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# Purification of wastewater using domestic carbon adsorbents and conducting physico-chemical analysis of water composition

**Abstract.** *In the face of population growth around the world and increased demand for the depletion of fresh water sources, various strategies are being implemented to improve the efficiency of water use. Wastewater treatment and reuse are among the most effective strategies, especially if the treated water can be reused. In countries that are heavily dependent on fresh water sources, it is always important to ensure that water quality does not deteriorate due to natural organic matter, which is formed by the decomposition of plant and animal substances. Water scarcity is a growing global problem caused by a combination of factors such as population growth, climate change, and unstable water management practices.*

*In this article, an accredited analytical laboratory of sewage treatment plants of the state enterprise «Astana Su Arnasy» carried out wastewater treatment with domestic carbon-containing adsorbents (Shubarkol, Shoptykol, humic acid, carbon molecular sieves, technical carbon) and carried out a chemical analysis of the water content. The results of the study revealed that samples obtained on the basis of carbon materials, in particular, can be used as adsorbents for cleaning liquid media (from suspended solids, heavy metal salts, surfactants, petroleum products, etc.).*

**Keywords:** *waste water, adsorbent, carbonization, humic acid, activated carbon, carbon.*

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**Introduction.** Water is the fundamental principle of life, the basis of ecological systems, a necessary condition for any social and economic processes. Issues of water as an environmental, social and economic factor are identified as a priority in the "Concept of the transition of the Republic of Kazakhstan to sustainable development for 2007-2024", approved by Decree of the President of the country No. 216 of November 14, 2006. Providing the population with drinking water that meets the physiological needs of the human body is named in the Concept as the most important tool for increasing the average life expectancy of the country's population. The conservation of the planet's water resources is considered one of the main tasks in the development of modern science, and the purification and efficient use of water resources is an important stage in its solution.

According to the UN, over the past 50 years, the provision of water resources to the population of Central Asian countries has decreased by almost 3.5 times and, according to calculations, by 2025 it may reach a critical level - 1.7 cubic meters per person per year. This situation makes us think about being careful with water [1]. Currently, the availability of drinking water and, in general, the characteristics of water supply systems in Kazakhstan remain unsatisfactory. The value of drinking water in Kazakhstan is increasing due to limited water resources, the high degree of their pollution, and the uneven distribution of their reserves throughout the country.

In each hydrographic region of the country, enterprises of various types of industry predominate, with significant water consumption and, accordingly, significant costs of discharged wastewater. Such enterprises include primarily oil refining, metallurgical, pulp and paper, chemical, coal (CHP, state district power plants, boiler houses), metalworking, machine-building, ore mining, food enterprises (meat, milk, wool, leather processing), as well as light industry enterprises, energy, agriculture (poultry farms, livestock complex).

There have been several new developments in water purification in recent years. Alternatives have presented themselves for classical and conventional water purification systems [2]. Improved wastewater treatment has become an area of global attention as individuals, communities, industries and countries strive to ensure that essential resources are accessible and recyclable. Advanced wastewater treatment technologies, coupled with a reduction in water recycling initiatives, offer hope for slowing and possibly stopping the inevitable loss of useful water [3, 4].

Deep cleaning of industrial and domestic wastewater of various facilities is one of the main environmental problems of modern society. Every year, the requirements for standards for the maximum concentration of purified substances from wastewater are tightened, and the anthropogenic and man-made pressure on the hydrosphere is steadily increasing. Industrial wastewater is characterized by a different chemical composition of components that directly depend on the production process. The most dangerous is tap water with high toxic organic matter. Such a composition of wastewater is characteristic of the oil refining, petrochemical and textile industries, where the surface of the waters is dominated by active substances, phenols, aldehydes, petroleum products, etc. In turn, the maximum concentration of water in these substances is about 100 mg and milligrams, and these indicators require purification methods [5].

