Таким образом, показано, что использование достаточно простой технологии извлечения и очистки полисахаридов из листьев вишни позволяет получить перспективные для практического применения гликаны. Наиболее эффективным экстрагентом, обеспечивающим максимальный выход (ПС-2 – 5,97%), является водный раствор лимонной кислоты. Данные ИК–спектроскопии подтверждают наличие характеристических полос поглощения, свойственных пектинам. Исследование элементного состава указывает на целесообразность дальнейшего изучения возможности применения полисахаридов вишни в качестве биологической добавки с комплексным набором свойств.

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Obtaining adsorbents based on coal of the Kazakhstan in a pilot-industrial installation

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Аннотация

В статье приведены результаты исследований по получению активированных адсорбентов на основе углей Казахстана путем его карбонизации и активации на опытно-полупромышленной установке на базе института. С помощью энергодисперсионной рентгеновской спектроскопии на приборе SEM (Quanta 3D 200i) с приставкой для энергодисперсионного анализа от EDAX определен его химический состав. Методом БЭТ определены адсорбционные характеристики образцов. При этом установлено, что удельная поверхность и удельный объем пор существенно повышаются в результате высокотемпературной обработки угля. Проведены испытания по апробации полученного активированного угля в качестве адсорбента для очистки сточной воды.

Ключевые слова: уголь, опытно-полупромышленная установка, адсорбент, карбонизация, активация, очистка

Abstract

The article presents the results of studies on the production of activated adsorbents based on coals of Kazakhstan by its carbonization and activation on a pilot plant at the institute. Using energy dispersive X-ray spectroscopy on an SEM instrument (Quanta 3D 200i) with an attachment for energy dispersive analysis from EDAX, its chemical composition was determined. The adsorption characteristics of the samples were determined by the BET method. It was found that the specific surface and specific pore volume

significantly increase as a result of high-temperature processing of coal. Tests were conducted to test the obtained activated carbon as an adsorbent for wastewater treatment.

Keywords: coal, pilot-industrial installation, adsorbent, carbonization, activation, purification

Recent decades have been marked by a surge of scientific activity in the development and study of carbon materials (CM). This is reflected in the targeted synthesis of allotropic forms of carbon (carbohydrates, fullerenes, nanotubes, compasses, etc.), as well as in the creation of a wide range of porous materials in a series of mixed (transitional) forms of carbon, which are of practical interest as adsorbents, catalysts, and carriers for catalysts, substrates in new generation current sources (lithium-ion batteries, supercapacitors, ionistors and fuel cells), etc. [1-4].

In the medium term, the Kazakhstan market of activated carbon will grow by at least 10-12% per year, primarily due to the tightening of environmental standards. It is expected that by 2021 the market volume will reach 10.7 thousand tons. In addition to the high demand for activated carbon in Kazakhstan as a whole, experts note the fact that the demand for activated carbon of high quality is growing [5]. The high quality of the activated adsorbent depends primarily on the raw materials used, as well as technologies for its production. In Kazakhstan, amid significant import dependence of the activated adsorbent market, including high-quality, there is an urgent need to develop domestic production, as well as introduce the latest processing technologies. As you know, the main characteristic of the adsorption capacity of materials during the adsorption of gases, steam, solid and liquid substances is surface development, total pore volume, pore size distribution, high specific surface, which gives them a number of unique properties. Being an excellent sorption material, coal can be used for the purification of gases, liquid media, including sewage from petroleum products, phenols and salts of heavy metals.

The aim of the work is the research and development of technology for the process of producing activated carbon (adsorbents) with high added value based on domestic raw materials for the purification of the gas phase from acidic components and wastewater.

Samples of activated carbon were obtained at the "Institute of Coal Chemistry and Technology" LLP (Nur-Sultan) by carbonization (at 700 ° C in a nitrogen atmosphere) and steam activation for 1 hour. To obtain activated adsorbents, the initial product was previously crushed to a fraction of 0.1 mm, then cylindrical samples ($d = 0.2-0.3$ cm) were obtained from it on an extruder. Further, the product passed the stage of heat treatment (carbonization) and activation in an inert atmosphere of nitrogen on a rotary drum furnace (with a volume of 50-100 kg).

The object of the study are carbon materials from the coal deposits of "Shoptykol", "Sarykol", "Saryadyr" (coal seams "Pyatimetrovyy", "Sputnik", "Nadezhnyy"), "Kushmurn", "Mamyt", "Shubarkul" (Central section), "Oi-Karagai".

