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RICE STRAW AND HUSK OIL SLUDGE FOR PROCESSING THROUGH THE USE OF LIGNOSULFONATE AS A BINDER WITH ACTIVATED CHARCOAL

Abstract: This article examines the effect of lignosulfonate binding of rice waste to oil waste to obtain activated carbon. Lignosulfonate was added to the mixture to produce briquetted activated carbon by processing rice residue (husk and straw) and oil sludge together. The mixture was carbonized and activated in a BR-12 NFT series high-temperature vacuum tube furnace with a length of 300 mm and a diameter of 60 mm and a heating section length of 200 mm in a quartz glass tube. Briquettes obtained by adding rice waste (husks and straw), oil sludge and lignosulfonate were placed in the kiln. Carbonation was carried out at a temperature of 500°C, activation was carried out at a temperature of 850°C in a ratio of 2: 1 with water vapor. The effect of the relationship of the addition of lignosulfonate binder to rice residue and oil sludge on the product properties was studied. The optimal ratio of cotreatment of the mixture was found in the ratio of rice residue: oil sludge: lignosulfonate = 9: 1: 2 (by weight). The adsorption activity of the obtained product on iodine, the total volume of pores on water, the mass fraction of moisture, the adsorption activity on methylene blue and the bulk density were studied. Activated carbon obtained from both rice straw and rice husk has high sorption properties. According to the results of experimental studies, activated carbon obtained by adding lignosulfonate to rice straw and oil sludge in a ratio of 9: 1: 2 corresponds to the brands BAC-A, WAC, BAC-Au.

Key words: activated carbon, rice husk, rice straw, oil sludge, lignosulfonate, carbonization, activation, briquettes.

Introduction. Currently, the problem of pollution due to active industrial activities, which are harmful to the environment, mainly water, is a matter of concern from year to year. Several processes are used to reduce the level of pollution of water resources and treatment of contaminated water, including the process of adsorption of activated carbon [1].

Adsorption is considered to be more favorable due to its high efficiency, low cost, simple operation and availability of adsorbents [2-4]. Activated carbon is often used as a sorption filter. Activated carbon is one of the most commonly used adsorbents for the removal of dyes from aqueous solutions. Many effective methods of adsorbent production are known, but in some cases are economically inefficient due to the high cost of use, preparation and recovery of raw materials [5]. Therefore, the use of waste and inexpensive products for the production of activated carbon is considered as one of the ways to save adsorbent [6].

One such inexpensive product is agricultural waste, as rice straw and rice husk. During the harvesting and industrial processing of rice, a large amount of waste is collected in the form of bran (up to 20% by weight) and straw (up to 50% by weight). At the end of the campaign, rice husks and straw are burned in the open air, which causes air pollution. Incineration of agricultural waste is a major problem not only for our country but also for the world and is one of the causes of global climate change. Today, the main problem of scientists is the utilization of straw and bran. The joint solution of environmental and technological problems - the utilization of rice husks and straw, as well as the production of solid products in demand is relevant today. The proposed technologies for the treatment of rice residues are based on the processes of thermal decomposition of soot without release into the atmosphere.

Currently, a number of countries have developed areas for the use of rice waste, the main of which are: production of heat and electricity [7], production of silicon dioxide, activated carbon and sorbents [8], production of liquid chemicals [9-11] and integrated treatment of solid waste [12-16].

In particular, activated carbon is a sorbent belonging to the class of high molecular weight porous carbon materials, capable of efficient and selective absorption of molecules of various chemical substances from vaporgas and liquid media [17].

Activated carbon is used in ventilation gases, water and other liquid treatment systems, as well as in the protection of the respiratory system [18, 19].

One of the components that determine the properties of activated carbon is the binder. It is designed to simultaneously combine the particles of coal powders into a plastic mass in order to effectively form the primary (raw) granules of carbon sorbent by extrusion and bind these particles into a strong granule with a porous structure developed as a result of heat treatment. In addition, the parameters of their production process are determined by the characteristics and composition of the connecting components.

Most often, granulated activated carbon is produced using wood resin binder [20], coal tar [21] or their mixtures [22-23]. In addition, potassium carbonate was used as a binder for coal tar, while coke residue in coal tar was 15% [24-28].