Around the world, water objects are suffering from toxic wastewater and are steadily deteriorating in quality, as industrialization, along with urbanization, has caused excessive wastewater discharge and led to serious environmental pollution. These toxic effluents damage the water biota. Industrial wastewater pollutes surface water, but also pollutes underground aquifers. Due to the bad smell, color, and turbidity of wastewater, most industrial processes use fresh water instead of waste water. Increasing pressure on demand for fresh water has led to severe pollution. Thus, wastewater treatment is recognized as an important problem worldwide, and with the help of wastewater treatment, the problem of water scarcity can be solved [6].

In the past few years, various physical, chemical, biological and combined wastewater treatment processes have been studied and developed. Various studies have shown that the traditional and non-traditional treatment processes adopted for the intake of wastewater cannot sufficiently reduce the level of pollutants to the point that they can be reused and the pathogen reduced. However, due in part to degradation and the destruction of pollutants, wastewater still poses a serious threat to underground and surface water, from where it can enter the food chain and affect humans as well as the river ecosystem [7,8].

The main methods of wastewater treatment are divided into three stages: primary treatment, including sand removal, screening, grinding and settling; secondary treatment, which involves the oxidation of dissolved organic matter using biologically active sludge, which is then filtered; and tertiary treatment, which uses advanced biological methods for nitrogen removal and chemical and physical methods such as granular filtration and activated carbon absorption, etc. [9,10].

Physical-chemical methods of wastewater treatment include the processes of flocculation, coagulation, deposition, filtration, ultrafiltration, reverse osmosis, etc. These methods are based on the use of chemical reagents to change the physicochemical properties of wastewater, such as pH, temperature, salt concentration. This allows the removal of various pollutants from wastewater, such as heavy metals, petroleum products, organic and inorganic compounds [6]. Physicochemical methods for treating urban wastewater, taking into account technical and economic indicators, are used very rarely. These methods are mainly used for the treatment of industrial wastewater [9].

Deep treatment of wastewater by the physical-chemical method, including the adsorption method, is an effective and energy-saving method for removing pollution. The adsorption method differs from other methods and has many advantages, today it is widely used when reusing treated wastewater, as well as for the preparation of domestic and drinking water. There are known works [11,12] of scientists from the USA, Japan, Great Britain, Germany and other countries on the purification of industrial and wastewater.

At the same time, the complex use of natural mineral resources is an urgent problem of our time. Kazakhstan is rich in coal deposits, which are an environmentally safe material for creating a sorbent for cleaning water and air. But the sorbic properties of these materials are not very high, so they must be chemically modified, processed. As a result of processing, much better properties are obtained compared to the original sorbent.

Most traditional synthesis methods use expensive carbon precursors, which results in high production costs and limits its industrial expansion and application. Replacing existing carbon feedstocks with abundant, low-cost coal will bring significant benefits. Large-scale production of carbon sorbents from coal is cost-effective compared to processes that use polymeric materials and precursors and can make a significant contribution to wastewater treatment and enable the commercialization of low-cost environmentally friendly products for global benefit.

The huge demand for high-quality brands of activated carbon that meet the requirements of specific technological regulations is leading engineers and scientists to develop new methods for producing sorbents, as well as finding the optimal raw material base [6].

Currently, the raw materials for the production of sorbents are wood and cellulose [13, 14], peat [15], brown and hard coal [16], liquid and gaseous hydrocarbons [17], synthetic polymers [18], plant waste [19] other raw materials.

**Practical part.** Sorbents from ores with rich natural reserves were used as primary raw materials in Kazakhstan. These sorbents were obtained in the «Laboratory of carbon nanocomposite materials» of «Institute of coal chemistry and Technology» LLP (Astana).

Activated adsorbents were obtained by carbonization and activation in argon and water vapor at 973 K, and the physicochemical characteristics and surface morphology of the samples under study were studied.

Humic substances were obtained from oxidized brown coal, purified, and determined in accordance with the recommendations of the International Humic Substances Society (IHSS). Humic acids were prepared based on potassium humates by acidifying them with a 5% acid solution to pH 2–2,5; as a result of the reaction, humic acids precipitated in the form of amorphous brown sediments.