As a result of carbonization and activation, we obtained: activated carbon (adsorbent), gas, and coal tar, which is further used to produce carbon nanofibers. The generator gas obtained during carbonization and activation is supplied to a gas distribution device (GDD), then to the burners for heating the drum furnace. After purification, water is used for the steam activation step. Therefore, the presented scheme for the production of carbon materials is economically and ecologically advantageous, since a complex, non-waste technology is used.

Humidity, ash content and volatility of adsorbents were determined on a "Thermoster Eltra" thermogravimetric analyzer. Bulk density, pH of the aqueous extract, adsorption activity by methyl orange was determined in accordance with [6]. The adsorption characteristics of the samples (specific surface area, specific pore volume by ultimate filling) were studied by the Brunauer-Emmett-Teller (BET) method. The elemental composition of the samples was studied by energy dispersive X-ray spectroscopy on an SEM instrument

(Quanta 3D 200i) with an attachment for energy dispersive analysis from EDAX. The results of the study of physico-chemical properties, elemental composition of the obtained adsorbents are presented in tables 1 and 2.

Table 1

Results of physico-chemical characteristics of adsorbents (AC) based on coal from the Kazakhstan deposit

Name of AC	W _{rt} , %	A _r , %	V _d , %	Total pore volume in water, cm ³ / g	Bulk density ρ, g / cm ³	pH of the aqueous extract	Adsorb. active by methyl orange, mg / g	Specific surface, m ² / g	Specific pore volume cm ³ / g
“Shoptkol”	0,56	25,08	27,96	0,448	0,536	9,51	57,5	348,99	-
“Sarykol”	0,75	70,52	5,39	1,099	0,640	9,20	26,00	179,39	-
“Pyatimetrovyy”	0,62	27,14	4,05	0,420	0,561	7,30	26,15	148,53	0,064
“Sputnik”	0,26	53,34	5,11	0,570	0,603	8,26	20,05	148,85	0,064
“Nadezhnyy”	0,76	40,93	6,71	0,660	0,648	8,47	22,35	294,44	0,126
“Mamyt”	1,25	32,13	14,14	0,608	0,697	8,22	41,50	364,59	0,156
“Shubarkul”	3,30	11,25	5,50	0,864	0,637	8,53	35,00	442,81	-
“Kushmurnyn”	1,25	38,74	8,32	0,560	0,517	10,94	20,00	343,63	0,147
“Oi-Karagai”	2,83	26,57	19,12	0,5	0,603	10,34	52,50	266,86	-
“Bogatyr”	1,93	32,37	7,30	0,67	0,664	6,25	36,80	11,552	0,005

Table 2

Results of the study of the elemental composition of adsorbents (AC) based on coal from the Kazakhstan deposit

Name	The content of elements, wt. %										
	C	O	Na	Mg	Al	Si	K	Ca	Fe	Ti	S
“Shoptkol”	60,69	19,44	-	0,58	5,29	10,09	1,05	0,75	1,60	-	-
“Sarykol”	52,42	19,81	0,44	0,47	4,87	10,32	1,85	1,39	7,14	0,55	0,04
“Pyatimetrovyy”	88,60	8,22	-	-	0,22	1,43	-	-	-	1,32	0,21
“Sputnik”	59,98	22,62	-	-	3,73	13,67	-	-	-	-	-
“Nadezhnyy”	61,11	21,17	-	-	8,05	9,24	0,43	-	-	-	-
“Mamyt”	77,60	9,94	0,37	-	3,15	2,69	-	1,97	3,45	-	0,82
“Shubarkul”	87,58	9,92	0,14	0,17	0,55	0,54	-	0,64	0,31	-	0,17
“Kushmurnyn”	82,96	5,77	0,41	0,91	1,21	0,47	-	6,51	0,92	-	0,30
“Bogatyr”	78,81	12,30	-	-	-	2,58	4,85	-	-	1,30	-

In the accredited laboratory of the “Research Center Coal” LLP, the main characteristics of the obtained adsorbents were studied according to ST RK 2246-2012 (table 3).

