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THERMAL ACTIVATION OF PLUMS

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Abstract: The activation process by thermal pyrolysis is critical in producing carbonaceous adsorbents based on local food waste. This article describes the initial pyrolysis and carbonization processes for obtaining activated carbons with high adsorption properties from plum pits. The research methods were carried out based on examples presented in the literature, test results obtained on devices that meet the requirements of world standards, and GOST standard indicators. It also allows understanding the mechanisms of optimal conditions for converting biomass-based food waste into valuable adsorbent material.

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

Introduction. Several scientists around the world have conducted scientific research on the pyrolysis of agricultural waste and the production of various carbon materials [1; 7 p., 2; 102-110 p., 3; 1115-1126 p., 4; 29 p., 5; 137 p., 6; 152 p., 7; 288 p.]. To process plant waste and obtain new products, it is very important to first study the adequacy of the raw material base. In this regard, many local plants that have stabilized due to the favorable climate in each country, region, and area are of particular importance. Among these resources, the plum plant, which is grown in large quantities around the world, is characterized as a product that is grown primarily due to its palatability, healing properties, and cheapness. It has been announced through special websites that this plant is grown in various regions of our country, and the largest amount falls in the Namangan region. This work presents the conditions and technological parameters for obtaining adsorbents with high sorption capacity by thermal activation of a local plant, plum seeds.

Methods. The characteristics of the pore structure at temperatures below 77 K, i.e., the total pore volume (VΣ), the specific surface area (S), and the pore radius (R), were analyzed by nitrogen adsorption using a Quantachrome Nova 1000e static adsorption device. For this purpose, the test samples were prepared by vacuum treatment at 100 °C for 12 hours. Curves representing the dependence of the adsorption amount on the residual pressure were plotted using the BET method [8; 166-167 p.]. The average value of the pore diameter was determined by the BET method using the formula Dωr=4V/S [9; 21956-21960 p.]. The t-Plot method was used to determine the micropore volume [10; 13266-13274 p.]. (BJH) i.e., Barrett-Joyner-Halenda. The mesopore volume was determined using the Horvat-Kawazoe (HK) method. The distribution of micropores according to their size and volume (average size 1.15-1.17 nm) was analyzed using the Horvat-Kawazoe (HK) method [11; 734-750 p.].

Results and their discussion. The effect of temperature and time on the physical-chemical and adsorption parameters of the carbonizate activated by temperature was studied.