The moisture content, ash content and volatility of the samples were determined using a Thermoster Eltra thermogravimetric analyzer (according to ASTM D7582-12). The total pore volume, bulk density, pH of the aqueous extract, and adsorption activity for methyl orange were determined in accordance with the methods of [6]. The adsorption characteristics of sorbents (specific surface area) were studied by the Brunauer–Emmett–Teller (BET) method, measurements were carried out on a KATAKON Sorbtometer M device. Determination of the pH value of adsorbents in water. To do this, 5 gr of each sorbent was weighed and placed in a 50 ml flask, and distilled water was poured on top. Then it was boiled on the stove for 3 minutes, then filtered with filter paper, and its value was checked on the pH meter.

BOD5 measures the mass of molecular oxygen consumed by microorganisms for five days in a liter of water at 20°C in the dark. There are several ways to measure BOD5. The most widely used physical-chemical method uses a dissolved oxygen probe to measure the concentration of $O_2$ in a representative sample, the operation is repeated after an incubation period of 5 days. BOD5 is the difference between the two dimensions. The results are expressed in mg/l. Sometimes it is necessary to dilute the sample before measuring BOD5. In cases where the BOD is particularly high, all dissolved $O_2$ can be used practically until the end of the 5-day period. The performance of a wastewater treatment plant is measured using PE (population equivalents) based on BOD5. COD or «chemical oxygen demand» measures the amount of oxygen needed to decompose by oxidizing all organic and inorganic substances. But let me remind you that BOD5 only measures the oxygen consumption of microorganisms, that is, biodegradable pollution. Thus, KOK 5 which measures biodegradable and non-biodegradable pollution, is higher than BOD5. COD/BOD5 ratio measures wastewater biodegradability:

1) < 2: wastewater is easily biodegradable

2) 2 to 4: the wastewater is biodegradable on average

3) 4: wastewater is not biodegradable

4) the COD test can be done in two to three hours using chemical reagents such as potassium dichromate. Then a clear picture of the performance of the water treatment plant can be obtained relatively quickly. KOK5 which is used by local authorities as a benchmark for water treatment, is also used to calculate payments and set limits for dumping waste into the natural environment.

**The obtained results and their discussion.** At the same time, 9 different samples were taken as adsorbents. Further research was carried out, studying the physical and chemical properties of each of them.

A total of nine (9) adsorbents were selected: 1 – «Shubarkol, activated», granule; 2 – «Shoptykol, corbonized», powder; 3 – «Shoptykol, activated» powder; 4 – «Shoptykol, activated» granule; 5 – «Humic acid», washed; 6 – «Humic acid, carbonized; 7 – «Humic acid», unwashed; 8 – Carbon molecular sieve sorbents; 9 – Technical carbon.

The obtained sorbents were tested as adsorbents for the treatment of wastewater received by «Astana Su Arnasy» (Astana). Sampling location: distribution chamber after preliminary mechanical cleaning. In the accredited analytical laboratory of sewage treatment plants of the state enterprise «Astana Su Arnasy», a chemical analysis was carried out before (control) and after wastewater treatment with adsorbents under dynamic conditions, where the main indicators of wastewater treatment were determined.

Samples were taken for physico-chemical analysis in sterilized plastic vials with a capacity of 1000 ml. The collected samples were properly labeled, stored in the refrigerator to maintain a constant temperature of 4°C, and immediately taken to the laboratory for further analysis. Samples of adsorbents were analyzed by methods of quality control by standard methods with compliance with the appropriate parameters.

Hydrochemical indicators of samples were determined by conventional methods and carried out according to the following indicators (mg/dm$^3$): $BOR_5$ (CT RK ISO 5815-2- 2010), COD (PND F 14.1:2:4.190-2003), suspended solids (CT RK 2015-2010), chlorides (GOST 26449.1-85), sulfates (GOST 26449.1-85), phosphates (GOST 18309-2014), synthetic surfactants (CT RK 1983-2010), nitrates (GOST 33045-2014), nitrites (GOST 33045-2014), nitrogen ammonium (GOST 33045-2014), iron (CT RK ISO 6332-2008), oil products (PND F 14.1:2:4.128-98).

