Obtainment activated carbon by processing plum stones and using them in industrial wastewater purification

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Abstract. The article describes the technological features of the obtaining process of an import-substituting adsorbent with high adsorption properties from local raw materials, massively grown in our republic, waste plum stone, as well as the indicators of wastewater treatment from a pesticide and mineral fertilizer workshop. These adsorbents are intended for wastewater treatment from industrial enterprises. The research methods were carried out based on samples presented in the literature and standard GOST indicators. According to the results, carbon activated with steam at a temperature of 800°C showed its effectiveness with higher adsorption properties compared to samples activated with acid and alkali. Therefore, this sample was used to purify wastewater from a pesticide and mineral fertilizer workshop. In conclusion, we can say that after thermal pyrolysis and steam treatment, the release of the elements O₂ and Si from the plum pit leads to an increase in the amount of C and higher adsorption properties of the resulting activated carbon.

1 Introduction

Today, environmental problems are among the most pressing problems in the world. One of these problems is the treatment of wastewater contaminated with various industrial wastes. One of the widely used wastewater treatment methods is adsorption treatment. Both synthetic and natural substances with an active surface are widely used as adsorbents for adsorption purification [1, 2]. Such materials include carbon adsorbents used on an industrial scale. As we know, wood adsorbents are not produced on an industrial scale in our country, since the adsorption properties of such adsorbents have not been studied sufficiently.

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2 Materials and methods

Adsorbate P/Pc (isotherm of adsorption-desorption of gases and vapors in the range of changes in relative pressure from 0...1) allows you to evaluate the structure of the material (monolayer capacity, specific surface area, micro- and mesopore volume, structural distribution of the adsorption volume along the pore diameter and differential crooked). High-precision methods for measuring adsorption activity are determined by the gravimetric method (by increasing the mass of the adsorbent) or by the volumetric method (by decreasing the amount of adsorbate in the cell after exposure to the adsorbent) [3, 4]. These methods also require special equipment, including deep vacuum cleaning of the material and long periods of observation during testing.

3 Results and discussion

At the beginning of the study, 200 grams of plum kernels were taken and pyrolyzed by dry roasting at 300 °C to 800 °C in an inert atmosphere without oxygen. The carbonization process occurs at the temperature range from 450 °C to 600 °C [5]. The moisture content of pyrolyzed samples was determined using equipment MA 210 R. Determination of ash content was carried out according to GOST 11022-95.

Fig. 1. Indicators of SEM analysis of plum stone.

The picture below shows that the plum stone is consist of 61.1% C, 38% O₂ and 0.9% Si. For increasing the carbon content and adsorption properties of the seed's thermal pyrolysis of pre-extracted plum seed waste processing.

At the beginning of these experimental studies, Argon gas was supplied at a pressure of 0.2 atmospheres to expel the air inside the pyrolysis unit. Argon gas was supplied at a pressure of 0.2 atmospheres for every 100 °C increase in temperature. In the pyrolysis device, the temperature increased by 5 °C per minute with the temperature increase in the range of 200-300 °C, and by 7 °C per minute with the temperature increase in the temperature range from 400 °C to 800 °C. In the process of activation by this pyrolysis method, the reduction of the mass of activated carbons obtained from local wastes (plum kernels) obtained as raw materials is characterized by separating tars, various functional groups, and water vapor from their composition. Observations showed that when the temperature increased to 200 °C, white smoke began to emerge from the outlet pipe of the pyrolysis unit. This smoke was particularly abundant in the temperature range of 350 °C to 550 °C. In conclusion, tars, hydrocarbons, and water vapors in the plum stone are released in the large amount at this temperature. Through this research work, temperature affect on the mass loss of the samples.
was studied. At the same time, the yield, humidity, and ash content of the obtained carbon adsorbents were determined. The obtained results are presented in the table below.

