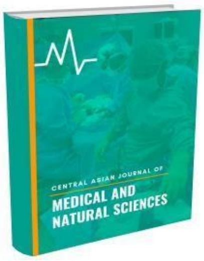

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Article

Study of Texture and Sorption Characteristics of Activated Carbon Obtained from Apricot Kernel Shells

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Abstract: The article studies the textural and sorption characteristics of activated carbon obtained from apricot kernel shells. The activation process involves carbonization at 800 °C and chemical activation with phosphoric acid at 400 °C. The textural properties of the carbon were studied by low-temperature nitrogen adsorption, revealing a specific surface area of 1200 m²/g and a microporous structure. The physicochemical properties were determined by IR spectroscopy, X-ray diffraction, and elemental analysis, which indicated the presence of functional groups and a high carbon content. The sorption properties were evaluated based on the adsorption of methylene blue and phenol from aqueous solutions and demonstrated high sorption capacity. The results obtained indicate the prospects for using apricot kernel peel to produce effective activated carbon suitable for cleaning the aquatic environment from organic pollutants.

Keywords: activated carbon, peat, apricot kernel peel, textural properties, physicochemical properties, sorbent, sorption properties, carbonylation, chemical activation, adsorption, carbon materials

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1. Introduction

Activated carbons with a large specific surface area (micro-, meso- and macroporosity) are widely used in such industries as the chemical industry, environmental protection and medicine. The main consumers of activated carbon are the food industry (42%), technological processes (38%) and environmental protection (10%). Therefore, these materials play a decisive role in solving problems related to the extraction of valuable components and ensuring environmental problems[1].

Activated charcoal has a long history. It has been known for its properties since ancient times. The ancient Egyptians discovered the wonderful properties of activated charcoal and used it in medicine for many years. Later, in ancient Rome, activated charcoal was used to purify liquids (water, wine, beer, etc.)[2]. Currently, activated charcoal is considered the most advanced among other filtering materials .

Activated carbon belongs to the class of macroporous carbonaceous adsorbents, which are high-molecular porous carbon-based materials, characterized by an increased specific surface area and the ability to efficiently and selectively adsorb various molecules from gases, vapors, and liquids. Carbonaceous adsorbents differ significantly from highly porous materials such as coke, pumice, and graphite in the presence of micropores and supermicropores. Carbon black has a high specific surface area (up to

100 m²/g) due to its small particle size, and carbon is classified as a nanoporous adsorbent[3].

It is known that carbon-containing materials (peat, coal, polymers, resins, wood, fruit seeds, plant substances) are used as raw materials for the production of activated carbon. The process of obtaining activated carbon usually consists of the stages of carbonization and activation of raw materials.

It is known from the literature that various fine-pored sorbents such as silica gel, natural and synthetic zeolites, alumina gels, porous glasses and ion exchangers are used for applications such as gas separation and purification, extraction of volatile organic solvents, and filtration and purification of solutions. However, when it comes to the absorption of solid dust in a gas environment, only activated carbon (AC) fully meets the necessary requirements[4].

Activated carbon production is constantly growing, and its application areas are constantly expanding. Traditionally, wood, peat, peat coke, some types of coal and semi-coke based on them are used as raw materials for the production of FC[5]. At the same time, a significant amount of waste is generated annually at food enterprises in our country as a result of the processing of apricots, which are widespread in the republic. In world practice, such waste is considered a promising raw material for the production of activated carbon. There is a lot of information on the processing of valuable products from fruit seed kernels, but information on the production of carbon sorbents from seed shells is rare[6].

Activated carbon is widely used in various fields, including chemistry, medicine, and environmental protection, due to its high adsorption properties. In recent years, special attention has been paid to alternative sources, such as agricultural waste, for obtaining activated carbon. One such source is apricot kernel shells. Intensive research is underway to develop technologies for obtaining special-purpose activated carbon, which is characterized by homogeneity with a pore size of less than 2 nm[7].

In this regard, obtaining homogeneous microporous carbon sorbents from plant materials is an urgent problem.

2. Materials and Methods

In this work, dried and crushed apricot kernel shells were used as a raw material for obtaining activated carbon. The textural properties of activated carbon were analyzed using scanning electron microscopy (SEM) at the High Technologies Center under the Ministry of Higher Education, Science and Innovation of the Republic of Uzbekistan, and semi-quantitative analysis of the elemental composition was performed using energy-dispersive X-ray spectroscopy (EDS)[8].

The total pore volume was determined according to GOST 17219-71, bulk density — according to GOST R 55959-2014, moisture content — according to GOST R 55956-2014. In addition, the pH value of the aqueous extract was measured using a pH meter and the textural characteristics were determined by the Brunauer-Emmett-Teller (BET) method for nitrogen adsorption[9]. Each measurement was repeated 5 times, and the results obtained were subjected to statistical processing at a significance level of P = 0.95.