Physicochemical characteristics of the samples are presented in Table 1.

Table 1 - Physical-chemical characteristics of samples

| № | Sample | $W^r_t$,% | $A^r$,% | $V^d$, % | $V_\Sigma$ (water), см$^3$/г | r | pH aqueous extract | $A_m$, mg/g | $A_{iodine}$, mg/g | $S_{BET}$, m$^2$/g |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | «Shubarkol, activated», granule | 1.10 | 10.18 | 8.59 | 0.81 | 0.66 | 10,1 | 59.0 | 27.94 | 442.81 |
| 2 | «Shoptykol, corbonized», powder | 3.88 | 23.00 | 10.86 | 0.50 | 0.57 | 6.60 | 19.0 | 35.72 | 100.58 |
| 3 | «Shoptykol, activated» powder | 0.56 | 25.00 | 17.96 | 0.53 | 0.45 | 9.51 | 57.5 | 36.51 | 348.99 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 4 | «Shoptykol, activated» granule | 1.40 | 20.69 | 19.34 | 0.63 | 0.70 | 9.35 | 19.0 | 45.72 | 589.53 |
| 5 | «Humic acid», washed | 13.32 | 25.73 | 62.25 | - | 0.95 | 4.09 | 28.0 | - | 0.42 |
| 6 | «Humic acid, carbonized | 5.27 | 48.42 | 34.30 | 1.45 | 0.55 | 9.90 | 39.0 | - | 16.93 |
| 7 | «Humic acid», unwashed | 10.32 | 35.70 | 52.20 | - | 0.98 | 2.01 | 25.0 | - | 0.62 |
| 8 | Carbon molecular sieve sorbents | 2.31 | 61.55 | 7.66 | 0.69 | 0.86 | 7.56 | 28.0 | - | 753.89 |
| 9 | Technical carbon | 17.24 | 8.97 | 39.30 | 1.96 | 0.33 | 8.0 | 37.50 | 27.62 | 207.15 |

The results of the physicochemical, adsorption properties of the samples showed that the best performance corresponds to samples № 1, 3, 4, 8, 9, where the specific surface area are ($m^2/g$) 442.81, 348.99, 589.53, 753.89, and 207.15 accordingly.

Different adsorbents had different cleaning capacities of other components. The good sorption capacity of these obtained sorbents has been studied and proven in the «Astana Su arnasy» (Astana).

The results of the pH values of adsorbent samples are presented in Table 2.

Table 2 - pH values of samples

| Name of indicators, units | Norms for RD (after biolog. purification) | Sample № 0 | Sample № 1 | Sample № 2 | Sample № 3 | Sample № 4 | Sample № 5 | Sample № 6 | Sample № 7 | Sample № 8 | Sample № 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH ST RK ISO 10523-2013 | 6-9 | 7.22± 0.02 | 7.58 ± 0.02 | 7.66 ± 0.02 | 7.38 ± 0.02 | 7.21 ± 0.02 | 2.82 ± 0.02 | 7.43 ± 0.02 | 2.61 ± 0.02 | 7.76± 0.02 | 7.55± 0.02 |

Note: №0- raw waste water

pH aqueous extract showed the neutral or slightly alkaline pH level (between 7.21 and 7.76) of all wastewater samples. This indicates that the process of cleaning the samples was completed without significant changes in the acidity and alkalinity of the tap water. Only adsorbents based on «humic acid» (Samples №5, №7) have an acidic environment. This is explained by the exchange of acid groups in the composition of the sorbent into water.

The samples were also examined for biochemical oxygen requirements, as we know, biochemical oxygen demand (BOD) is the amount of oxygen consumed for aerobic biochemical oxidation under the influence of microorganisms and the decomposition of unstable organic compounds contained in the water under study. BOD is one of the most important criteria for the level of pollution of a reservoir with organic substances; it determines the amount of easily oxidized organic pollutants in water. The results of the study are shown in Table 3.

