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TECHNOLOGICAL BASIS OF ACTIVATED CARBON PRODUCTION PROCESS THROUGH PROCESSING OF PLUM SEED WASTE

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Abstract:

Objective. The article describes the technological properties of the process of obtaining an import-substituting adsorbent with high adsorption properties from local raw materials - plum kernel waste, obtained through processing. It is assumed that these adsorbents are intended for the treatment of wastewater from industrial enterprises.

Methods. Research methods were carried out on the basis of samples, methods and normative indicators of GOST, presented in the literature.

Results. According to the results, activated carbon with steam at 800 ^{0}C showed its efficiency with high adsorption properties.

Conclusion. In conclusion, it can be said that after thermal pyrolysis and steam treatment, the release of O_2 and Si elements in the grains causes an increase in the number of carbon and high adsorption properties of the obtained activated carbon.

Keywords: adsorption, desorption, adsorbate, isotherm, plum kernel waste, pyrolysis, steam activation, tar, ash content, moisture, benzene.

Introduction. The problems of large tons of waste from the agriculture and food industry of our republic require the search for effective ways to solve them. In particular, the expediency of using plum seed waste as a raw material for the production of activated carbon is interesting as another new object to search for efficient methods of obtaining expensive activated carbons that replace imports, as well as to eliminate the waste problem. The article describes the pyrolysis of these wastes and the technological basis of the activation of the obtained carbonates with water vapor. This task is very urgent due to the practical absence of local production of these adsorbents in our country and the need for effective use, disposal of these wastes, as well as deep cleaning and neutralization of wastes from public enterprises. The technology of processing these wastes into activated carbon is the most optimal and cheap, pyrolyzing them with the production of products of this operation (carbonizates) and activating such carbonized materials with water vapor [1]..

Methods. At the beginning of the study, 200 g of plum stones were taken and subjected to pyrolysis by dry roasting at a temperature of 300 °C to 800 °C in an inert atmosphere without access to oxygen. Carbonization occurs in the temperature range from 450 °C to 600 °C. [6,7]. The moisture content of the pyrolyzed samples was determined on an MA 210.R instrument. The ash content was determined according to GOST 11022-95. [2,4]. **Weight method.** In this method, the adsorbent is weighed before and after adsorption equilibrium has been established. The increase in mass indicates the amount of adsorption. There are two types of weights - spring and manual. To implement the weighing method, it is advisable to use the device "Mac Ben Bakra". The adsorbent cup is attached to a coil of quartz plate attached to a glass tube. The spiral is pre-calibrated by loading analytical weights into the cup and measuring the length of the resulting spiral. Typically, quartz spirals obey the HUK law well, that is, their elongation is strictly proportional to the increase in mass [5]. Determination of adsorption activity was carried out according to GOST 6217-74. [3,4].

Results and their discussion. The results showed that the original plum kernel content was C 61.1%, O_2 38%, Si 0.9%, and after thermal pyrolysis at 500 °C for 2 hours, C was 94.4%, O_2 5.6%, After steam activation at 800 °C, C is 99.5%, Ca is 0.5%, and their elemental composition was investigated using SEM analysis (EVOMA 10 brand scanning electron microscope). Moreover, when these samples were examined by absorption of benzene vapor in the McBen Bakra device, the sample pyrolyzed at exactly 800 °C showed high adsorption activity. This result again confirmed the results of SEM analysis.

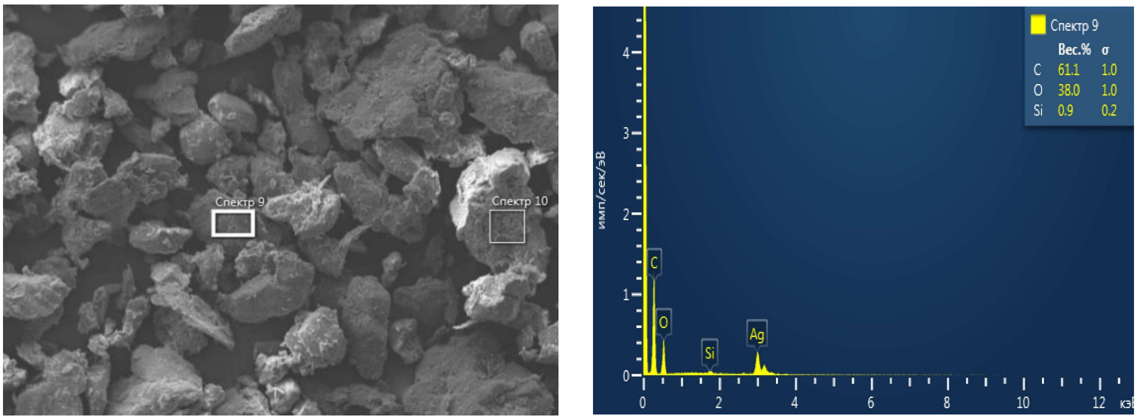

Figure - 1. SEM analysis indicators of plum kernel

As you can see from this picture, the composition of plum kernel is 61.1% S, 38% O_2 and 0.9% Si. In order to increase the C content and adsorption properties of the kernel by reprocessing, the work began with the thermal pyrolysis of plum kernel waste prepared in advance.

