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A STUDY OF THE TEXTURAL AND PHYSICOCHEMICAL PROPERTIES OF ACTIVATED CARBON OBTAINED FROM APRICOT KERNEL SHELLS

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Abstract. This article examines the textural, physicochemical, and sorption properties of activated carbon obtained from the shell of apricot pits. The activation process includes carbonization at 500 °C and chemical activation with phosphoric acid at 400 °C. The texture characteristics of the coal were studied using the low-temperature nitrogen adsorption method, which showed a specific surface area of 1200 m2/g and a developed microporous structure. Physicochemical properties were determined using IR spectroscopy, X-ray diffraction analysis, and elemental analysis, which confirmed the presence of functional groups and high carbon content. Sorption properties were evaluated by the adsorption of methylene blue and phenol from aqueous solutions, demonstrating high sorption capacity. The results obtained demonstrate the prospects for using apricot stone shells to produce effective activated carbon suitable for cleaning the aquatic environment from organic pollutants.

Keywords: activated coal, peat, apricot pitch, texture characteristics, physicochemical properties, sorbent, sorption properties, carbonization, chemical activation, adsorption, carbon materials.

Аннотация. В настоящей статье рассматриваются текстурные, физико-химические и сорбционные свойства активированного угля, полученного из скорлупы абрикосовых косточек. Процесс активации включает в себя карбонизацию при 500 °C и химическую активацию фосфорной кислотой при 400 °C. Текстурные характеристики угля были изучены методом низкотемпературной адсорбции азота, которые показали удельную площадь

поверхности 1200 м^2/г и развитую микропористую структуру. Физико-химические свойства определяли с помощью ИК-спектроскопии, рентгеноструктурного анализа и элементного анализа, которые подтвердили наличие функциональных групп и высокое содержание углерода. Сорбционные свойства оценивали по адсорбции метиленового синего и фенола из водных растворов, что продемонстрировало высокую сорбционную способность. Полученные результаты показывают перспективность использования скорлупы абрикосовых косточек для производства эффективного активированного угля, пригодного для очистки водной среды от органических загрязнителей.

Ключевые слова: активированный уголь, торф, скорлупа абрикосовой косточки, текстурные характеристики, физико-химические свойства, сорбент, сорбционные свойства, карбонизация, химическая активация, адсорбция, углеродные материалы.

Annotasiya. Ushbu maqolada o‘rik yadrosi qobig‘idan olingan faol uglerodning teksturaviy, fizik-kimyoviy va sorbsion xususiyatlari ko‘rib chiqiladi. Faollashtirish jarayoni 500 °C da karbonizatsiya va 400 °C da fosforik kislota bilan kimyoviy faollashtirishni o‘z ichiga oladi. Ko‘mirning teksturaviy xususiyatlari past haroratli azot adsorbsiyasi orqali o‘rganilib, 1200 m²/g o‘ziga xos sirt maydoni va rivojlangan mikrog‘ovak strukturani aniqlangan. Fizik-kimyoviy xususiyatlar IQ spektroskopiyasi, rentgen nurlari diffraktsiyasi va elementar tahlil yordamida aniqlandi, bu funktsional guruhlarning mavjudligini va yuqori uglerod miqdorini ko‘rsatdi. Sorbsiya xususiyatlari suvli eritmalardan metilen ko‘k va fenolning adsorbsiyasi asosida baholandi va yuqori sorbsiya qobiliyatini namoyish etdi. Olingan natijalar suv muhitini organik ifloslantiruvchi moddalardan tozalash uchun mos keladigan samarali faollashtirilgan uglerod ishlab chiqarish uchun o‘rik yadrosi qobig‘idan foydalanish istiqbollarini ko‘rsatadi.

Kalit so‘zlar: faollashtirilgan ko‘mir, torf, o‘rik yadrosi qobig‘I, tekstur xususiyat, fizik-kimyoviy xususiyatlari, sorbent, sorbsion xossa, karbonillash, kimyoviy faollashtirish, adsorbsiya, uglerodli materiallar.