Table 3 – Indicators of biochemical oxygen requirements of adsorbents

| Name of indicators, units | Norms for RD (after biolog. purification) | Sample № 0 | Sample № 1 | Sample № 2 | Sample № 3 | Sample № 4 | Sample № 5 | Sample № 6 | Sample № 7 | Sample № 8 | Sample № 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $BOR_5$, mg/dm$^3$ | 15.23 | 55.0 ± 2.5 | 22.0 ± 1.0 | 42.0 ± 1.9 | 70.0 ± 3.2 | 8.0 ± 0.3 | 50.0 ± 2.3 | 42.0 ± 1.9 | 188.0 ± 8.7 | 6.0 ± 0.3 | 5.0 ± 0.2 |

As the results showed, BOD decreased in Samples № 4, 8, 9, which indicates the effectiveness of these samples in purifying steadfast organic pollutants by 85.45-90.91%. In Sample №1 the indicator decreased by almost 2 times.

Table 4 presents the results of the analysis, where for comparison the degrees of purification and norms according to RD (regulatory documents) corresponding to wastewater after biological treatment are given.

Table 4 – Adsorbent's ability to purify waste water from chemical toxic elements

| № | Name of indicators, units | Norms for RD (after biolog. purification) | Sample № 0 | Sample № 1 | Sample № 2 | Sample № 3 | Sample № 4 | Sample № 5 | Sample № 6 | Sample № 7 | Sample № 8 | Sample № 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1 | COD, mg/dm$^3$ | 118.67 | 251.0 ± 35.0 | 114.0 ± 16.0 | 152.0 ± 21.0 | 220.0 ± 31.0 | 73.2 ± 10.2 | 1125.0 ± 157.0 | 159.0 ± 22.0 | 3300.0 ± 462.0 | 87.2 ± 12.2 | 86.0 ± 12.0 |
| 2 | Suspended solids, mg/dm$^3$ | 22.65 | 247.0 ± 56.0 | 76.0 ± 17.0 | 48.0 ± 11.0 | 70.0 ± 16.0 | 44.0 ± 10.0 | 33.0 ± 7.0 | 66.0 ±15.0 | 337.0 ±77.0 | 48.5 ±11.2 | 36.5 ±8.4 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 3 | Chlorides, mg/dm$^3$ | 350.0 | 293 ±9 | 293 ±9 | 293 ±9 | 293 ±9 | 288 ±8 | 532 ±17 | 297 ±9 | 5072 ±152 | 273 ±8 | 302 ±9 |
| 4 | Sulfates, mg/dm$^3$ | 500.0 | 207±6 | 243±7 | 234±7 | 237±7 | 286±8 | 242±7 | 238±7 | 365±11 | 272±8 | 302±9 |
| 5 | Phosphates, mg/dm$^3$ | 3.5 | 13.23 ±1.67 | 8.26 ±1.27 | 11.85 ±1.56 | 10.24 ±1.43 | 11.13 ±1.50 | 2.99 ±0.85 | 12.27 ±1.59 | 3.29 ±0.87 | 12.15 ±1.58 | 9.40 ±1.36 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Synthetic surfac-tants, mg/dm$^3$ | 0.83 | 1.71 ±0.41 | 0.60 ±0.14 | 0.62 ±0.15 | 0.81 ±0.19 | 0.14 ±0.03 | 1.93 ±0.46 | 1.36 ±0.33 | 3.28 ±0.79 | 0.12 ±0.03 | 0.12 ±0.03 |
| 7 | Nitrates, mg/dm$^3$ | 45.0 | 0.70 ±0.35 | 0.66 ±0.33 | 0.92 ±0.46 | 0.82 ±0.41 | 0.53 ±0.27 | 1.47 ±0.74 | 0.65 ±0.33 | 13.00 ±6.50 | 0.80 ±0.40 | 1.00 ±0.50 |
| 8 | Nitrites, mg/dm$^3$ | 3.3 | 0.01 ±0.01 | 0.03 ±0.01 | 0.01 ±0.01 | 0.02 ±0.01 | 0.02 ±0.01 | 0.04 ±0.02 | 0.02 ±0.01 | 0.23 ±0.11 | 0.03 ±0.01 | 0.02 ±0.01 |
| 9 | Nitrogen ammo-nium, mg/dm$^3$ | 16.93 | 77.44 ±10.84 | 57.95 ±8.11 | 65.13 ±9.12 | 69.23 ±9.69 | 66.67 ±9.33 | 272.84 ±38.19 | 64.11 ±8.97 | 255.40 ± 35.76 | 62.57 ±8.76 | 66.67 ±9.33 |
| 10 | Iron, mg/dm$^3$ | 0.3 | 1.81 ±0.25 | 1.78 ±0.25 | 1.28 ±0.18 | 1.28 ±0.18 | 0.62 ±0.09 | 7.81 ±1.09 | 0.95 ±0.13 | 59.71 ±8.36 | 0.53 ±0.07 | 0.44 ±0.06 |
| 11 | Oil products, mg/dm$^3$ | 0.35 | 0.87 ±0.22 | 0.16 ±0.04 | 0.63 ±0.16 | 0.93 ±0.23 | 0.13 ±0.03 | 0.13 ±0.03 | 0.41 ±0.10 | 0.32 ±0.08 | 0.07 ±0.02 | 0.27 ±0.07 |