Table 3

Results of studies of the physico-chemical characteristics of activated adsorbents

№	Name of indicator	Unit of measurement	Adsorbent value		
			“Saryadyr”	“Shoptkol”	Kushmurnyn”
1	Mass fraction of water	%	0,91	2,24	0,86
2	Mass fraction of ash	%	41,59	25,53	21,69
3	Structural Strength	%	86,72	87,63	92,25
4	Total pore volume in water	cm ³ / g	0,27	0,44	0,42
5	Adsorption activity by iodine	%	15,55	19,58	30,93
6	Bulk density	g / cm ³	0,86	0,54	0,60
7	Mass fraction of chlorine	%	0,01	0,01	0,26

8	Mass fraction of arsenic	%	0,0002	0,0006	0,0003
9	Mass fraction of total sulfur	%	0,52	0,58	3,64
10	Grading	%			
	More than 5 mm		22,97	18,61	13,91
	3-5 mm		72,88	73,26	61,78
	1-3 mm		2,71	6,82	14,88
	0.1-1 mm		0,47	0,36	2,28
	Less than 0.1mm		0,97	0,95	1,15
	Total		100,00	100,00	100,00

The obtained activated adsorbents were tested for the treatment of wastewater taken from the SUC “Astana su Arnasy” (Nur-Sultan) (table 4). Place of sampling: distribution chamber after preliminary mechanical cleaning. Chemical analysis of wastewater before (control) and after treatment with adsorbents in laboratory adsorption units was carried out in an accredited analytical laboratory of sewage treatment facilities of SUC “Astana su Arnasy”, in which the main indicators of wastewater treatment were determined. The degree of purification was also calculated by the main indicators (to compare the adsorption properties).

Table 4

The results of chemical analysis of wastewater “Astana su Arnasy” before and after treatment with adsorbents

The name of indicators	The degree of purification, in %							
	“Shoptykol”	“Sarykol”	“Pyatimetrovyy”	“Sputnik”	“Nadezhnyy”	“Mamyt”	“Oi-Karagai”	“Kushmuryyn”
pH	8,82	8,70	7,35	7,85	7,9	8,5	9,00	10,10
BOC, mgO / dm ³	86,31	72,63	87,77	70,00	88,44	84,44	36,84	84,24
COC, mgO / dm ³	61,53	34,23	52,75	57,14	68,29	52,75	14,61	29,43
Suspended solids, mg / dm ³	73,22	67,58	65,51	93,11	73,79	69,65	59,94	72,31
Chlorides, mg / dm ³	46,29	23,14	3,74	2,14	3,74	0,13	-	-
Ammonium nitrogen, mg / dm ³	63,74	56,99	10,88	14,23	22,04	11,72	48,16	89,81
Nitrite, mg / dm ³	57,61	58,27	35,03	13,63	29,92	42,33	45,03	42,22
Nitrates, mg / dm ³	79,62	64,81	21,42	18,75	12,5	30,35	40,74	47,61
Iron, mg / dm ³	81,74	76,58	56,31	66,11	76,69	61,16	22,61	56,52
Phosphates, mg / dm ³	22,52	46,92	33,93	35,68	47,65	65,34	79,87	93,32
Zinc, mg / dm ³	24,75	14,35	8,16	33,66	-	-	29,20	66,66
Copper, mg / dm ³	43,47	47,82	9,67	16,00	22,58	41,93	-	6,66
Synthetic Surfactants, mg / dm ³	25,35	29,57	39,91	81,31	66,94	50,10	11,97	13,64
Petroleum products, mg / dm ³	65,25	56,16	88,19	94,73	95,13	92,36	55,84	18,00

An analysis of the obtained data showed that after wastewater treatment, the values of all chemical indicators for all adsorbents decrease, especially indicators such as BOC, suspended solids, phosphates, iron and petroleum products. These research results show that the obtained samples based on carbon materials can be considered promising, in particular, as adsorbents for cleaning liquid media.

Thus, as a result of high-temperature processes of carbonization (in an inert atmosphere) and activation (water vapor) of the Kazakhstan coals, which has a more developed and ordered surface structure, as well as higher adsorption properties. In this regard, activated adsorbents can be considered promising, in particular, as an adsorbent for

the purification of liquid media and gas. To date, Kazakhstan imports the most expensive activated adsorbent from Japan - \$ 16,000 per ton. From Russia, as the main importer, activated carbon is imported at an average cost of \$ 1103 per 1 ton of products. The large-scale use of carbon adsorbents for environmental protection (sewage treatment, gas emissions, contaminated soils) requires the expansion of AC production from cheap types of organic raw materials: fossil solid fuels, various natural and technogenic organic wastes. Established production of ACs will ensure water management, Housing and utilities, the air basin of the Republic of Kazakhstan with efficient and inexpensive domestic-made nanomaterials, which will contribute to improving the environment and water resources, which will ultimately have a beneficial effect on public health.□□□

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