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PREPARATION OF ACTIVATED CARBON FROM ALMOND SHELLS

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ABSTRACT: In the work the results of electron microscopic examination of samples of activated carbon, prepared from almond shells show that their structures have a developed porous surface. According to the results of semi-quantitative elemental analysis of the adsorbents under study by the method of energy dispersive X-ray spectroscopy (EDAX), it was found that the adsorbent based on almond shells has the highest carbon content (94%). The activated carbon prepared from almond shells has the following characteristics: moisture content - 7.7%, total pore volume on water - 0.71 cm3/g, pH of the aqueous extract - 7.2, bulk density - 282 g/dm3, adsorption activity on iodine - 63.4%, specific surface area - 882 m2/g.

KEYWORDS: adsorbent, activated carbon, activation, carbonization, volume, microscopy, almond, pore, wastes.

INTRODUCTION

Activated carbons with well-developed pore structures have been used as adsorbents in wastewater treatment [1,2,3], in various areas of the chemical industry, ecology and medicine [4,5,6]. According to the authors [7], the main consumers of carbon adsorbents are food production (42%), technological use (38%), environmental protection (10%). On their basis, many problems of recovering valuable components, as well as environmental protection are solved.

Carbonaceous materials of various origins are used as raw materials for the preparation of activated carbons: peat, coal, vegetable raw materials like wood, bark, shells, fruit pits and others [8,9,10,11,12]. Technological issues related to the production of multi-purpose carbon sorbents from the above listed raw materials are practically solved and consist of two stages, including carbonization and activation of the raw material [13].

In recent years, the researches on the development of technology for the preparation of carbon sorbents for special purposes, in particular homogeneous-microporous (pores with a radius of <2 nm) have been most intensively carried out. In this connection, the production of homogeneous microporous carbon sorbents from seeds raw materials is actual.

PURPOSE OF THE RESEARCH

Prepare activated carbon from almond shells and study their textural, physicochemical and sorption characteristics.

MATERIAL AND METHODS OF RESEARCH

In this work, the almond shells grown in Uzbekistan were used to prepare activated carbon, since the plant fiber of the shells are low-ash, and its high density determines the possibility of obtaining strong carriers with high specific surface area [7].

The textural characteristics of the activated carbon prepared from almond shells have been studied by scanning electron microscopy SEM EVO MA 10 (Carl Zeiss). Semi-quantitative analysis was performed by energy dispersive X-ray spectroscopy using EDAX equipment to determine the chemical composition of the shells. The analysis was carried out at the “High Technologies Center” under the Ministry of Innovation Development of the Republic of Uzbekistan.

Determination of the total pore volume on water was carried out according to GOST 17219- 71 [14], bulk density according to GOST R 55959-2014 [15] and moisture content according to GOST P 55956-2014 [16]. In addition to these indicators, the pH of the aqueous extract was determined with a pH meter, the sorption capacity for iodine, as well as the specific surface area and the total pore volume of the activated carbon according to the Brunauer-Emmett-Teller method (BET). Traditional birch-based activated carbon (BAC) (Irbit Chemical Pharmaceutical Plant, Irbit, Russia) was used as reference samples.

The arithmetic average of two parallel determinations was taken as the test result, the allowable discrepancies between them with a confidence probability of $P = 0.95$, which did not exceed 2.5% relatively to the smaller value.

RESULTS AND DISCUSSION

The almond shells have been water washed, dried, crushed and a working fraction of 3 ÷ 5 mm was selected by sieving. The process of carbonization of the samples of the almond shells was carried out using Muffle furnace in isothermal conditions. Thermic treatment of the raw material was carried out in an inert atmosphere in the temperature range of 650–700°C with a heating rate of 15–20°C/min and a holding time of 60 min (at a given temperature). At the next stage, for the formation of micropores in the internal structure of the coal and thus to increase the specific surface area, the resulting raw coal was subjected to activation with water vapor at an activation temperature of 800–850°C for 60 min on a vapor – gas activation device. The gas flow rate was 1 l per 200 g of the adsorbent.