Chemical oxygen demand (COD) is used to assess the level of organic pollution in natural and waste waters. Currently, COD is considered one of the most informative indicators of anthropogenic water pollution, and data obtained in laboratories provide the necessary information about the concentrations of pollutants and their nature. The results of the COD study showed that Samples № 1, 4, 8, 9 also showed the best performance in purifying organic substances in water.

The concentration of nitrates ($NO_3^-$) in Samples №1, 4, 6, 8, 9 are within the normal range for drinking water. The concentration of nitrites $(NO_2^-)$ is also low and amounts to only 0.014 - 0.026 mg/dm$^3$, which is also within the permissible values for drinking water, except for Sample №7 in which the nitrite content increased several times. The concentration of ammonium ($NH_4^+$) and iron in samples except № 5 and 7 also does not exceed the maximum permissible values. Thus, we can conclude that the quality of water Sample № 1, 4, 8, 9 are suitable for domestic needs. In Sample №9, low concentrations of nitrites and ammonium are also observed, but it should be noted that the concentration of nitrates in this sample is slightly higher than the original sample and is 1.0 mg/dm$^3$.

The chloride content increases significantly for Sample 7 (humic acid-unwashed) from 293 to 5072 mg/l (about 15 times). This can be explained by the fact that hydrochloric acid was used to obtain humic acid from potassium humate, which explains the leaching of chloride ions from sorbents when interacting with wastewater. If we compare humic acid after washing (Sample 5), the content of chloride ions is almost 10 times lower than in sample 7.

Sample №6 carbonized humic acid also showed good results for iron and petroleum products, where the content decreased almost 2 times. Although the specific surface area of the sample is low, humic acids form complex compounds with metals. Oxygen-containing functional groups (-COOH, phenolic and alcohol -OH, as well as >C=O) included in the composition of HS can form stable complexes with metal ions. Amine (-$NH_2$), amide (CO-$NH_2$) and imine (>C=NH) groups also participate in the formation of organometallic complexes [20].

