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PHYSICOMECHANICAL PROPERTIES OF PETROSORBENTS OF THE PHYTOGENESIS

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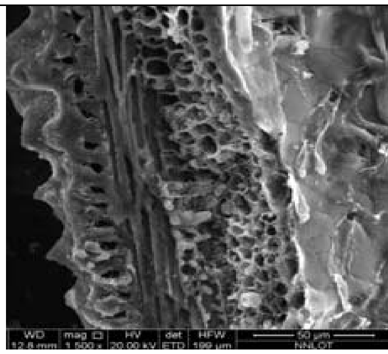
Sorbents of oil of a phytogenesis are studied and the structural characteristics and properties of a surface are compared. The researches have been carried with a rice husk, obtained by thrashing of the Kazakhstan rice which has been grown up in the Kyzyl-Orda area.The carbon-polystyrene sorbent (21.0 % of a rice husk) with excellent production characteristics is synthesized. It is revealed that the oil capacity of carbon - polystyrene foam fibrous sorbents with the content of a rice husk to 35.0 - 40.0 wt.% exceeds the oil capacity of pure fiber of polystyrene foam. Environmentally friendly technology of synthesis and the relatively low cost sorbents are achieved thanks to the absence of chemical binders and one-step process.



INTRODUCTION

One of the most effective methods of deep purification from the dissolved organic substances of waste water of the enterprises is sorption.[1] The materials of a phytogenesis accumulating in a significant amount in the form of a waste of an agricultural production, represent practical interest as raw materials for production of the sorbents which can be used for the decision of many ecological issues: cleaning of waste water, gas bursts, a ground etc.[2] Use of these materials having low cost for production of sorbents, allows to combine abandonment of the agricultural production wastes with the environmental protection activity.[3-5] It is known that production of sorbents from the rice production wastes is developed basically within the limits of a problem of utilization of a husk. The flower films of rice (husk) and straw contain a considerable quantity of silicon dioxide, so this waste can be a source of obtaining of different siliceous sorbents. From the literature data,[6-8] by the fat-free bran of rice can clean the solutions of ions of chrome, copper, zinc, and a rice husk - from ions of strontium, cadmium, nickel, lead, zinc, chrome, cobalt and aluminium. [9-11]

Also is shown,[12] that the quantity of copper and zinc sorbtion from the waste waters of galvanic manufactures does not yield to some used sorbents (to the activated coals, zeolites).

The aim of the work was to study the sorbents of vegetable origin of oil and a comparison of the structural characteristics and surface properties to assess the effectiveness of their use in the process of water surface cleaning from oil products.

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RESULT AND DISCUSSION

It was found that the carbonization of the sorbent surface of sunflower husk (SH) significantly influences at its water-absorbing. For example, if for the initial sorbent SH which is thermally activated at 200°C, it amounts 34.0 % of its weight but for carbonated sample does not exceed 2.5% ability. With the increase of carbonization temperature the water absorption capacity is sharply reduced. Thus, by selecting the optimum conditions for carbonizing of the surface of the sorbent SH it s possible to synthesize the sorbents with a fixed hydrophobic-hydrophilic balance. When using the granular material with a closed porous structure (for example, foam granulated polystyrene) placement of oil is possible only between the granules in a layer of sorbent due to capillary forces and oleophilic. The liquid is retained between the granules due to capillary forces and adhesion.[13,14] The compositions of granulated foam polystyrene + carbonizate of sunflower husk show a high degree of substitution of synthetic material and good performance of oil capacity and oil return (table). It is revealed that the fibrous sorbents (the synthetic wadding and modified foam) have characterized the high degrees of extraction of oil absorbed and demonstrate the high enough absorption of water, due to the low surface hydrophobicity. The indicated disadvantage can be eliminated by introducing of special hydrophobic additives of carbonizates of rice husk (RH) and SH. The data in Table show that the carbonizates of rice husk and apricot pits (AP) show that carbonizates of rice husk and apricot seeds have almost the same values of water absorption, but different indicators of oil absorption. Such distinction is possibly explained by distinction in structures of materials. RH has cellular structure (Fig. 1).

SEM images of the original raw of RH (Fig.1a) shows the presence of spherical particles of various forms of silicon dioxide on organic matrix, which is composed of cellulose, hemicellulose and lignin. This figure clearly shows that the RH initial structure is compact and does not contain any pores. The external wall of a carbonizate of RH shows emergence of a great many structures which were not found in the initial raw particles of RH (Fig.1b). Emergence of the same structures can be caused by fast removal of volatile organic components from the particles. The particles in this process of high-temperature processing have undergone changes. It is visible some particles of carbon and amorphous dioxide of silicon (Fig.1c).