3. Results

In this work, apricot kernel shells were used as raw materials for obtaining activated carbon. Apricot kernel shells were crushed and a fraction of 3-5 mm was collected by passing through sieves. Carbonization of the sample was carried out under isothermal conditions at a temperature of 400 °C. Heat treatment of the raw material was carried out in an inert atmosphere in the temperature range of 400-800 °C at a rate of 15-20 °C/min and maintained at 800 °C for 40 minutes[10]. In order to form micropores in the internal structure of the carbon and increase the specific surface area, the raw material was activated with water vapor for 60 minutes. The resulting sample was used to study its textural and sorption characteristics. To study the morphological characteristics of the texture, the surface of the obtained sample was analyzed using a scanning electron microscope[11]. The results of SEM and energy-dispersive X-ray spectroscopy (EDS) of the sample under study are shown in Figure 1.

According to the results obtained, the carbon content in adsorbents obtained from apricot kernel peel is 88.6% before carbonization, and 92.6% after carbonization and activation[12].

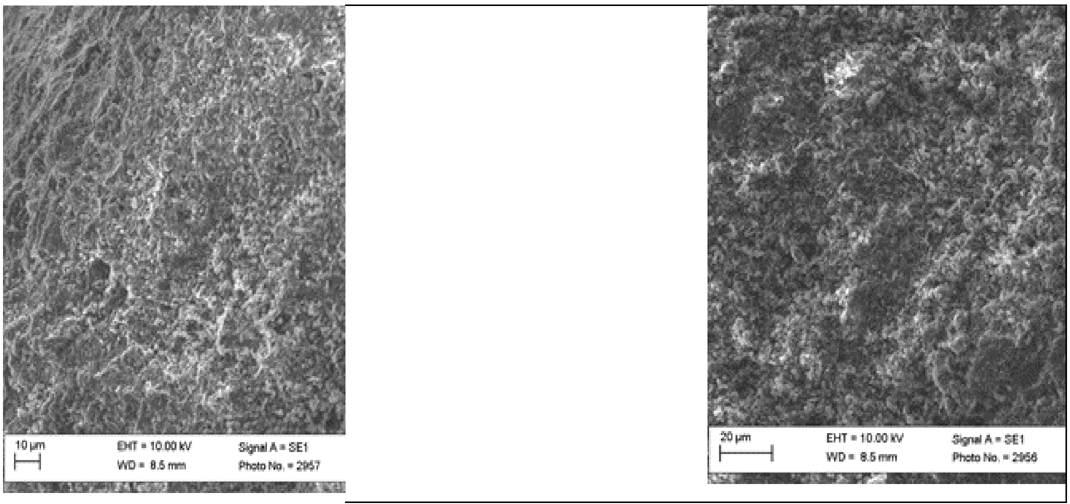

Figure 1. SEM image of the surface of activated carbon obtained from apricot kernel shells (at 500 °C)[13].

The SEM surface image of the surface of activated carbon, which was steamed in a vacuum reactor at 8000C, and the X-ray microanalysis of the sample are shown in Figure 2.

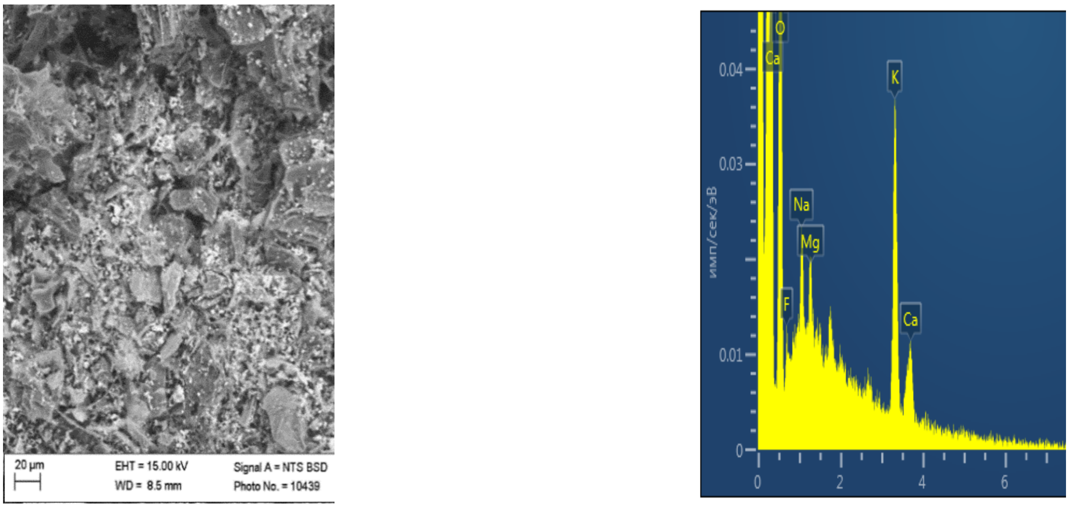

Figure 2. Image of the surface and elemental composition of a sample activated by water vapor

Table

Physicochemical characteristics of activated carbon

Characteristics	Adsorbent	
	Apricot peel	Standard FK
Humidity, %	7,40	7,90

Water pore volume, cm^3/g	0,75	0,58
pH of the aqueous extract of the sorbent	7,10	6,70
Density during dispersion, g/dm^3	255	230
Relative surface area (BET method), m^2/g	905	725

It can be noted that activated carbon obtained from apricot kernel peel has a high adsorption surface area, the value of which was 905 m^2/g[14].