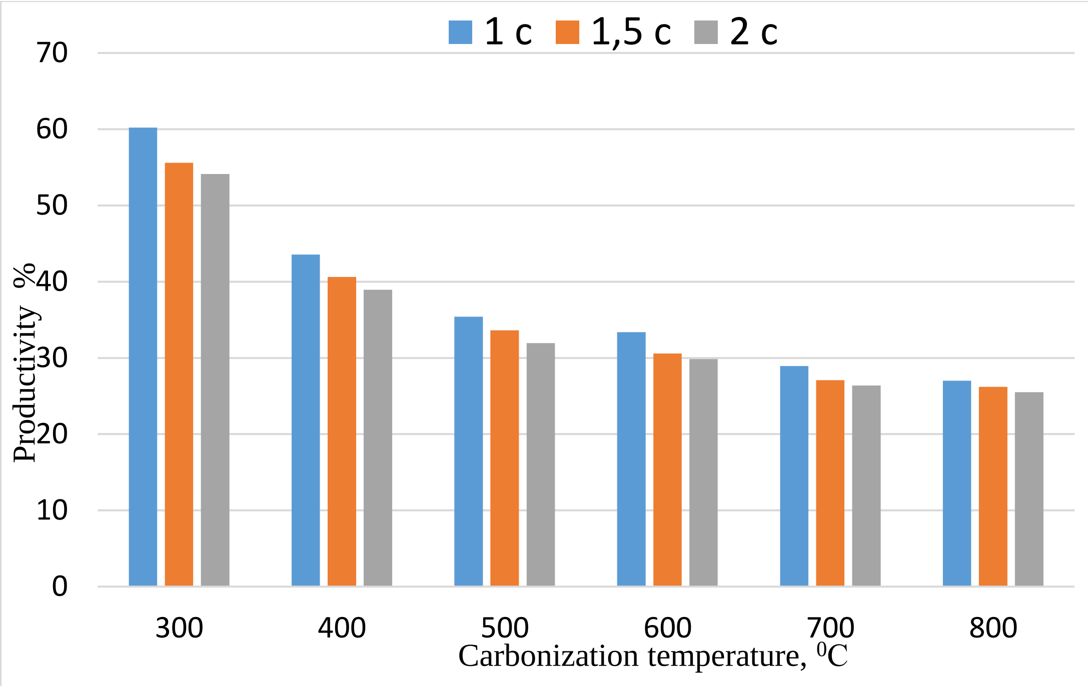

Figure 1. Histogram of the effect of temperature and time on mass loss

The blue column, representing the carbonizate thermally pyrolyzed for 1 hour, is particularly noteworthy for its minimal mass loss compared to the others. This indicates that the carbonization process is not sufficient to obtain the expected product within this period. The almost close indicators of the 1.5-hour (brown) and 2-hour (gray columns allow us to conclude that a 1.5-hour carbonization period is the most optimal for plum seed peel. This period is sufficient for the decomposition and release of organic components in the seed peel.

Changes and features representing the carbonization process were analyzed within this research work.

Table 1. Effect of the carbonization process on mass loss (pyrolysis time 1.5 hours)

T, °C	Product release, %			Humidity, %	Ash content, %
	coal	tar	gaseous		
300	55,61	11,2	10,7	3,772	1,21
400	55,61	15,4	43,97	3,561	1,32
500	33,61	21,8	44,59	3,475	1,34
600	30,57	22,3	44,59	2,902	1,45
700	27,07	12,4	44,59	2,896	1,58
800	26,21	10,7	63,09	2,702	1,91

Experimental part. Initially, a block diagram was created to conduct the research work. Figure 2 describes the block diagram for obtaining plum seed adsorbent.

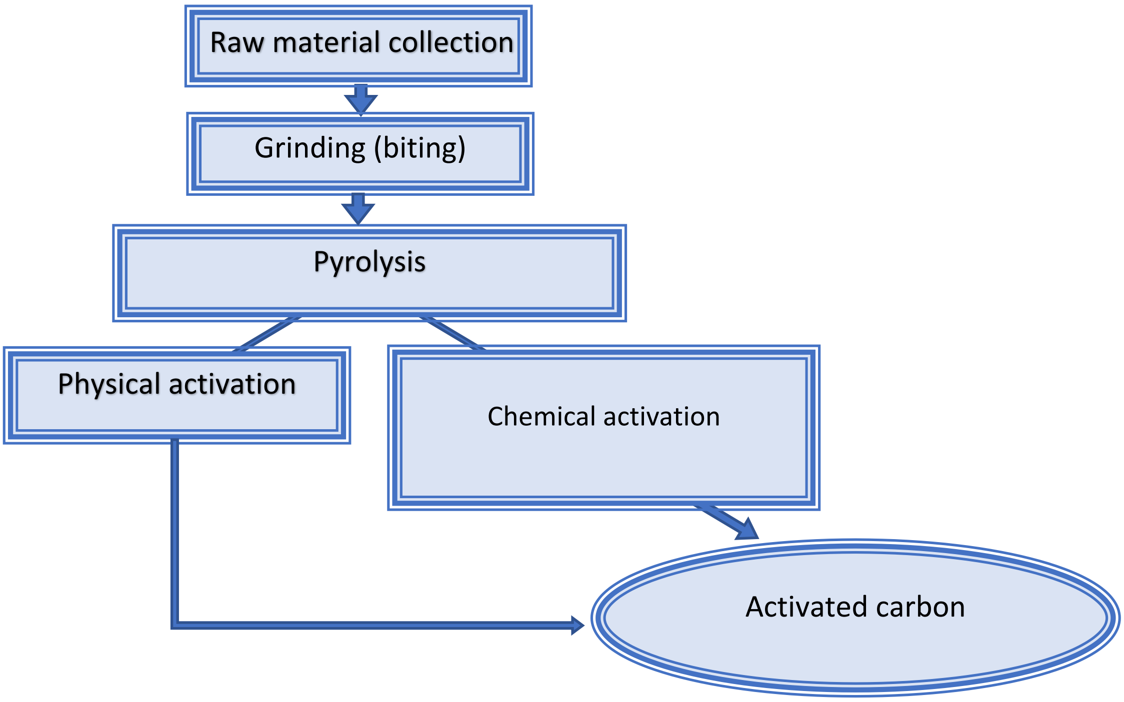

Figure 2. Flow chart of the process of obtaining activated carbon from plum seeds