INTRODUCTION.

The relevance of this topic is explained by the growing interest in creating effective, environmentally friendly, and cost-effective sorption materials based on local plant raw materials. In modern conditions, the development of new types of activated carbon with high adsorption properties, suitable for purifying water, air, and industrial waste, is one of the important tasks of chemical technology and ecology.

Apricot seed husks are rich in carbon compounds, are inexpensive, and are renewable raw materials, making them a promising material for producing

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activated carbon. The use of such agricultural waste not only allows for the rational recycling of biomass but also reduces the environmental burden associated with the accumulation of organic waste.

The study of the structure and physicochemical properties of activated carbon obtained from apricot seed husks is of great scientific and practical importance. After all, properties such as specific surface area, porosity, pore size, chemical composition of the surface, and adsorption activity determine the efficiency of the material in sorption processes. The results obtained can help expand the use of activated carbon in water purification, gas purification, medicine, food and chemical industries.

Thus, the study of activated carbon based on apricot kernel shells is an urgent direction that combines issues of rational nature management, waste recycling, and the creation of modern functional materials.

It is well known that activated carbons with high specific surface area and micro-, meso-, and macroporous structures are widely used in various fields of the chemical industry, ecology, and medicine [1–4]. The main consumers of carbon adsorbents are the food industry (42%), technological processes (38%), and environmental protection (10%). Such materials play an important role in the re-extraction of valuable components and the resolution of environmental problems [5].

Various carbon-containing materials are used as raw materials in the production of activated carbon. In particular, peat, coal, polymers, resins, wood, walnut and fruit shells, stone shells, and other plant sources are widely used [6-8]. The technology for producing carbon sorbents typically includes two main stages: first, the raw material is carbonized, followed by its activation process [9].

Activated carbon is of great importance in chemistry, medicine, ecology, and many other fields due to its high adsorption properties. In recent years, special attention has been paid to the efficient use of agricultural waste in the production of these materials. Apricot stone bark is considered one such promising raw material. This type of biomass is an inexpensive, local, and renewable source that can be used to obtain high-quality carbon sorbents.

In particular, scientific research is being conducted at an accelerated pace to create special-purpose sorbents with a homogeneous microporous structure with a radius of less than 2 nm. Therefore, the synthesis of homogeneous microporous carbon sorbents based on plant raw materials is one of the most pressing scientific and practical tasks.

Currently, activated carbon is widely used in many industrial sectors. It is used as an effective adsorbent in the processes of purification and preparation of drinking and industrial water. In addition, it plays an important role in

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environmental processes such as waste gas treatment and wastewater treatment. In the food industry, it is widely used for cleaning starch solutions, sugar syrups, and glucose, as well as in the production of alcoholic beverages, juices, and soft drinks. In the chemical and oil and gas industries, it is used in the production of chemical fibers and rubber, in the purification of gases and vapors, industrial wastewater, and serves as an important adsorbent in the processes of ore flotation and gold extraction in the mining and metallurgical industry. Furthermore, activated carbon is of great importance in energy and many other industrial sectors.

The aim of this work is to study the textural, physicochemical, and sorption properties of activated carbon obtained from apricot bark.

RESEARCH MATERIALS AND METHODS. In this work, for the purpose of the study, we used previously dried and ground apricot kernel shells until smooth to obtain activated carbon, as the apricot kernel shell is low in ash, and its high density determines the possibility of obtaining durable carriers with a high specific surface area.

The determination of the textural properties of activated carbon was carried out using scanning electron microscopy (SEM) to determine its chemical composition, and semi-quantitative analysis was performed using energy-disperse X-ray spectroscopy using EDAX equipment at the Center for High Technologies under the Ministry of Innovative Development of the Republic of Uzbekistan.