The results of low-temperature nitrogen adsorption showed that the activated carbon obtained from apricot kernel peel had a high specific surface area of 905 m^2/g and a predominantly microporous structure. Regarding the physicochemical characteristics, IR spectroscopy revealed the presence of functional groups such as hydroxyl and carbonyl groups on the surface of the activated carbon. X-ray diffraction revealed the amorphous nature of the carbon material.

The specific surface area of 905 m^2/g indicates a well-developed porous structure, which is essential for enhancing adsorption capacity. A larger surface area typically provides more active sites for interaction with pollutants, gases, or other adsorbates, making it suitable for a wide range of applications, including water purification, gas storage, and industrial separation processes[15]. The total pore volume of 0.75 cm^3/g further supports the presence of a highly porous network, contributing to the material's ability to effectively trap and retain various substances.

Additionally, the physicochemical properties of the apricot kernel shell-derived activated carbon, such as a moisture content of 7.4% and a neutral pH of 7.1, indicate stability and compatibility in various environmental conditions[16]. The neutral pH is particularly beneficial, as it minimizes the risk of altering the pH of treated solutions, making it suitable for applications in both acidic and basic environments. The bulk density of 255 g/dm^3 suggests that the material is lightweight, which can be advantageous in large-scale industrial applications where handling and transportation are key considerations.

4. Conclusion

In conclusion, the findings of this study highlight the exceptional carbon content and physicochemical properties of activated carbon derived from apricot kernel shells. The results of the semi-quantitative elemental analysis, conducted using energy-dispersive X-ray spectroscopy (EDAX), indicate that this adsorbent exhibits an impressively high carbon content of 99.4%[11]. Furthermore, the activated carbon demonstrates favorable characteristics, including a moisture content of 7.4%, a total pore volume in water of 0.75 cm^3/g, and a neutral pH of 7.1. Additionally, its bulk density is measured at 255 g/dm^3, while the specific surface area reaches 905 m^2/g. These properties suggest that apricot kernel shell-derived activated carbon possesses significant potential for adsorption applications, making it a promising material for various industrial and environmental uses.

REFERENCES

[1] A. A. Surkov, I. S. Glushankova, and N. A. Balabenko, 'Synthesis of carbon sorbents from polycarbonate waste by chemical activation', *Fundam. Res.*, vol. 1, no. 9, 2012.

[2] H. C. Foley, 'Carbogenic molecular sieves: synthesis, properties and applications', *Microporous Mater.*, vol. 4, no. 6, pp. 407–433, 1995.

[3] N. V. Chesnokov and others, ‘Synthesis of carbon sorbents by chemical modification of fossil coals and plant biomass’, *J. Sib. Fed. Univ. Chem.*, vol. 7, no. 1, p. 42, 2014.
[4] M. A. Perederiy and others, ‘Sorption of petroleum products by carbon sorbents’, *Chem. Solid Fuel*, no. 5, pp. 42–46, 2009.
[5] M. F. Hassan and others, ‘Recent trends in activated carbon fibers production from various precursors and applications—A comparative review’, *J. Anal. Appl. Pyrolysis*, vol. 145, p. 104715, 2020.
[6] *Activated angle. Standard methods for determining moisture content*. Standartinform, 2014.
[7] A. V. Samarov and others, ‘Production of highly porous carbon materials (sorbents) from coals, cokes and individual organic compounds for adsorption storage of methane’, *Coke Chem.*, no. 9, pp. 29–34, 2012.
[8] O. N. Baklanova, G. V. Plaksin, and V. A. Drozdov, ‘Microporous carbon sorbents based on plant raw materials’, *Russ. Chem. J.*, vol. 48, no. 3, pp. 89–94, 2004.
[9] *Activated carbons. Method for determination of total pore volume by water*. Publishing House of Standards, 1987.
[10] R. Sh. Vartapetyan and A. M. Voloshuk, ‘Mechanism of adsorption of water molecules on carbon adsorbents’, *Adv. Chem.*, vol. 64, no. 11, pp. 1055–1072, 1995.
[11] V. M. Mukhin and others, ‘Activated carbons and their application in non-ferrous metallurgy enterprises’, *Non-Ferr. Metall.*, no. 4, pp. 32–37, 2014.
[12] A. S. Vyacheslavov and E. A. Pomeranseva, *Measurement of surface area and porosity by the method of capillary condensation of nitrogen: methodical development*. Moscow State University, 2006.
[13] L. G. Pyanova, ‘Carbon sorbents in medicine and proteomics’, *Chem. Sustain. Dev.*, vol. 19, no. 1, pp. 113–122, 2011.
[14] *Activated carbon. Standard method for determination of bulk density*. Standartinform, 2014.
[15] G. A. Budnisky, B. S. Matveyev, and M. E. Kazakov, ‘Carbon fibers and materials based on viscose fibers’, *Chem. Fibers*, no. 5, pp. 19–22, 1993.
[16] N. V. Keltsev, *Basics of adsorption technology*. Chemistry, 1984.