**Table 1.** Effect of carbonization process on properties and weight loss.

<table>
<thead>
<tr>
<th>№</th>
<th>t, °C</th>
<th>W₁, g</th>
<th>W₂, g</th>
<th>Yield, %</th>
<th>Humidity, %</th>
<th>Ash content, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>300</td>
<td>200</td>
<td>61.22</td>
<td>30.61</td>
<td>3.772</td>
<td>1.21</td>
</tr>
<tr>
<td>2</td>
<td>400</td>
<td>200</td>
<td>59.26</td>
<td>29.63</td>
<td>3.561</td>
<td>1.32</td>
</tr>
<tr>
<td>3</td>
<td>500</td>
<td>200</td>
<td>57.20</td>
<td>28.60</td>
<td>3.475</td>
<td>1.34</td>
</tr>
<tr>
<td>4</td>
<td>600</td>
<td>200</td>
<td>55.14</td>
<td>27.57</td>
<td>2.902</td>
<td>1.45</td>
</tr>
<tr>
<td>5</td>
<td>700</td>
<td>200</td>
<td>52.15</td>
<td>26.07</td>
<td>2.896</td>
<td>1.58</td>
</tr>
<tr>
<td>6</td>
<td>800</td>
<td>200</td>
<td>50.41</td>
<td>25.20</td>
<td>2.702</td>
<td>1.91</td>
</tr>
</tbody>
</table>

The sample taken for analysis was placed in a steaming installation heating began, bringing 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 desirable to regulate the temperature by adding sufficient current. At the same time, about 1 liter of distilled water was poured into the steaming apparatus. When the temperature inside the engine exceeded 800 °C, the evaporation device was connected to a current voltage of 72 V, heated for approximately 30 minutes and evaporated at a pressure of 10 atmospheres [5, 6, 7].

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 (Vₚ), sorption pore volumes in water vapor, CCl₄ and benzene (V₈₆H₆₆) and absorption of iodine (I₂) and methylene blue, etc.

Following parameters present, the test results of carbon adsorbents pyrolyzed at 500 °C for 2 hours and steamed at 800 °C for the same sample. 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.

![SEM analysis of a sample pyrolyzed at 500 °C and activated with steam at 800 °C.](image)

**Table 2.** Texture characteristics of a sample pyrolyzed at 500 °C and activated with steam at 800 °C.

<table>
<thead>
<tr>
<th>Adsorbent</th>
<th>aₘ, mol/kg</th>
<th>C, C•10⁻³, m²/kg</th>
<th>Wc, mol/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulm stone</td>
<td>1.574</td>
<td>379.09</td>
<td>0.294</td>
</tr>
</tbody>
</table>
These activated carbons were investigated by absorbing different adsorbates and for iodine and water purification. Samples were tested on TB 210 IR brand LOVIBOND water clarity testing device of wastewater of "Pesticides" and "Mineral Fertilizers" workshop of "IFODA AGROKIMYO HIMOYA" LLC. For water purification, we put 200 ml of waste water in a 250 ml conical flask and mixed it for 35-40 minutes with a magnetic stirrer at a speed of 1000 rpm. When the magnetic stirrer starts rotating, we put 6%, i.e. 12 g of adsorbent. 0.5 mm adsorbent was used for cleaning. We filtered the treated wastewater for 35-40 minutes and compared the results.

![Image of water clarity test results](image)

**Fig. 3.** The clarity test results of water "IFODA AGROKIMYO HIMOYA" LLC.

### 4 Conclusion

The results showed that the initial content of plum stone was C 61.1%, O2 38%, Si 0.9%, and after thermal pyrolysis at 500 °C for 2 hours, C was 94.4%, O2 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). In addition, 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. The results showed that the water clarity of the Pesticides plant changed from 204 to 7, and that of the Mineral Fertilizers plant changed from 128 to 30.

### References

2. V.V. Strelko, T.G. Plachenov, N.T. Kartel et al., *Carbon adsorbents* (M., Science, 1983)