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PROCESSING OF RICE WASTES INTO ACTIVATED CARBON

Abstract. A method for processing of rice wastes (husk, straw) into activated carbon was proposed. The thermolysis of raw material and the activation of carbonizate were carried out at 500ºC and 800ºC temperatures respectively. The properties of obtained activated carbon are determined by standard methods. The porous structure of obtained carbon have been studied under scanned electronic microscope. According to the results of experimental studies, activated charcoal obtained from rice husks corresponds to the WAC brand, activated charcoal obtained from rice straw corresponds to BAU-A grade. The research will allow rational use of agricultural waste in order to obtain useful secondary adsorbent products intended for adsorption and liquid media.

Keywords: carbonization, rice husk and straw, activating of carbonizate, sorbent, activated carbon.

Introduction. Rice is one of the most important food products of agriculture in the world. Currently, world production of rice is more than 485 million tons per year. According to Kazagromarketing JSC in the Republic of Kazakhstan, rice-growing regions are Kyzylorda, Almaty and Turkestan regions. Kyzylorda region is the leading rice growing region of the country (more than 85% of the crop).

At harvesting and industrial processing of rice, waste in the form of husks (up to 20% of mass) and straw (up to 50% of mass) are formed in a large number. To date, the utilization of straw and husk is, in fact, the main problem of rice. The main amount of rice husk and straw is burned, which leads to a deterioration of the ecological situation. Joint solution of ecological and technological problems – utilization of rice husk and straw, as well as production of demanded solid products is actual today.

In the literature there are works on the thermal processing of rice husk and the production of phenol-containing products from it [1, 2].

In given work using of rice husks and straws to obtain a wide-using adsorbent – activated carbon is offered. Activated carbon is obtained from various carbon-containing materials of organic origin: charcoal (BAU, DAK, etc.) [3], coal coke (activated carbon brand AG, AR, etc.) [4], petroleum coke, coconut shells, fruit pits, agricultural waste, paper production waste, garbage, sewage sludge, worn rubber tires, synthetic polymer waste, etc. [5-10].

The use of agricultural waste to produce activated carbon is of environmental importance, because The use of wood as raw material is excluded, which in turn excludes deforestation, as well as rational use of agricultural waste. Methods are

known for producing activated carbon from barley wastes by pre-drying in hot air and performing one-step carbonization at 290-320°C for 7-15 minutes in a cylindrical reactor [11], and also producing activated carbon from rapeseed straw, including carbonization in an inert nitrogen atmosphere at a temperature of 450-500°C and activation by steam at a temperature of 820-850°C [12].

There are works on obtaining highly porous active coal from rice husk, which has a selective sorption activity on lead ions [13-14]. In work [15] it is reported that the co-processing of rice husks with polytetrafluoroethylene shows a high porous structure.

EXPERIMENT

Carbonization of rice husk and straw was carried out in a tubular furnace made of stainless steel with a height of 250 mm and an inner diameter of 25 mm at a temperature of 500°C and activation of carbonate with steam at a temperature of 800°C.

The surface of the obtained active coals was taken with a scanning electron microscope JSM-6510 LV from JEOL (Japan).

Properties of the obtained active coals: iodine adsorption activity, total water pore volume, mass fraction of moisture, bulk density were determined by the known method [3,16-18].

RESULTS AND DISCUSSION

10 mm of raw material is placed in a tube furnace made of stainless steel with a height of 250 mm and an internal diameter of 25 mm, sealed and carbonized at a rate of 10°C per minute rise to 500°C and kept at this temperature for 100 minutes. The yield of carbonizate in the processing of husk and straw is 44% and 37%, respectively. Then, from the bottom of the tube furnace, a vessel is connected to supply water vapor at a rate of 2:1 per weight of carbonizate. The activation is carried out at a temperature of 800°C, the yield of activated carbon is 27% and 29%, based on the weight of the husk and straw taken, respectively.

Microphotographs of active coals (500 fold magnification) are shown in figures 1 and 2, in the figures can be seen the developed porous structure of the obtained sorbents.

The properties of the active carbons obtained are determined by the following methods: iodine adsorption activity by the titrimetric method, the total pore volume by water by pouring with water and removing excess water from the surface of the sample under study by suction, the mass fraction of moisture by drying the sample to constant weight, bulk density by weight method. The data are given in the table.

According to the results of the research, activated charcoal obtained from rice husk corresponds to WAC activated charcoal, activated charcoal obtained from rice straw corresponds to BAU-A grade, which are intended for adsorption from liquid media [3].