The content of synthetic surfactants increases after purification for sample №7 (humic acid-unwashed), this can be explained by the fact that humic acids, as colloidal systems, have all the basic properties of surfactants (surfactants), this is due to hydrophilic and hydrophobic regions in their molecules. The amphiphilicity (or diphilicity) of HA molecules promotes the formation of structured (colloidal) micelles. Colloidal HS micelles are capable of solubilizing hydrophobic compounds, including oil and petroleum products, within themselves. Solubilization is colloidal dissolution, 20 more precisely, the spontaneous and reversible penetration of a solubilizate (any hydrophobic substance) into colloidal micelles [21]. According to Yu.G. Frolova (1988), the properties and surface area of disperse systems depend on the nature of the molecules of surfactants, their concentration, as well as the shape and size of the micelles. The surface-active properties of humic acids are explained by the fact that some sections of HA molecules can be hydrophobic, while others can be hydrophilic. Organic substances of amphiphilic (otherwise amphiphilic) nature are capable of adsorbing at the interface between two phases, and a monomolecular layer is formed (Frolov, 1988). Because of this feature of GV N.I. Laktionov (1978) classified HA as a surfactant. An important property of colloidal surfactants is the hydrophilic-lipophilic balance. The hydrophilic-lipophilic balance (HLB) depends on the structure of surfactants, as well as on their composition. Each structural unit takes part in the GLB. Hydrophilic groups include, for example, – COOH, –COONa and –COOK, and lipophilic (otherwise hydrophobic) are: =CH–, $–CH_2–$, $–CH_3$ and =C= (Frolov, 1988) [22].

The content of iron cations increases significantly after water purification for Sample №7 (humic acid-unwashed), analyzes showed the iron content in HA from 1.5% to 5%; when interacting with chloride ions, etc., they form soluble salts that can go into wastewater. We used this sample for comparison with Sample №5 where humic acid was partially washed. These studies have shown the importance of washing humic acid to a neutral state before using it to purify aqueous media.

It has been shown that after wastewater treatment, the values of almost all chemical indicators for all adsorbents decrease significantly, especially such indicators as suspended solids, BOR, COR, phosphates, ammonium nitrogen, iron, surfactants and petroleum products. However, sulfate, nitrite amounts for all sorbent, and nitrate amounts for some sorbents (№2,3,5,7,8,9) there is a slight increase in the number of samples used compared to the original Sample №0, which is explained by the presence of these ions in the composition of the sorbent used. The sulfate content after purification increases for all samples, this can be explained by the fact that sulfates can be washed out of it, which can be formed during carbonization and activation of coal with water vapor where sulfur is present, analyzes showed that the sulfur content in the resulting adsorbents after carbonization and activation ranged from 0.09% to 0.45%. Water-soluble sulfate ions easily go into solution, and therefore, for further research, we will pre-wash carbon-containing sorbents before using them for cleaning, so as not to additionally contaminate them with these ions.

**Conclusion.** Summing up, we can say that the study of deep wastewater treatment by the physical-chemical method is of great relevance, since the optimal composition of adsorbents and the operating modes of treatment systems play a decisive role in achieving the maximum efficiency of the treatment process, as well as the development of recommendations for optimizing the process of wastewater treatment using sorbents and black soot carbon through a carbon molecular sieve.

Studying the influence of various factors such as temperature, pH (ST RK ISO 10523-2013), contact time, pollutant concentration (ST RK 2015-2010) on the treatment process, as well as evaluating the effectiveness of the treatment process and comparing it with other wastewater treatment methods, allows you to accurately determine the level of wastewater treatment by comparing it with other wastewater treatment methods. An analysis of the table of indicators of wastewater treatment in Kazakhstan shows the need for such research and development in this area in order to improve the ecological situation of the country and ensure the preservation of natural resources for future generations.

In general, based on the study, we can conclude that the quality of Samples №1 «Shubarkol, activated» granule, №3 «Shoptykol, activated» powder, №4 «Shoptykol, activated» granule, №8

«Carbon molecular sieve sorbents», №9 “Carbon molecular sieve sorbents” meets the standards and is suitable for household and commercial use. However, there is a significant excess of the norm for some indicators such as sulfates, nitrites and nitrates after the use of sorbents, but the data does not exceed the norm after biological treatment. If necessary, additional purification measures can be taken to ensure water quality in this area, since samples were taken for the study after the first stage of purification, that is, mechanical purification. As is known, in the Astana Su-Arnasy municipal wastewater treatment plant, after mechanical treatment, water is supplied for biological treatment, chemical treatment and ultraviolet disinfection. It should be noted that the physicochemical and adsorption properties (specific surface area) of the above samples also showed the best results.