The thermal pyrolysis of crushed plum kernels in laboratory conditions was carried out in a pyrolysis device with a stainless steel reactor with a height of 1 m and a diameter of 0.055 m (Fig. 2) in an argon atmosphere at a flow rate of 40 ± 1 ml / s.

The device has the following working principle: initially, 1) 500 g of raw material (dry) is placed on the mesh installed on the reinforcing mesh of the inner part of the pyrolysis furnace, and the furnace lid is closed with the necessary fittings. Argon gas is supplied to the flow furnace using gas control, pressure control, and inert atmosphere control, and is maintained. In addition, (2) a thermocouple is always placed in a separate part of the furnace, and (4) the current is connected. Initially, the speed is selected for the slow activation method, and pyrolysis is started at a heating rate of 5 ^{0}C/min.

The temperature was 24 °C, the current was 30 volts. With this current, the temperature could be raised to 300 °C. Argon gas was supplied to maintain the stability of the environment every 100 °C. In each experiment from 400 °C to 800 ± 20 °C, the set values for the heating intensity of the raw material, the final temperature, time, and the expected product yield were monitored. The volatile and liquid components, possibly resins, in the raw material were discharged through special outlet holes of the reactor and (5) fell into the resin trap. The volatile gases and condensates released from the resin trap were collected in the condensate trap (6), and the gases were analyzed using (7) [12; 030054 1-5 p].

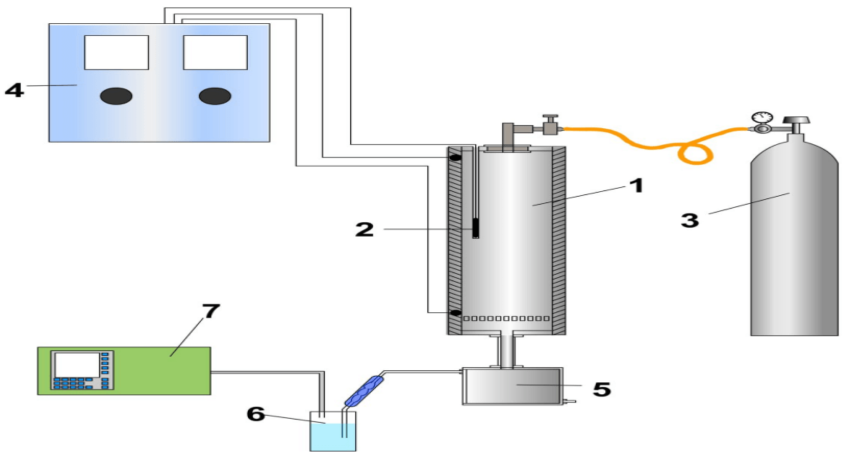

Figure 3. Laboratory experimental pyrolysis device
1-pyrolysis furnace, 2-thermocouple, 3-argon (nitrogen), 4-electronic control box, 5-resin holder, 6-condensate holder, 7-gas analyzer

a) *b)*

Figure 4. *a*) plum kernel peel; *b*) carbonization of plum seed husk

Conclusions. As a result of the studies, it was observed that the release of tar and gaseous carbonaceous substances in coal is at its highest in the range of 500-600 0 C and decreases at temperatures above that. The results of these observations allow us to optimize the physicochemical and adsorption properties of the expected activated carbons, as well as to control the activation duration and temperature, and to select for processing by physical and thermochemical methods during the study.

The scientific data presented in this research work will serve as the basis for the creation of environmentally friendly technologies for the rational use of waste, not only from the agro-industrial sector, but also from the food industry, for the utilization and processing of organic materials.

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