To obtain activated carbon, the furnace soot was mixed with lignosulfonate, the mixture was granulated, the pellets were dried and activated in a steam-gas medium. Mixing of furnace soot and lignosulfonate was carried out in the form of dry matter in a ratio of 1: 0.6-1.8, and activation was carried out at a temperature of 680-780°C for 60-180 minutes [29]. Petroleum was used as a binder to obtain activated carbon from hard coal. Coal and oil slag are ground together, 4-5% KOH solution is added and activated carbon up to 40-50% by weight is obtained, which allows to remove N, N-dimethylformamide from industrial wastes [30-32]. In addition, technical lignosulfonate dried in air until dry was used as a binder when using peat as a carbon material [33-35].

Although lignosulfonate is widely used in the literature, its use as a binder in the production of activated carbon is still poorly understood. Therefore, the purpose of this research to obtain a stable of high-quality activated carbon components on the basis of this development.

Lignosulfonate - technological processing of vegetable raw material for wood pulp and paper industry products. Lignosulfonate in various fields, because it has a high surface activity can be used as anionic surfactants. Lignosulfonate concrete solutions, dyes, and as a binder component in the production of vanilla is widely used in the production of food [36].

In our previous studies, activated carbon was extracted from rice straw and husks, as well as from rice husks and oil sludge [37, 38], and binders were used to improve its sorption properties and improve our study. As noted above as a binder lignosulfonate used because it is available and has a high surface activity.

Materials and methods. Carbonization with rice residue (husk and straw) by adding lignosulfonate to the oil sludge was carried out in a nitrogen atmosphere at 500 ° C and activation at 850°C with water vapor in a BR-12 NFT series high-temperature vacuum tube furnace. Activated carbon adsorption of iodine from water activity, total pore volume and density of the products from the area were determined by standard methods.

To determine the adsorption activity on iodine, a solution of iodine in potassium iodide at a concentration of 0.1 mol/dm^3 was added to a certain part of activated carbon and shaken in a mixer for 15 minutes at an intensity of 100-125 oscillations. Then, after waiting until the solution precipitates, it accumulates the required volume for titration and titrates with 0.1 mol/dm^3 of sodium thiosulfate solution until the blue color disappears, using starch as an indicator [39].

To determine the total pore volume in water, pores in the range of 0.5-10^4 nm are determined by heating in boiling water for 15 minutes, pumping out at a pressure of 8 kPa, separating excess water and weighing it on a balance. Determination of the bulk density of activated carbon was carried out by measuring the mass of normalized compaction of a certain amount of activated carbon [40-41].

Results and discussion. The bricked mixture was placed in a tubular furnace by adding lignosulfonate to rice residue and oil sludge (husk and straw). Hermetically sealed, the tube was filled with nitrogen gas supplied from the cylinder, the carbonization process was increased from 10°C to 500°C per minute and held at this temperature for 100 minutes, and activation was carried out at 850^0C in a 2: 1 ratio of carbonate and water vapor. The effect of lignosulfonate ratio on the yield and physical and chemical properties of activated carbon was studied (Table 1).

Table 1 - Properties of activated carbon obtained by the use of lignosulfonate as a binder in the processing of rice straw and with oil sludge

Indicator	The results of experimental research			
	Rice straw: lignosulfonate	Rice straw: Oil sludge: Lignosulfonate		
Ratio	10:1	9:1:1.1	9:1:1.25	9:1:2
Carbonation temperature, °C	500			
Carbonate consumption, mass %	61.57	53.76	74.5	84.30
Activation temperature, °C	850			
Water: carbonate ratio	2:1			
Consumption of activated carbon, dr. %	35.92	33.99	29.86	24.72
Adsorption activity on iodine,%	39.37	55.88	62.33	64.77
Total volume of pores on water, cm^3/g	0.929	0.930	0.946	0.950
Mass fraction of moisture,%	1.49	1.56	1.68	2.39
Heap density, g/dm^3	233.94	239.59	246.01	251.86
Adsorption activity on methylene blue, mg/g	432.20	412.35	431.10	411.12

According to the results shown in Table 1, rice straw: oil sludge: as the content of lignosulfonate in activated carbon obtained from lignosulfonate increases, its adsorption activity for iodine increases from 39.37% to 64.77%, the total porosity of water increases from 0.929 cm^3/g 0.950 cm^3/g, the mass fraction of moisture increased from 1.49% to 2.39%, the bulk density increased from 233.94 g/dm^3 to 251.86 g/dm^3. When processing rice straw with oil sludge, the ratio of 9: 1: 2 was chosen as the optimal ratio for the production of activated carbon with the addition of a binder lignosulfonate. In Figure 1 shown the optimal ratio of activated carbon.

