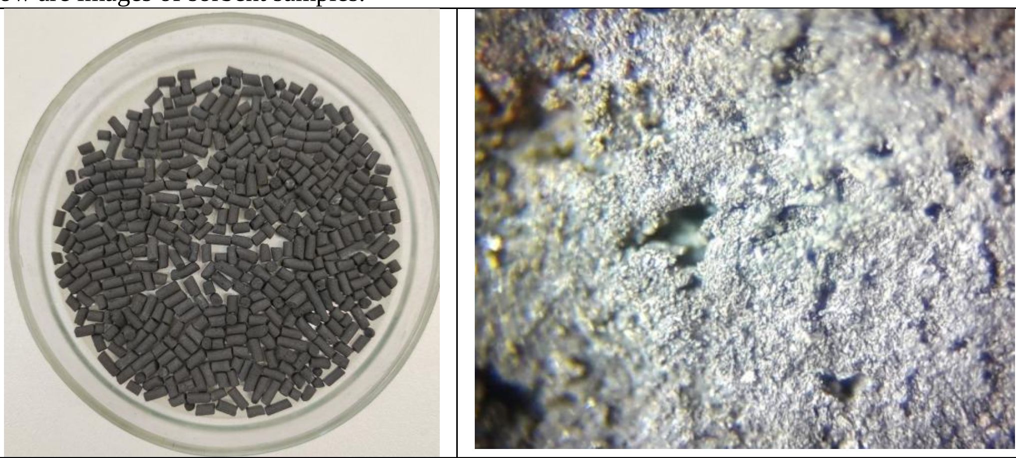
Porosity parameters of the structure of sorbent samples calculated on the basis of nitrogen adsorption isotherm

Table 1

Sample	**Ratio**	**According to BET C_{salt}, m^2/g**	**According to Langmuir C_{salt}, m^2/g**	**V_{mikr}, mm^3/g**	**V_{total}, mm^3/g**	**Microporous surface area, m^2/g**	**Non-microporous field surface, m^2/g**	**Average diameter D, nm**
1	BK12/H-5	35,142	45,07	17,93	-	50,875	5,805	-
2	BK 12/CH-5	128,85	184,02	38,01	188,1	107,870	20,980	60,21
3	BK12/O-10, K-5	62,9	86,53	10,901	82,11	30,940	31,965	26,77

Below are images of sorbent samples.



a) b)

Figure 2. Bentonite-coal sorbents a) simple; b) microscope image

Currently, a production facility specializing in BIOX technology has been built in the city of Uchquduq. Technological and waste waters of the BIOX production facility were brought to the laboratory of NDKTU for analysis. In the university laboratory, the amount of cations and anions in the waste water was examined using a DR-900 portable calorimeter.

The table below shows the amount of ions absorbed by bentonite-coal sorbents after regeneration.

Table 2

Ions (mg/l) / Sample	**Al**	**Br**	**Ca**	**Cl^-**	**Cu**	**Fe**	**K**	**Mg**	**Mo**	**Mn**	**SiO_2**	**happiness**
BIOX	0,028	0,12	0,21	0,09	0,01	0,04	0,3	0,10	4,3	0,4	2	11
Waste	0,068	0,0433	0,203	0,246	0,723	0,033	0,4	0,09	4,67	0,33	0,0967	30
Sorbent (B)	0,011	0,05	0,08	0,03	-	0,01	0,1	0,04	0,01	0,2	1	1
Sorbent (Ch)	0,006	0,02	0,05	0,01	0,11	0,00	0,0	0,02	0,02	0,0	0	2
Sorbent (B, reg. 1)	0,012	0,06	0,10	0,03	1,02	0,02	0,1	0,05	0,03	0,2	1	5
Sorbent (Ch, reg. 1)	0,006	0,03	0,06	0,01	-	0,01	0,0	0,02	0,02	0,0	1	3
Sorbent (Б, рег. 2)	0,010	0,04	0,08	0,02	-	0,01	0,1	0,04	0,03	0,2	-	4
Сорбент (Ч, рег. 2)	0,006	0,03	0,05	0,01	-	0,00	0,0	0,02	0,02	0,0	0	2

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The sorbents of each sample were regenerated under laboratory conditions. For regeneration, initially weak solutions of sulfuric acid (H_2SO_4) and hydrogen peroxide (H_2O_2) were prepared. BIOX and waste water sorbent samples were regenerated with sulfuric acid and hydrogen peroxide. After regeneration, the sorbent samples were re-introduced into BIOX and wastewater. After the sorbent samples were regenerated several times, it was found that the index of absorption of anions and cations did not change when they were put into BIOX and waste water for the last time [10].

V. CONCLUSION AND FUTURE WORK

Based on the derivatographic analysis of bentonite and coal, the initial raw materials obtained, the porosity indicators of the prepared sorbents gave good results. The addition of modifying reagents to the sorbent mass, which burn out during the activation process and cause the formation of additional pores in the sorbent due to their burned-out areas, significantly helped to increase the sorption properties of the sorbent.

Thus, after conducting additional research to purify industrial process waters from heavy metal ions and other pollutants, the expected result, i.e. the high degree of regeneration of the sorbent, was found, which in turn serves as the basis for industrial scale production.

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