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THE SORBENTS FOR COLLECTION OF OIL AND PETROLEUM OF THE PHYTOGENESIS

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ABSTRACT

It is shown, that compositions polystyrene granulated + carbonizate of a sunflower husk combined the considerable degree of replacement of a synthetic material and at the same time showed also high indicators of oil capacity and return of mineral oil. It is established, that values of oil capacity of carbon-polystyrene foam fibrous sorbents with the content of a rice peel to 35-40% by weight exceed oil capacity of a pure fibre of polystyrene foam. The received carbonic-polystyrene sorbent (21% the rice peel) had good operational characteristics. Absence of the chemical binding and single-stage process provided the ecological cleanliness of technology of production and rather low cost price of sorbents.

Key words: Oil-spot, Sorption capacity, Oil film.

INTRODUCTION

Sorption represents one of the most effective methods of deep purification from the dissolved organic substances of waste water of the enterprises of pulp-and-paper, chemical, petrochemical, textile and other industries. Advantages of this method are possibility of absorption of substances from multi component mixes and high degree of the cleaning, especially poorly concentrated waste waters[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 problems: cleaning of waste water, gas bursts, a ground etc.[2] Low cost, simple enough technology of preparation of sorbents stimulate the researches directed on production of new adsorbtion-active materials from the vegetative raw materials. Use of these materials for production of sorbents, allows to combine abandonment of the agricultural production wastes with the environmental protection activity[3]. By present time

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production of sorbents from the rice production wastes is developed basically within the limits of a problem of utilization of a peel. As the flower films of rice (peel) and straw contain a considerable quantity of silicon dioxide, this waste can be a source of obtaining of different siliceous sorbents (diatomites, terra siliceas, casting boxes) or pyrogenic silicon earth. From the literature it is known[3,4], that fat-free bran of rice can clean the solutions of ions of chrome, copper, zinc, and a rice peel - from ions of strontium, cadmium, nickel, lead, zinc, chrome, cobalt and aluminium[3], and also is shown[5], 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).

EXPERIMENTAL

The researches have been carried with a rice peel (RP), 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 our laboratory[6-8]. Installation on thermal pyrolysis of initial materials consisted of system of feeding system of gases-reometers supervising streams of gases. It consisted of the reactor made of the quartz maintaining temperature to 1000^{o}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 objects of research, the certain kinds of vegetative sources of the organic wastes and coal: a sunflower peel, polystyrene foam and foam rubber were used.

Oil absorption is determined by Eq. (1):

$$OA = (M_{PS} – M_0) \quad \ldots(1)$$

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 one gram of oil sorbent. For its experimental determination 1 g of the test oil sorbent as a continuous layer is applied to the surface of the water. After 20 mins 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 Eq. (2):

$$W = (V_{fin.} - V_{init.})\cdot\rho_{water} = M_{fin.} - M_{init.} \quad \ldots(2)$$

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);

ρ_{water} – Density of water, $\rho_{water} = 1$ g/mL;

$M_{init.}$ – Initial weight of the water sample (g);

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

RESULTS AND DISCUSSION

As shown in Table, the fibrous sorbents (the synthetic wadding and modified foam) are characterized by a high degree of extraction of oil absorbed and demonstrated the high enough absorption of water, due to the low surface hydrophobicity. This disadvantage can be eliminated by introducing of special hydrophobic additives of carbonizates of rice and sunflower husk (RH and SH).

Carbonation surface of the sorbent of SH and strongly influenced by its water absorption capacity. As shown by the results of measurements with increasing of carbonization temperature the water absorption ability is greatly reduced.

For example, if for the initial sorbent, SH which is thermally activated at 200°C, it amounts 34% of its weight but for carbonated sample does not exceed 2.5%. Consequently, by selecting the optimum conditions for carbonizing of the surface of the sorbent SH it s possible to obtain the sorbents with a certain hydrophobic-hydrophilic balance, which is very important by their use in various fields.

The experimental results on the absorption of crude oil showed that by using the granulated material with a closed porous structure (e.g. granulated foam polystyrene) placement of oil is only possible between the granules in sorbent layer due to capillary forces and the oleophilic property.

With a sufficient thickness of an oil film the effective introducing of crude oil into the area of porosity occurs, but by the layer contact with the water also absorption of water between the granules begins well in the space. Liquid is retained between the granules due to capillary forces and adhesion[9,10].

The results in Table showed that the compositions of the granulated foam polystyrene + carbonizates of SH combined the substantial degree of substitution of synthetic material, and at the same time and also demonstrated the high values of oil capacity and oil return.