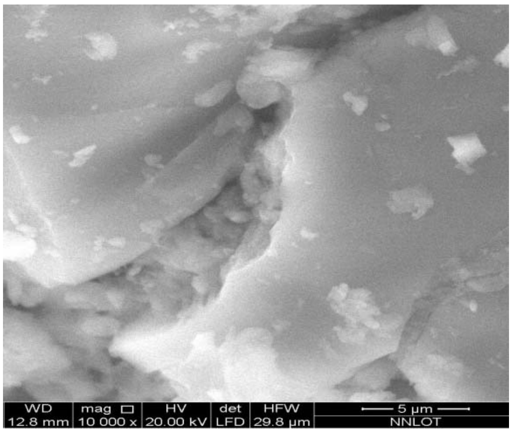
It is found that RH removes oil significantly worse than apricot stone due to the lower porosity and higher density. Thus, comparison of structural characteristics and surface properties of vegetable materials (RH, SH) and AP allow to evaluate the effectiveness of their use in cleaning of the water surface from oil and makes it possible to select the most perspective materials. By the results of researches it is possible to conclude that absorption of oil and water by the vegetable wastes proceeds according to the different mechanisms. If materials have the considerable hydrophylic nature, then it leads to the fact that water is easily is adsorbed in the material structure, while crude oil is retained on the surface of the absorber by adhesion forces. Therefore the vegetable waste tend better retain the viscous oil in comparison with a low viscosity crude oil.

Table 1

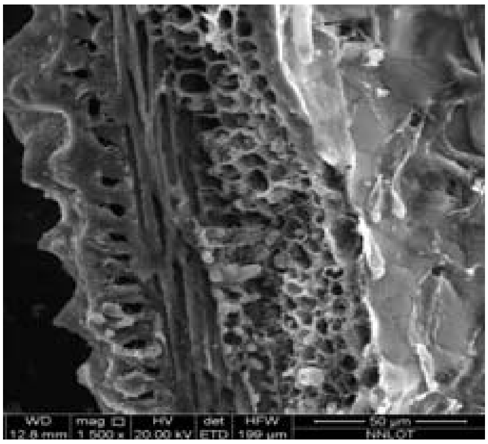
Physical and mechanical properties of the synthesized sorbents

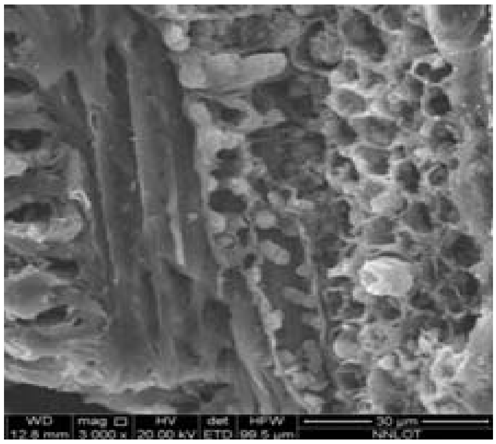
Material	Absorption of oil, g/g	Absorption of water, g/g	Oil squeezing degree of,%
Carbonizate of sunflower husk (CSH)	3.5-4.0	2.5	44.0
Carbonizate of rise husk (CRH)	6.0-7.0	4.0-5.0	55.0
Carbonizate of apricot pits (CAP)	8.0-9.0	3.0-4.0	30.0
Synthetic wool	9.0-10.0	2.6	60.0
Carbon powder	1.0-2.0	0.5	-
Synthesized technical carbon	4.0-6.0	0.0-1.0	60.0
Foam rubber modified	40.0	30.7	75.0
Polystyrene foam	10.0	15.0	5.0
Polystyrene foam granulated+carbonizate of sunflower husk	25.0-26.0	15.0	50.0-55.0
Polystyrene foam granulated +carbonizate of rise husk	10.0	10.0	40.0

In this work the carbon-foamed polystyrene fiber material for collection of oil and petroleum products, containing as an excipient RH (30.0 % by wt.) was obtained. The fibers of foam polystyrene in the composite were as a reinforcing matrix in which the fibers of RH being sufficiently evenly distributed (Fig. 2).