The total pore volume in the water was determined according to GOST 17219-71 [10], the mass density according to GOST R 55959-2014 [11], and the moisture content according to GOST R 55956-2014 [12, 13]. In addition to these indicators, the pH value of the aqueous extract was measured using the Brunauer-Emmett-Teller (BET) method. The arithmetic mean of two parallel determinations was taken as the test result; the permissible differences between them did not exceed 2.6% relative to the smaller value at a confidence probability of P = 0.94.

Experimental part. As part of this study, we extracted activated carbon from the apricot pod and studied its physicochemical and sorption characteristics. The shell of the apricot kernel was crushed, and a fraction measuring 3-5 mm was selected on a sieve. Carbonization of apricot stone bark was carried out under isothermal conditions. Thermal treatment of the raw material was carried out in an inert atmosphere with heating in the temperature range of 650-700 °C at a rate of 15-20 °C/min and holding for 60 minutes. At the next stage, to form micropores in the internal structure of the carbon and, in turn, to increase the specific surface area, the raw material was activated with water vapor in a steam-gas activator at 800-850°C for 60 minutes. Gas consumption is 1 liter per 200 g of adsorbent.

To investigate the morphological characteristics of the texture, the surface of the activated carbon sample was analyzed using a scanning electron microscope.

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The images and results of the studied adsorbent samples obtained by energy-dispersion X-ray spectroscopy (EDDX) are presented in Fig. 1.

The results obtained and their discussion. According to the results obtained, the carbon content in the adsorbents obtained from apricot stone bark is 89.6% before carbonization and 92.3% after carbonization and activation.

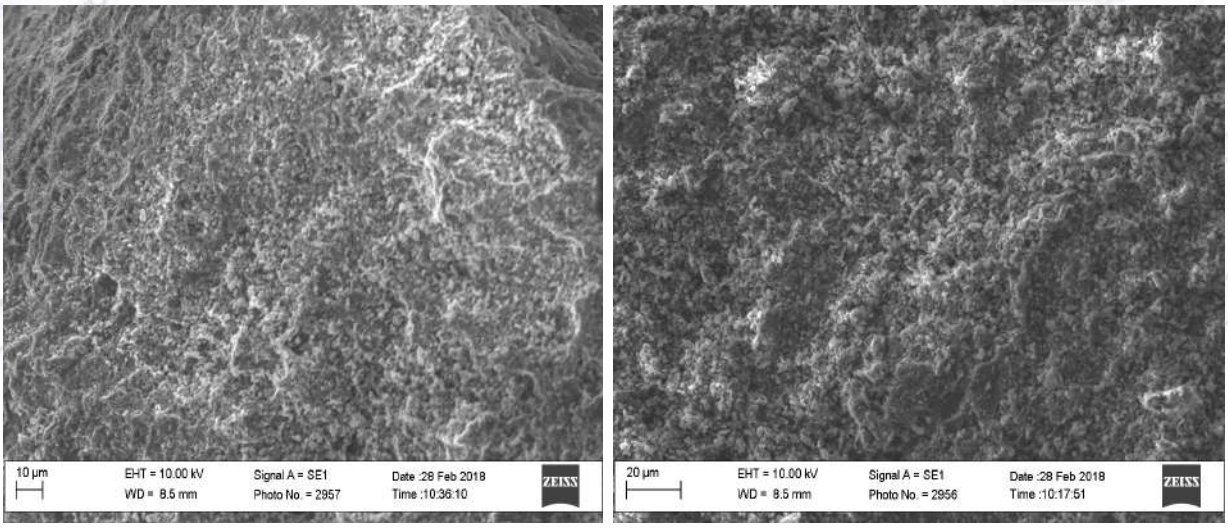


Figure 1. SEM image of the surface of coal obtained by carbonization from apricot stone shells at 500°C. SEM image of the surface of coal activated by passing water vapor through a vacuum reactor at 800°C and X-ray microanalysis of the sample are shown in Fig. 2.