Experimental part. At the beginning of these experimental studies, gaseous argon was supplied at a pressure of 0.2 atmospheres to displace air from the pyrolysis unit. Initially, the current was brought to 27 volts for pyrolysis at 300 °C, and the environment was operated at 62 volts when increased to 700 °C. Gaseous argon was supplied at a pressure of 0.2 atmospheres for every 100 °C increase in temperature. In the pyrolysis unit, the temperature increased by 5 °C per minute with an increase in temperature in the range of 200–300 °C and by 7 °C per minute with an increase in temperature in the range from 400 °C to 800 °C. [8]. In the process of activation by this method of pyrolysis, a decrease in the mass of activated carbons obtained from local waste (plum stones) obtained as raw materials is characterized by the release of resins, various functional groups and water vapor from their composition. Observations showed that when the temperature rose to 200 °C, white smoke began to come out of the outlet hose of the pyrolysis plant. This smoke was especially abundant in the temperature range from 350 °C to 550 °C [8,9]. From this we can conclude that resins, hydrocarbons and water vapor in the grain are released in the greatest amount at this temperature. As part of this research work, the effect of temperature on the weight loss of the samples was studied. At the same time, the humidity and ash content of the obtained carbon adsorbents were also studied. The results obtained are presented in the table below.

Table 1.

Influence of the carbonization process on mass loss and properties

№	Pyrolysis temperature, ^{0}C	Weight before heat processing, gr	Weight after heat processing, gr	Output performance after heat processing, %	Moisture %	Ash content %
1	300	200	61,22	30,61	3,772	1,21
2	400	200	59,26	29,63	3,561	1,32
3	500	200	57,20	28,60	3,475	1,34
4	600	200	55,14	27,57	2,902	1,45
5	700	200	52,15	26,07	2,896	1,58
6	800	200	50,41	25,20	2,702	1,91

The next research work was the activation of the resulting pyrolysis samples with steam. The purpose of activating pyrolysis samples is to increase the amount of carbon in the sample, to determine micro- and mono-capacitive sizes. For this, a sample pyrolyzed at 500 °C determined by the rapid method was selected [11]. This sample, when examined by SEM analysis, showed a retention of 94.4% C and 5.6% O_2.

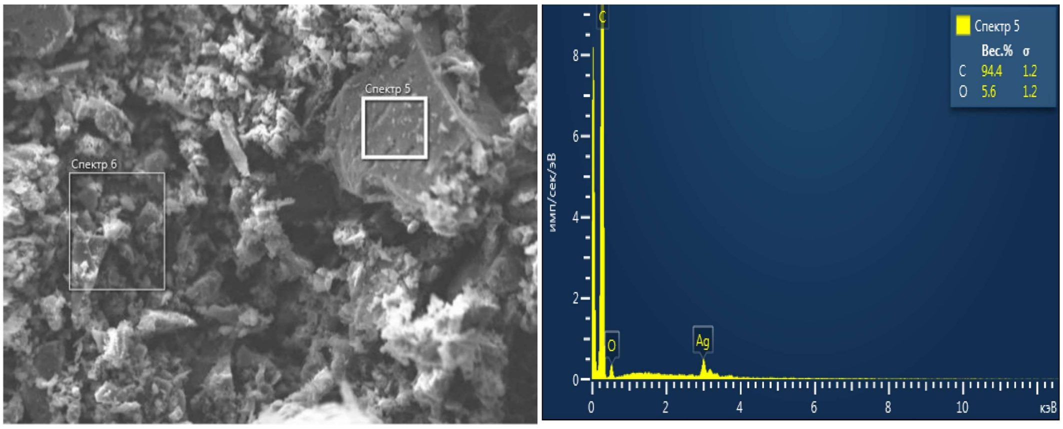

Figure 2. SEM analysis of the sample pyrolyzed at 500 °C

The sample taken for analysis was placed in a special device for steaming and started heating by adjusting the temperature to 800 ± 20 °C and the current to 27 volts. This voltage is sufficient until the temperature reaches 300 °C. At higher temperatures, it is advisable to adjust the temperature by adding a sufficient amount of current. At the same time, about 1 liter of distilled water was poured into the device to be steamed. When the temperature inside the device exceeded 800 °C, the device for steaming was connected to the current, adjusted to 72 volts, heated for approximately 30 minutes and steamed at a pressure of 10 atmospheres [8,9].