The specific surface area of the samples was estimated by the BET method, the micropore volume by the t-method on the adsorption branch of the isotherm, and the average diameter of the mesopores by the Barrett-Joyner-Halenda method (BDH) on the desorption branch of the isotherm. The total specific pore volume was determined by the nitrogen adsorption isotherm with the value of the relative pressure of 0.99. Before measuring the adsorption isotherms, the samples were degassed at 200°C and a residual pressure of 10–3 mm Hg within 2 hours [17,18].

To study the morphological features of the surface texture of the samples of the activated carbon, an analysis was performed using scanning electron microscopy and the result is presented in figure 1.

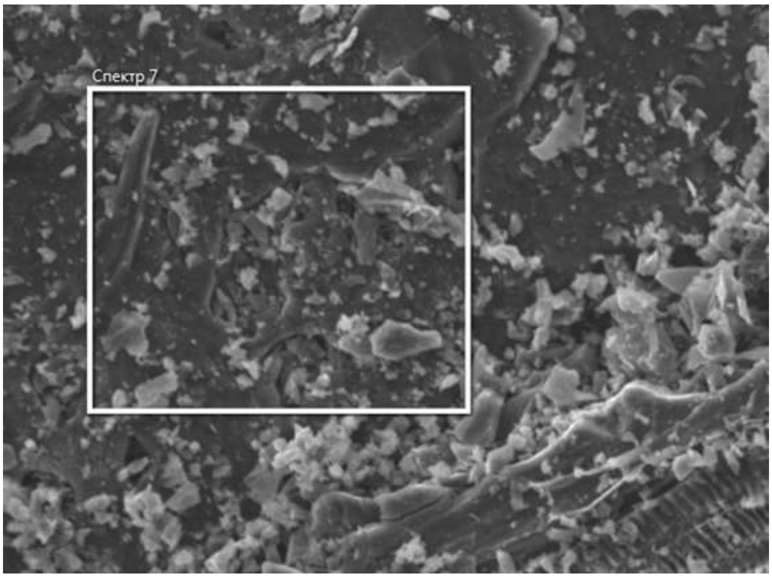

Figure 1. Micrograph of an activated carbon sample

The results of electron microscopic examination of all samples showed that their structures have a developed porous surface. In micrographs of carbonizates of the almond shells, a small number of large pores in the form of cracks, as well as a large number of micropores can be observed.

Pictures and results of semi-quantitative elemental analysis of the studied adsorbents, obtained by the method of energy dispersive X-ray spectroscopy (EDAX), are presented in Figure 2.