Figure 1 – Rice straw: oil sludge: activated carbon which was taken in the ratio of lignosulfonate 9: 1: 2

Table 2 - Properties of activated carbon obtained by the use of lignosulfonate as a binder in the processing of rice husk and with oil sludge

Indicator	The results of experimental research			
	Rice husk: lignosulfonate	Rice husk: Oil sludge: Lignosulfonate		
Ratio	10:1	9:1:1.1	9:1:1.25	9:1:2
Carbonation temperature, °C	500			
Carbonate consumption, mass%	68.14	81.75	71.11	79.07
Activation temperature, °C	850			
Water: carbonate ratio	2:1			
Consumption of activated carbon, dr. %	34.83	28.07	35.29	32.73
Adsorption activity on iodine,%	31.75	48.26	54.61	61.17
Total volume of pores on water, cm^3/g	0.551	0.563	0.571	0.584
Mass fraction of moisture, %	1.19	1.29	1.81	1.88
Heap density, g/dm^3	351.27	362.95	367.17	392.18
Adsorption activity on methylene blue, mg/g	344.50	355.50	362.70	352.70

On table 2, rice husk: oil sludge: it can be seen that as the amount of lignosulfonate in activated carbon obtained from lignosulfonate increases, the adsorption activity for iodine increases from 31.75% to 61.17%, the total porosity of water increases from 0.551 cm^3/g to 0.584 cm^3/g, the mass fraction of moisture increases from 1.19% to 1.88%, the bulk density increases from 351.27 g/dm^3 to 392.18 g/dm^3. When processing rice hulls with oil sludge, the ratio of 9: 1: 2 was chosen as the optimal ratio for the production of activated carbon by adding a binder lignosulfonate. In figure, 2 shown the activated carbon obtained in an optimal ratio.

Figure 1 – Rice husk oil sludge: activated carbon obtained in the ratio of lignosulfonate 9: 1: 2.

Comparing rice bran to rice soap, the total number of pores in water in rice soap is 1.6 times greater than that in rice bran. The density of the heap in rice hulls is 1.5 times that of rice hulls. There is no significant difference in the mass fraction of moisture and the values of the adsorption activity for methylene blue. When processing rice straw and husks with oil sludge, the ratio of 9: 1: 2 was chosen as the optimal ratio for the production of activated carbon with the addition of lignosulfonate as a binder.

Conclusions. In conclusion, the optimal conditions were determined in the ratio of rice husk: oil sludge: lignosulfonate = 9: 1: 2 and rice straw: oil sludge: lignosulfonate = 9: 1: 2. The adsorption activity of activated carbon on iodine was 61.74% in rice husk, 64.77% in rice straw, the total volume of water pores was 0.584 cm^3/g in rice husk, 0.950 cm^3/g in rice straw and the bulk density was 392.18 g/dm^3 in rice husk in rice straw showed 251.86 g/dm^3. According to the results of experimental studies, activated

carbon obtained by adding lignosulfonate to oil sludge with rice residue in a ratio of 9: 1:2 corresponds to the brands BAC-A, WAC, BAC-Au. The use of the proposed method of production of activated carbon compared to the known method provides high adsorption activity, and it is recommended to use rice waste and oil waste and lignosulfonate as raw materials. The results of the study allow for the rational use of environmentally important and natural resources.