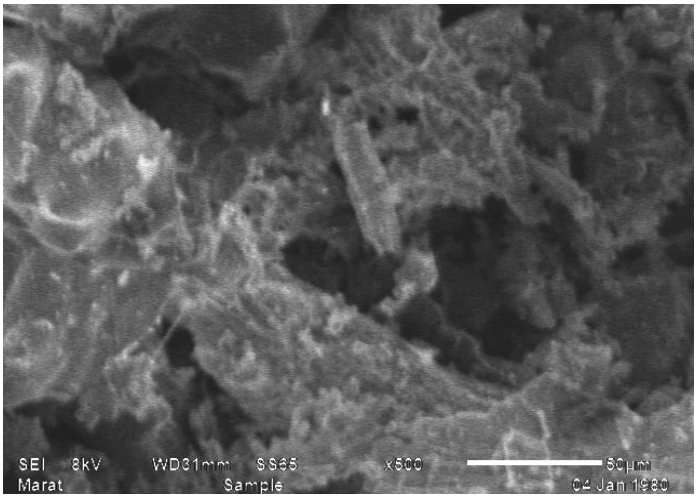

Figure 1 – Photomicrograph of activated carbon obtained from rice husk

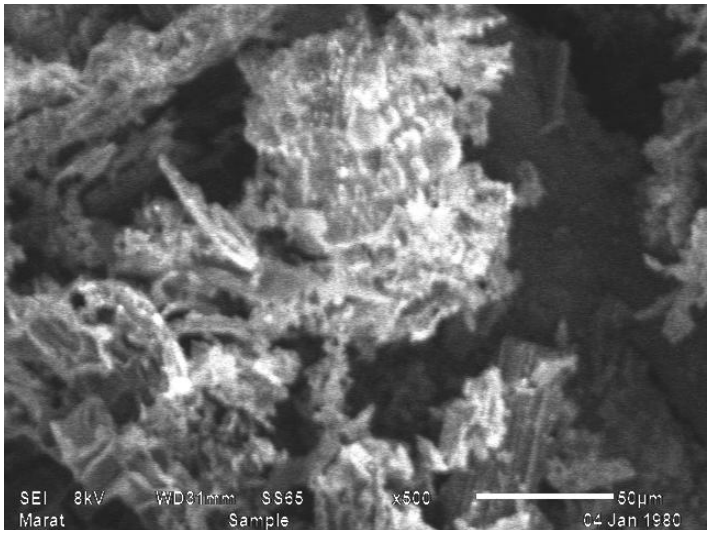

Figure 2 – Photomicrograph of activated carbon obtained from rice straw

Properties of activated carbons obtained from rice husk and straw

Activated carbon	Adsorption activity by iodine,%	Total pore volume in water, cm^3/g	Moisture volume fraction, %	Bulk density, g/dm^3
Husk	51	1.57	3.6	236.1
straw	64	1.63	3.6	181.3

Conclusions. Thus, active coals were obtained from rice husk and straw. The properties of the products obtained are determined. According to certain properties, the sorbents obtained can replace wood activated charcoal, which makes it possible to rationally dispose of agricultural waste, reduce deforestation, and produce value-added products

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Резюме

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КҮРІШ ҚАЛДЫҚТАРЫН БЕЛСЕНДІРІЛГЕН КӨМІРГЕ ӨҢДЕУ

Күріш қалдықтарын (қауыз, сабан) белсендірілген көмірге өңдеу тәсілі ұсынылады. Шикізаттың термолизі мен карбонизатты белсендіру 500 және 800ºС температураларда жүргізілді. Алынған белсендірілген көмірдің қасиеттері стандартты әдістермен анықталды. Алынған белсендірілген көмірдің кеуекті құрылымы сканерлеуші электронды микроскоп арқылы зерттелді. Жүргізілген тәжірибелік зерттеулер нәтижесі бойынша күріш қауызынан алынған белсендірілген көмір ДАК маркасына, ал күріш сабанынан алынған белсендірілген көмір БАУ-А маркасына сәйкес келеді. Жүргізілген зерттеулер нәтижелері сұйық ортадан адсорбциялауға арналған адсорбенттер алу мақсатында ауылшаруашылық қалдықтарын тімді пайдалануға жол ашады.

Түйін сөздер: карбонизация, күріш қауызы мен сабаны, карбонизатты белсендіру, сорбент, белсендірілген көмір.

Резюме

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ПЕРЕРАБОТКА ОТХОДОВ РИСА В АКТИВИРОВАННЫЙ УГОЛЬ

Предлагается способ переработки отходов риса (шелуха, солома) в активированный уголь. Термолиз сырья и активацию карбонизата проводили при температурах 500 и 800ºС, соответственно. Свойства полученного активированного угля определены стандартными методами. Пористая структура полученного активированного угля исследована сканирующим электронным микросокопом. По результатам экспериментальных исследований, активированный уголь, полученный из рисовой шелухи, соответствует марки ДАК, активированный уголь, полученный из рисовой соломы, соответствует марки БАУ-А. Проведенные исследования позволят рационально использовать сельскохозяйственные отходы с целью получения полезных вторичных продуктов – адсорбентов, предназначенных для адсорбции из жидких сред.

Ключевые слова: карбонизация, рисовая шелуха и солома, активация карбонизата, сорбент, активированный уголь.