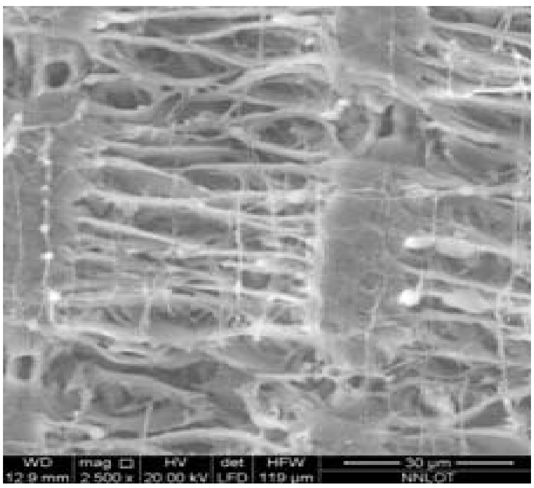
a

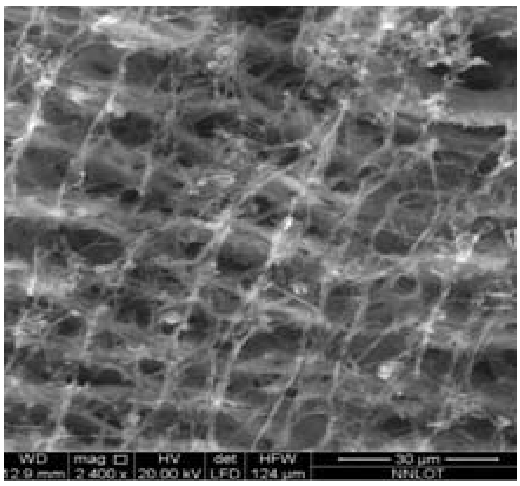




b c

Fig. 1 – SEM photographs of RH: a – initial RH, b, c – after the heat treatment (at various increase).





a b

Fig. 2 – SEM pictures of the carbon-polystyrene material with excipients of RH 30% after the heat treatment:
a – Carbon+polysterene+CRH (CPCRH400), b – Carbon+polysterene+CRH (CPCRH700).

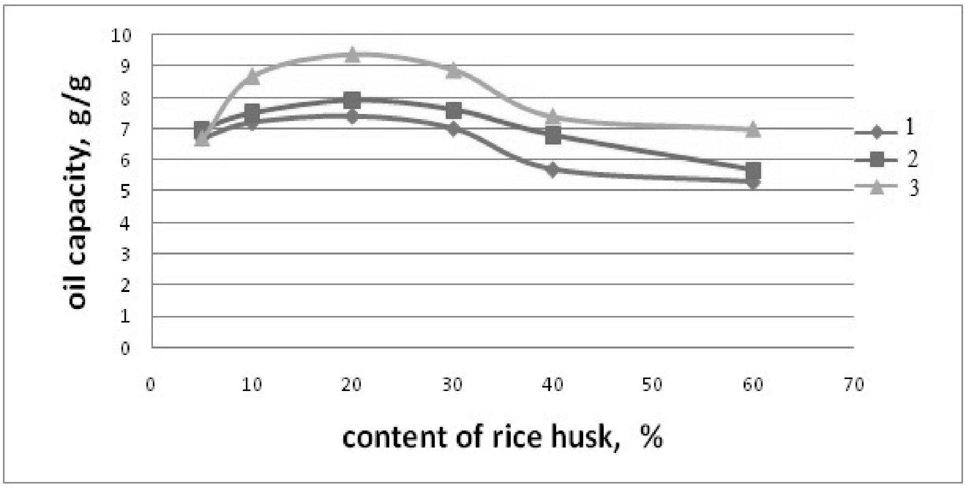


Fig. 3 – Effect of rice husk on oil intensity of carbon polystyrene sorbent (CPS) adsorbent at the various temperatures: 1 – oil capacity of CPS at temperature 0°C, 2 – oil capacity of CPS at temperature 10°C, 3 – oil capacity of CPS at temperature 25°C.