Table 1: Physical and mechanical properties of the synthesized sorbents

Material	Oil absorption (g/g)	Water absorption (g/g)	The degree of oil squeezing (%)
Carbonizate of sunflower husk	3.5-4	2.5	44
Carbonizate of rise husk	6-7	4-5	55
Carbonizate of apricot pits	8-9	3-4	30
Synthetic wool	9-10	2.6	60
Carbon powder	1-2	0.5	-
Synthesized technical carbon	4-6	0-1	60
Foam rubber modified	40	30.7	75
Polystyrene foam	10	15	5
Polystyrene foam granulated + carbonizate of sunflower husk	25-26	15	50-55
Polystyrene foam granulated + carbonizate of rise husk	10	10	40

Analysis of the structural characteristics and surface properties of vegetable materials (RH, SH, AP) allowed to evaluate the effectiveness of their use in cleaning of the water surface from oil. For example, a comparison of the characteristics of different types of plant wastes made it possible to select the most perspective materials.

The data in Table 1 showed that carbonizate of rice husk and apricot seeds are characterized by a water absorption is substantially the same, but differed in terms of the absorption of oil. This may explain the difference in the structure of materials. Rice husk has cellular structure (Fig. 1).

However, the rice husk removes oil significantly worse than apricot stone due to the lower porosity and higher density.

These results demonstrate that absorption of oil and water by the vegetable wastes proceeds according to the different mechanisms. The hydrophilicity of these materials leads to that water is easily is adsorbed in the material structure, while crude oil is retained on the surface of the absorber by adhesion forces.

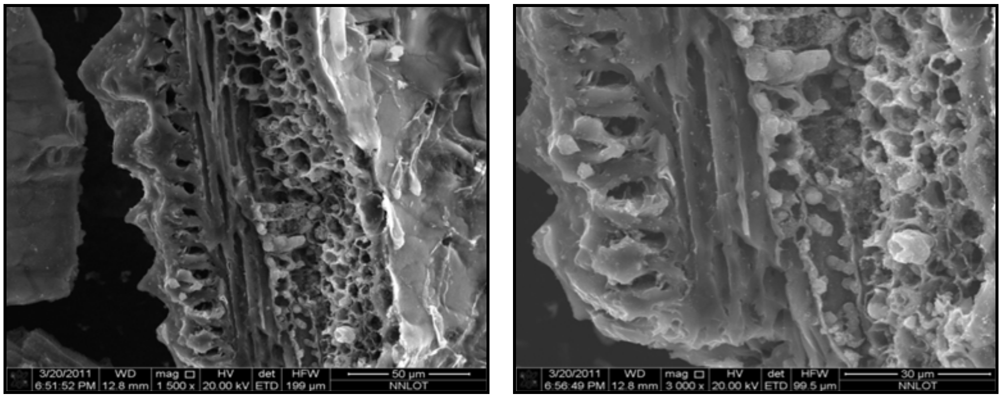
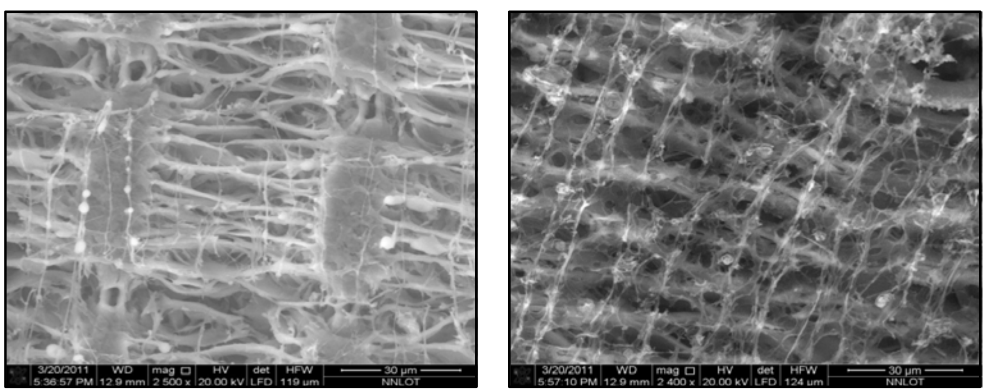


Fig. 1: SEM photographs of rice husk after the heat treatment

Therefore, the vegetable waste tend better retain the viscous oil in comparison with a low viscosity crude oil.

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



(a)-CPCRH400 (b)- CPCRH700

Fig. 2: SEM pictures of the carbon-polystyrene material with excipients of rice husk 30% after the heat treatment

It was found that the values of oil capacity of carbon-fiber polystyrene sorbents with the content of rice husk to 35-40 wt.% exceed the oil intensity of pure polystyrene fibers.

The maximum value of oil capacity showed the sample containing 21% of rice husk filler. Oil capacity indicators for all the samples of carbon-fiber polystyrene are decreased with temperature decreasing. By the quantity of the collected oil at 0^oC carbon-fiber polystyrene adsorbent (21% rice husk) was an optimum sorbent having 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 was 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[11].

However, the foregoing carbon sorbent polystyrene (21% rice husk) at temperature below 0°C has lost the ability to collect oil, which was associated with the high viscosity oil. The investigated sorbents were characterized by 100% buoyancy at the water surface, and the degree of oil recovery didn't exceed of 0.5-1.0%.

CONCLUSION

Thus, the obtained carbon-polystyrene sorbent (21% rice husk) had good performance. Absence of chemical binders and one-stage process ensured the environmental cleanliness of production technology and relatively low cost of sorbents.

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