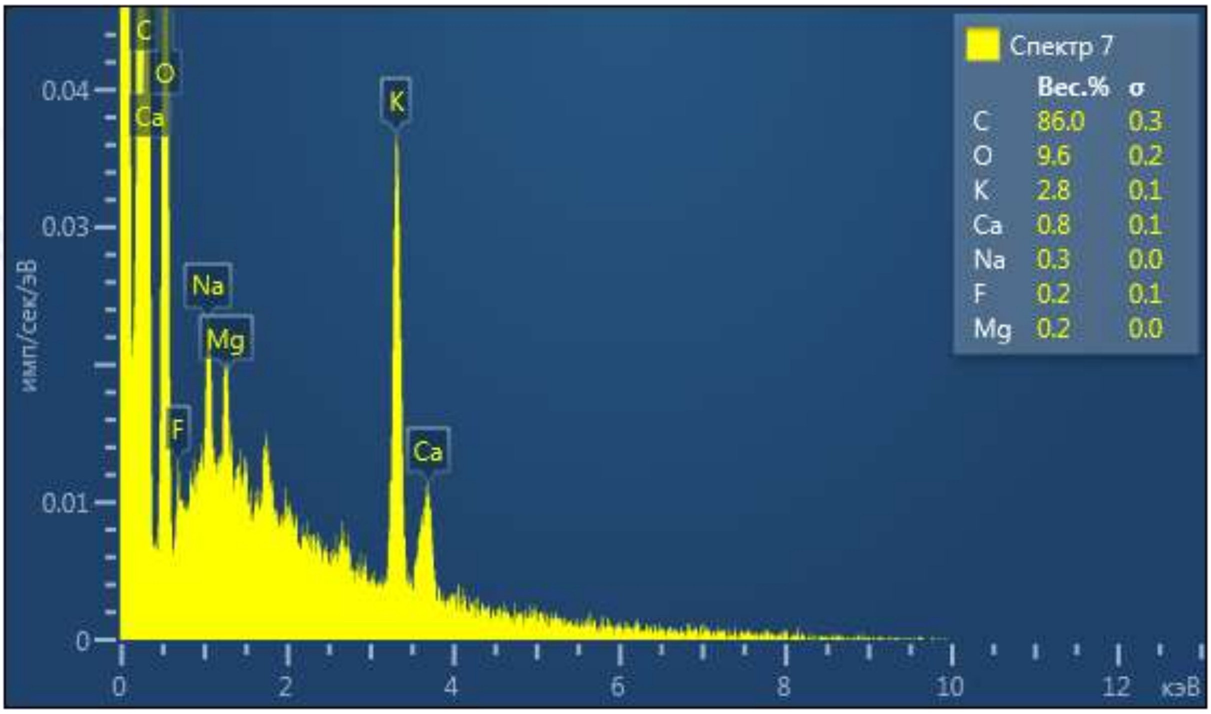

Figure 2. Results of semi-quantitative elemental analysis by energy dispersive X-ray spectroscopy

According to obtained results carbon content in the adsorbents based on the almond shells before carbonization is 86.0 wt %, after carbonization and activation – 92 wt%.

The physicochemical characteristics of the prepared carbon-containing adsorbents (Table 1) are comparable with those of the adsorbent based on activated carbon (AC), and surpass it on some indicators.

Bulk density is one of the most important indicators of porous carbon materials. The lower this index, the better the adsorption qualities of coal in volume, since an adsorbent in a bulk quantity is poured into an adsorber for gas purification [19]. The indicator of the bulk density of the obtained adsorbent is greater than that of AC and is respectively 282 and 230 g/dm3. The resulting adsorbents also have a weakly acidic medium, i.e. the pH of the aqueous extract is 6.9.

Table 1. Physico-chemical characteristics of activated carbon produced from almond shells

Characteristics	Adsorbent	
	Almond shells	AC
Moisture contents, %	7,7	7,9
Total pore volume on water, cm3/g	0,71	0,58
pH of the aqueous extract	7,2	6,7
Bulk density, g/dm3	282	230
Adsorption activity on iodine,%	63,4	59,4
Specific surface area (Multipoint BET method), m2/g	882	725

Iodine number is a relative indicator of the porosity of activated carbons. It does not necessarily correlate with the adsorption capacity of carbon relative to other adsorbates [20]. The iodine number can be considered as an indicator of the free specific surface area, provided, mainly, by larger micropores; the obtained values for iodine number for the adsorbents investigated show that these adsorbents have high microporosity [20]. The highest indicators of adsorption activity on iodine in an adsorbent based on almond shells are 63.4%. Micropore volume also affects the specific surface area. According to the obtained results, it follows that the adsorbent based on the almond shells also has the highest indicator of specific surface area - 882 m2/g.

CONCLUSIONS

1. The results of electron microscopic examination of all samples showed that their samples have a developed porous surface. According to the results of semi-quantitative elemental analysis of the adsorbents under study by the method of energy dispersive X-ray spectroscopy (EDAX), it was found that the adsorbent based on the almond shells has the highest carbon content (92 %).
2. 2. The activated carbon prepared from the almond shells has the following characteristics: moisture content - - 7.7%, total pore volume on water - 0.71 cm3/g, pH of the aqueous extract - 7.2, bulk density - 282 g/dm3, adsorption activity on iodine - 63.4%, specific surface area - 882 m2/g

REFERENCES:

[1]. Varsha Raynade1, Ravindra Chigare1, Jaykumar Patil2, Siddharth Kamat1. Preparation of Activated Carbon using Almond Shell for Removal of Thymol Blue Dye from Waste Water Sample. // International Research Journal of Engineering and Technology (IRJET). -2020. –V.7. –Issue 8. –P.2550-2555.