The results of this study indicate that samples obtained on the basis of carbon materials can be considered promising, in particular, in the use of liquid media (from suspended solids, heavy metal salts, surfactants, petroleum products, etc.) as adsorbents for purification.

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## Очистка сточных вод отечественными углеродными адсорбентами и проведение физико-химического анализа состава воды

**Аннотация.** В условиях роста населения во всем мире и увеличения спроса на истощение источников пресной воды реализуются различные стратегии по повышению эффективности использования воды. Очистка и повторное использование сточных вод являются одними из наиболее эффективных стратегий, особенно если очищенную воду можно использовать повторно. В странах, которые сильно зависят от источников пресной воды, всегда важно следить за тем, чтобы качество воды не ухудшалось из-за естественного органического вещества, которое образуется в результате разложения растительных и животных веществ. Дефицит воды - это растущая глобальная проблема, вызванная сочетанием таких факторов, как рост населения, изменение климата и нестабильная практика управления водными ресурсами.

В данной статье предоставлены результаты исследовании в аккредитованной аналитической лаборатории очистных сооружений ГПК «Астана Су Арнасы», где проведена очистка сточных вод отечественными углеродосодержащими адсорбентами («Шубаркол», «Шоптыкол», гуминовая кислота, углеродные молекулярные сита, технический углерод) и был проведен химический анализ воды. Результаты данного исследования показали, что образцы, полученные на основе углеродных материалов, могут быть использованы в качестве адсорбентов для очистки жидких сред (от взвешенных веществ, солей тяжелых металлов, ПАВ, нефтепродуктов и др.).

**Ключевые слова:** сточные воды, адсорбент, карбонизация, гуминовая кислота, активированный уголь, уголь.

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## Ағынды суларды отандық көміртек құрамды адсорбенттермен тазарту және су құрамына физика-химиялық талдау жүргізу

**Аңдатпа.** Бүкіл әлемде халық санының өсуі және тұщы су көздерінің таусылуына сұраныстың артуы жағдайында суды пайдалану тиімділігін арттыру үшін әртүрлі стратегиялар жүзеге асырылуда. Ағынды суларды тазарту және қайта пайдалану ең тиімді стратегиялардың бірі болып табылады, әсіресе тазартылған суды қайта пайдалануға болатын болса. Тұщы су көздеріне қатты тәуелді елдерде су сапасының өсімдіктер мен жануарлардың ыдырауы нәтижесінде пайда болатын табиғи органикалық заттардың әсерінен нашарлап кетпеуін қамтамасыз ету әрқашан маңызды. Су тапшылығы – бұл халық санының өсуі, климаттың өзгеруі және суды басқарудың тұрақсыз тәжірибесі сияқты факторлардың жиынтығынан туындаған өсіп келе жатқан жаһандық проблема.

Бұл мақалада «Астана Су Арнасы» МКҚК-ның кәріздік тазарту құрылыстарының аккредиттелген аналитикалық зертханасында ағынды суларды отандық көміртек құрамды адсорбенттермен (Шұбаркөл, Шөптікөл, гумин қышқылы, көміртекті молекулалық – елеуіштер, техникалық көміртек) ағынды суды тазарту жұмыстарын жүргізіп, судың құрамына химиялық талдау жүргізілді. Зерттеу нәтижелері көміртекті материалдар негізінде алынған үлгілерді, атап айтқанда, сұйық орталарды (суспензияланған қатты заттардан, ауыр металл тұздарынан, беттік белсенді заттардан, мұнай өнімдерінен және т.б.) тазартуға арналған адсорбенттер ретінде қолдануға болатыны анықталды.

**Түйін сөздер: Ағынды су, жер,** гумин қышқылы көміртекті материалдар.

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