The properties of the obtained carbon dioxide and activated carbons as adsorbents can be determined to a certain extent by their total pore volume in water (V∑), sorption pore volumes in water vapor, CCl_4 and benzene (VC_6H_6) and absorption of iodine (J_2) and methylene blue, etc.

The following parameters show the test results of carbon adsorbents pyrolyzed at 500 ^{0}C for 2 hours and steamed at 800 ^{0}C. This sample was found to absorb 3.313 mol/kg of benzene vapor when activated by steam, as tested by a McBen Bakra device, and it contained 99.5% C and 0.5% Ca ion when examined by SEM analysis.

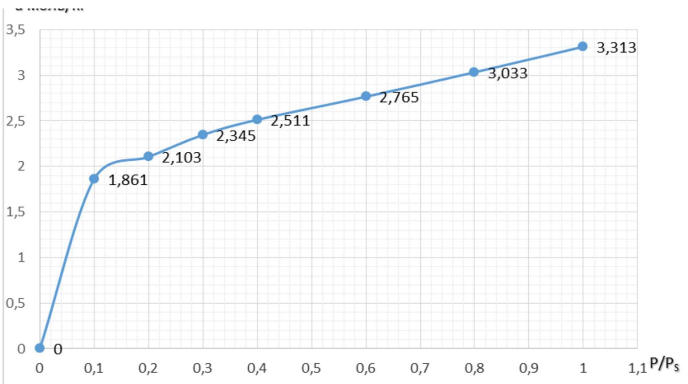

Figure 3. Test result of a sample subjected to pyrolysis at 500 °C and steam activated at 800 °C using a McBen Bakra device

Table 2.
Texture indicators of carbon adsorbent pyrolyzed at 500 °C and steam activated at 800 °C

adsorbent	a_m monolayer capacity, mol/kg	S comparative surface, S•10-3, m2/kg	W_s saturation volume, mol/kg
plum seeds	1,574	379,09	0,2936523

One of the main indicators of the adsorption process is a graph of the ratio of adsorbed substances (a) to relative gas pressure (P/Ps) at a constant temperature (T-const). The adsorption isotherm is found by the following formula:

$$a = \frac{1000}{Mr(C6H6)*(h-hx)}$$

P- pressure, mm.Hg.; *h*- extended spring length, mm; h_x- length of the spring stretched after the adsorption of the adsorbate on the adsorbent, mm; *a*- amount of absorbed adsorbent, mol; *P/Ps*- relative specific pressure, mm.Hg.

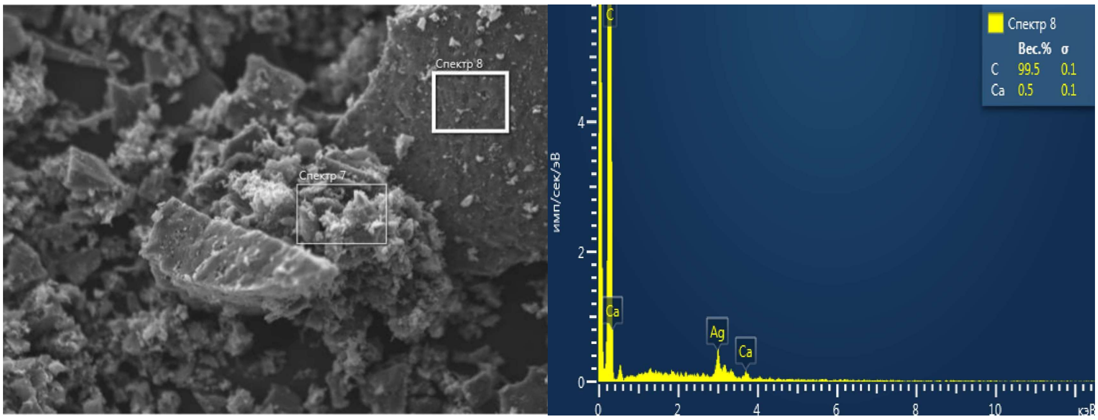

Figure 4. SEM analysis of the sample pyrolyzed at 500 °C and steamed at 800 °C

Conclusion. In this work, the physico-chemical parameters, adsorption activity, carbonization process and properties after steam treatment of activated carbons obtained on the basis of plum seed waste were studied. After thermal and steam treatment, the release of O_2 and Si elements in the grains causes an increase in the number of C and the adsorption properties of the obtained active carbons are high.

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