[2]. Yilin Jiang. Synthesis of activated carbon from walnut shells by physical activation. // AIP Conference Proceedings 1839. -2017.

[3]. Shahla Davidi, Asghar Lashanizadegan and Hakimeh Sharififard. Walnut shell activated carbon: optimization of synthesis process, characterization and application for Zn (II) removal in batch

and continuous process. // Materials Research Express 6 (2019) 085621.
[4]. Foley H. C. Carbogenic molecular sieves: synthesis, properties and applications //Microporous Materials. – 1995. – V. 4. – №. 6. – P. 407-433.
[5]. Pyanova L. G. Carbon sorbents in medicine and proteomics // Chemistry for Sustainable Development. - 2011. - V. 19. - №. 1. - p. 113-122. (in Russian)
[6]. Peredney M.A. Carbon sorbents from fossil coal: state of the problem and development prospects // Chemistry of solid fuels. - 2005. - №. 1. - p. 76-90. (in Russian)
[7]. Perederiy M.A., et al. Sorption of oil products with carbon sorbents // Chemistry of solid fuels. - 2009. - No. 5. - pp. 42-46. (in Russian)
[8]. Baklanova O. N., Plaksin G. V., Drozdov V. A. Microporous carbon sorbents based on vegetable raw materials // Russian Chemical Journal. - 2004. - V. 48. - №. 3. - p. 89-94. (in Russian)
[9]. Mukhamadiev A.N., Sayitkulov Sh.M., Muhamadiev N.Q. Study of textural, physico-chemical and sorption characteristics of activated carbon, prepared from apricot kernels. // International Journal of Research in Medical and Basic Sciences. – 2019. –V.5. -Issue 6. –P.1-7.
[10]. Surkov A.A., Glushankova I.S., Balabenko N.A. Synthesis of carbon sorbents from polycarbonate wastes by the method of chemical activation // Basic research. - 2012. - V. 1. - №. 9. (in Russian)
[11]. Chesnokov N.V. et al. Synthesis of Carbon Sorbents by Chemical Modification of Fossil Coals and Plant Biomass // Journal of Siberian Federal University. Chemistry. - 2014. - V. 7. - №. 1. - p. 42. (in Russian)
[12]. Budnitsky A. A., Matveev V. K., Kazakov M.E. Carbon Fibers and Materials Based on Viscose Fibers, Chem. Fibers. - 1993. - No. 5. - p. 19-22. (in Russian)
[13]. Vartapetyan R. Sh., Voloshchuk A.M. The mechanism of adsorption of water molecules on carbon adsorbents // Advances in Chemistry. - 1995. - V. 64. - №. 11. - p. 1055-1072. (in Russian)
[14]. GOST 17219-71. Coals are active. Method for determining the total pore volume on water. -M.: Publishing Standards, 1987. – p.11-14. (in Russian)
[15]. GOST R 55959-2014. Activated carbon. Standard Test Method for Bulk Density. - M .: Standardinform, 2014. – p.1–5. (in Russian)
[16]. GOST R 55956-2014. Activated carbon. Standard methods for determining moisture content. -M .: Standardinform, 2014. – p.1-6. (in Russian)
[17]. Vyacheslavov A.S., Pomerantseva E.A. Measurement of surface area and porosity by capillary condensation of nitrogen: methodical development. - M .: MSU, 2006. - P. 55. (in Russian)
[18]. Vyacheslavov A.S., Efremova M. Determination of surface area and porosity of materials by the method of gas sorption. - M .: MSU, 2011. - 65 p. (in Russian)
[19]. Kabulov A.T. The technology of obtaining composite carbon-containing materials based on carbon raw materials of Kazakhstan // Dis. d.ph. (PhD) - Almaty. - 2015. - 59 p. (in Russian)
[20]. Patent 2426591. High effective adsorbents based on activated carbon with high porosity represented by meso and macropores. Patent 2426591, 2016, 4-5 p. (in Russian)