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КҮРІШ САБАНЫ МЕН ҚАУЫЗЫН МҰНАЙ ШЛАМЫМЕН БІРГЕ ӨҢДЕУ КЕЗІНДЕ ЛИГНОСУЛЬФОНАТТЫ ПАЙДАЛАНУ ОТЫРЫП БЕЛСЕНДІРІЛГЕН КӨМІР АЛУ

Аннотация. Бұл мақалада белсендірілген көмір алу үшін күріш қалдығымен мұнай қалдығына байланыстырушы лигносульфонат әсері зерттелді. Күріш қалдығы (қауызы және сабаны) мен мұнай шламын бірге өңдеу арқылы брикеттелген белсендірілген көмір алу үшін қоспаға лигносульфонат қосылды. Қоспаны карбонизациялау және белсендіру кварцты шыныдан жасалған түтікте ұзындығы 300 мм және диаметрі 60 мм, қыздыру бөлімінің ұзындығы 200 мм болатын BR-12 NFT сериялы жоғары температуралы вакуумдық түтікті пеште жүргізілді. Карбонизация 500ºС температурада, белсендіру 850ºС температурада 2:1 қатынаста су буымен жүргізілді. Күріш қалдығы мен мұнай шламына лигносульфонат байланыстырғышын қосу қатынастарының өнім қасиеттеріне әсері зерттелді. Қоспаны бірге өңдеудің оңтайлы қатынасы күріш қалдығы: мұнай шламы: лигносульфонат = 9:1:2 (салмақтары бойынша) қатынастары табылды. Алынған өнімнің йод бойынша адсорбциялық белсенділігі, су бойынша жалпы кеуектер көлемі, ылғалдың массалық үлесі, метилен көгі бойынша адсорбциялық белсенділігі және үйінділік тығыздығы тәрізді көрсеткіштер зерттелді. Жүргізілген зерттеулер нәтижесі бойынша белсендірілген көмірдің құрамындағы лигносульфонат мөлшері артқан сайын оның собрциялық қасиетінің артатыны байқалды. Күріш сабанынан да, күріш қауызынан да алынған белсендірілген көмір жоғары сорбциялық қасиеттерге ие. Тәжірибелік зерттеулер нәтижесі бойынша 9:1:2 қатынастағы күріш қалдығы мен мұнай шламы және лигносульфонатты қосу арқылы алынған белсендірілген көмір БАУ-А, ДАК, БАУ-Ац маркаларына сәйкес келеді.

Түйін сөздер: белсендірілген көмір, күріш қауызы, күріш сабаны, мұнай шламы, лигносульфонат, карбонизация, белсендіру, брикеттер.

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ПОЛУЧЕНИЕ АКТИВИРОВАННОГО УГЛЯ С ИСПОЛЬЗОВАНИЕМ ЛИГНОСУЛЬФОНАТА В КАЧЕСТВЕ СВЯЗУЮЩЕГО ПРИ СОВМЕСТНОЙ ПЕРЕРАБОТКЕ РИСОВОЙ СОЛОМЫ И ШЕЛУХИ С НЕФТЕШЛАМОМ

Аннотация. В данной статье изучено влияние лигносульфоната как связующего вещества для получения брикетированного активированного угля путем совместной переработки отходов риса (шелухи и соломы) и нефтешлама. Карбонизацию и активацию смеси проводили в высокотемпературной вакуумной трубчатой печи серии BR-12 NFT длиной 200 мм, в нагревательной стеклянной трубке из кварца размером 300 мм и диаметром 60 мм. В печь помещали отход риса (шелуху или солому) в виде брикетированного с добавлением лигносульфоната и нефтешлама. Карбонизацию проводили при температуре 500ºC, активацию – водяным паром при температуре 850ºC в соотношении 2:1. Исследовано влияние соотношений лигносульфонатного связующего, отхода риса и нефтешлама на свойства активированного угля. Оптимальным соотношением совместной переработки смеси является отход риса: нефтешлам: лигносульфонат 9:1:2 (по массе). Исследования проводились по следующим показателям: адсорбционная активность по йоду, общий объем пор по воде, массовая доля влаги, адсорбционная активность по метиленовому голубому и насыпная плотность. По результатам проведенных исследований было отмечено, что по мере увеличения содержания лигносульфоната в активированном угле повышаются его сорбционные свойства. Активированный уголь, полученный как на основе рисовой соломы, так и на основе рисовой шелухи, обладает высокими сорбционными свойствами. По результатам экспериментальных исследований установлено, что активированный уголь, полученный из отходов риса, нефтешлама и лигносульфоната, в соотношениях 9:1:2 соответствует маркам БАУ-А, ДАК, БАУ – Ац.

Ключевые слова: активированный уголь, рисовая шелуха, рисовая солома, нефтешлам, лигносульфонат, карбонизация, активация, брикеты.

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