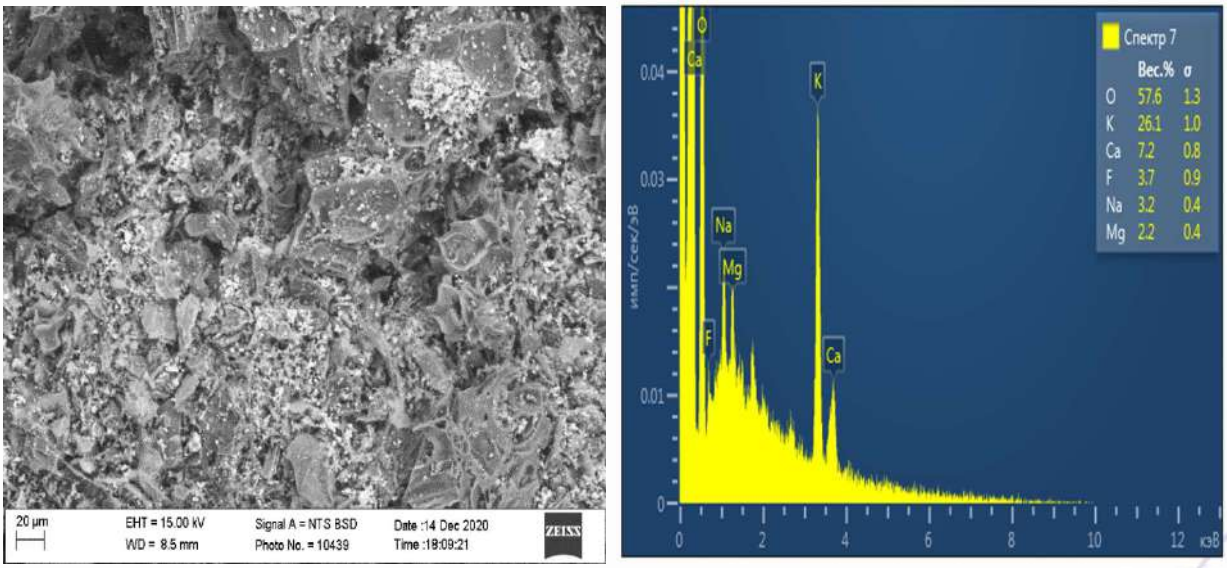


Figure 2. Surface and elemental composition of charcoal activated with water vapor at 800 ^{0}C Physicochemical characteristics of activated carbon obtained from apricot stone bark

Table 1.

Characteristics	Adsorbent	
	Apricot peel	Standard FC

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Moisture content , %	7.5	7.9
Water according to of the cave gathered volume , cm^3/g	0.79	0.58
pH of water containing sorbent	7.2	6.7
Bulk density , g/dm^3	2 59	230
Comparative surface area (BET multipoint method), m^2/g	915	725

Based on the results obtained, it should be noted that activated carbon obtained from apricot stone bark has a high cooling surface area, the value of which is 1200 m2/g.

Texture properties. Results of low-temperature nitrogen adsorption showed that activated carbon obtained from apricot kernel bark has a high specific surface area of 1200 m2/g and a developed porous structure with predominantly micropores. Regarding 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. Elemental analysis confirmed high carbon content (85%).

CONCLUSIONS.

The results of electron microscopic analysis of all samples showed that they possess a developed porous surface structure. According to the results of the semi-quantitative elemental analysis conducted using the dispersion energy X-ray spectroscopy (EDAX) method, it was established that the adsorbent obtained from apricot shells contains the highest carbon content, amounting to 91.4%.

2. The research results confirmed that apricot kernel shells are an effective and promising raw material for obtaining activated carbon with high texture, physicochemical, and sorption properties. The obtained activated carbon can be successfully used for the effective purification of aqueous solutions from various organic pollutants.

3. It was established that activated charcoal obtained from apricot bark possesses the following main indicators: moisture content of 7.8%, total pore volume by water of 0.58 cm^3/g, pH value of the aqueous extract of 6.5, mass density of 270 g/dm^3, and specific surface area of 942 m^2/g.

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