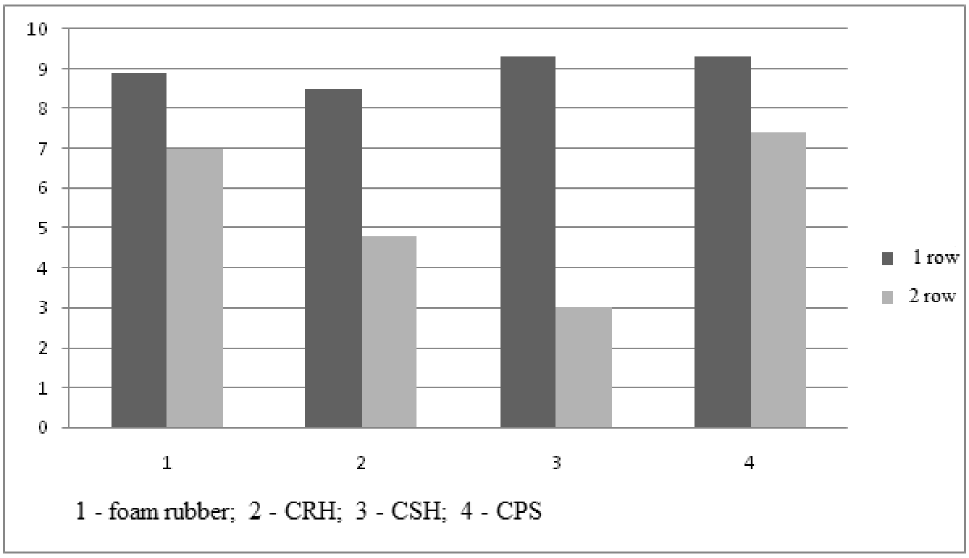


Fig. 4 – Comparative characteristics of sorbents: 1 row – oil collected at 0° C, 2 row – squeezed oil at room temperature.

The values of oil capacity of carbon-fiber polystyrene sorbents with the content of RH to 35-40 wt.% exceed the oil intensity of pure polystyrene fibers. It was shown that the oil capacity indicators for all the researched samples of carbon-fiber polystyrene are decreased with temperature decreasing (Fig. 3).

The maximum value of oil capacity shows the sample containing 21.0% of RH filler (fig.4), by the quantity of the collected oil at 0°C this carbon-fiber polystyrene adsorbent (CPS), 21.0% RH is an optimum sorbent and has a high oil capacity and a high percentage of oil squeezed as compared with foam rubber and carbonizates of rice and sunflower husk.

This factor is the indisputable advantage in the conditions of winter oil spill. This can be considered a significant positive feature as oil capacity of many famous collectors at a temperature below 4°C decreases one order of magnitude.[2-5] However, the foregoing carbon sorbent polystyrene (21.0 % RH) at temperatures below 0°C loses the ability to collect oil, which is associated with high viscosity oil. The investigated sorbents are characterized by 100% buoyancy at the water surface, and the degree of oil recovery does not exceed of 0.5 - 1.0%.

EXPERIMENTAL

The researches have been carried with a rice husk (RH), obtained by thrashing of the Kazakhstan rice which has been grown up in the Kyzyl-Orda area. Process of samples carbonization was carried out in the isothermal conditions on the methods developed earlier in laboratory.[5, 12-14] Installation on thermal pyrolysis of initial materials consists of system of feeding system of gases - reometers supervising streams of gases. It consists of the reactor made of the quartz maintaining temperature to 1000°C, the furnace, the monitoring system of temperatures - platinum-rhenium thermocouple submitting signals on millivoltmeter, floating trough with the samples, the receiving tank of gases. The wastes gases were analyzed on Chromatograph. Also as the objects of research the certain kinds of vegetative sources of the organic wastes and coal: SH, polystyrene foam and foam rubber were used.

Oil absorption is calculated by the formula (1):

$$\mathbf{OA=M_{PS}-M_0} \quad (1)$$

where: OA-oil absorbtion of sorbent, g of oil/g of sorbent

M_{PS} – weight of polypropylene fabric with the sample, g

M_0- weight of polypropylene fabric without the sample, g

The water absorption of oil sorbent - the amount of water in grams, which sorbed by 1.0 g of oil sorbent. For its experimental determination 1.0 g of the test oil sorbent as a continuous layer is applied to the surface of the water. After 20 min. the oil sorbent is collected from the water surface and mass of water collected by one gram of oil sorbent (water absorption) is determined with use of the weight method, by the formula:

$$\mathbf{W=(V_{fin.}-V_{init.})d_{water}=M_{fin.}-M_{init.}} \quad (2)$$

where: B – water absorption of oil sorbent, g of water /g of oil sorbent;

$V_{init.}$ – the initial volume of the water sample, mL;

$V_{fin.}$ – final sample volume of water, mL;

d_{water} – density of water, d_{water} = 1 g/mL;

$M_{init.}$ – initial weight of the water sample, g;

$M_{fin.}$ – the final mass of the sample water.

CONCLUSION

The obtained carbon-polystyrene sorbent (21.0% RH) has good performance. Absence of chemical binders and one-stage process ensure the environmental cleanliness of production technology and relatively low cost of sorbents. In the work the sorbents of oil of a phytogenesis are studied and the structural characteristics and properties of a surface are compared. The carbon-polystyrene sorbent (21.0 % RH) with good performance characteristics is synthesized. Absence of chemical binders and one-stage process ensure the environmental cleanliness of production technology and relatively low cost of sorbents.

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