Research of Wastewater Treated with Shungite of Novocarbon 10 grade

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Abstract. The formation of industrial wastewater occurs at chemical plants in technological processes. The main water polluting substances include oils of petroleum and coal origin and suspended substances (technical carbon), the sources of which are equipment lubrication, powdered substances being with water and on products. Therefore, it is necessary to control suspended solids and petroleum products at the tire enterprise. It is established that shungite influence on water is diverse. During the process of water purification it can act as a filtering material, sorbent, catalyst of purification- and reduction processes and a biological disinfection agent.

1. Introduction
The wastewater discharged from industrial enterprises can be of three types: industrial; household; atmospheric. The formation of industrial wastewater occurs as a result of water use in technological processes, with heat removal from technological equipment, during raw materials and finished products preparation, etc. Depending on the volume, place of formation, type and concentration of pollutants, industrial wastewater can be diverted either by one general flow or by several independent ones [1-4].

The conditions influencing the mode of supply and the amount of waste water flowing into the external sewerage network of the enterprise are the capacity of the enterprise, the number of shifts, types of raw materials, the production technology, the number of units and apparatus, the specific water consumption per unit of production, etc [5,6].

2. Relevance
Slightly concentrated effluents, purified with ion-exchange materials, cannot be processed together with liquids having a high salts concentration [7,8]. Such a mixing will lead to unwanted absorption of ions of the second flow by ionites and, as a result, to a reduction in the filters working cycle, as well as to an increase in the volume of spent regeneration solutions that are the main waste [9]. Therefore, it is important to study the technical water after production and to increase the degree of wastewater treatment with the help of modified shungites.

The main components that pollute the water are oils of petroleum and coal origin and suspended substances (technical carbon). They are present simultaneously in wastewater: their average...
concentration at the outlet of treatment facilities varies from 0.5 to 10 mg/l for petroleum products (oils) and from 5 to 50 mg/l for suspended substances, including 4 to 35 mg/l for carbon black [10].

Thus, the quality of wastewater treatment should first of all be controlled by the content of petroleum products (oils) and suspended particles.

The known methods for controlling the contamination of wastewater are not suitable for technical carbon from plant effluents, since the technological contamination of these waters is complex [11-13]. Therefore, new methods and means are needed to control the content of oil products and suspended solids in wastewater, for example, for turbidity of water, specifically to determine the concentration of carbon black particles in water.

3. Formulation of the problem

The main objective of the study is to analyze the technical water after production and to increase the degree of wastewater treatment with shungite of Novocarbon 10 grade.

4. Theoretical part

In industrial wastewater, the concentration of contaminants can vary significantly over the time. Degradation in treatment facilities performance and the problem of their exploitation are directly related to the unevenness of wastewater inflow and variations in contaminants concentrations in them. The presence of unfavorable conditions can cause a sharp reduction in the purifying effect, especially when using biological oxidants. The significant influence on the decrease in contaminants concentration in wastewater is extraction of valuable impurities from them for the utilization purpose [14, 15].

When designing the sewerage of an industrial enterprise, the problem of separation or integration of individual wastewater flows is one of the most urgent, since the cost of the construction of sewage facilities depends on this, the efficiency of their exploitation, the possibility of valuable substances extracting and utilizing, and the reliability of reservoirs protecting from pollution.

Thus, the control of pollutants content can be carried out mainly by two indicators - suspended substances and petroleum products treated with shungite as the filtering and sorbing material.

5. Practical value, proposals and implementation results, experimental studies results

The structure of shungite is a composite, the matrix of which carbon forms. In the carbon matrix, highly dispersed (less than 10 microns) silicate particles are uniformly distributed. Contact surface of silicates with carbon is more than 10 m²/g [8].

The main characteristics of Novocarbon, estimated with the methods of Russian and international standards for carbon and silica fillers are given in table 1.

The measurement of petroleum products mass concentration in samples of natural, drinking and waste water was carried out on the basis of the fluorometric method on the "Fluorat-02" liquid analyzer. The range of measured concentrations was 0.005 - 50 mg/dm³.

The measurements of suspended solids content were carried out on the basis of measuring suspended solids content and the total content of impurities in samples of natural and treated wastewater by gravimetric method.

The measurements were carried out under normal laboratory conditions: the ambient temperature (22±6) °C; atmospheric pressure (84-106) kPa; relative humidity (80x5) %; alternating current frequency (50 ± 1) Hz; voltage in the network (220 ± 10) V.

The average results of analyzes for 2017 show that the existing purification system is not sufficiently effective, therefore, it is proposed to install a granular filter with shungite filler (Tables 2, 3, 4).
Table 1. The main characteristics of Shungite of Novocarbon 10 grade.

| Physical form | Finely dispersed powder of black color |
|---------------|---------------------------------------|
| Specific surface area for nitrogen adsorption, [m²/g] | 24 |
| Absorption activity, [mg/g]: |
| by phenol | 14 |
| on thermolysis resins | 20 |
| for petroleum products | 40 |
| Loss of mass, [% (wt.)] at 105 °C | 1,5 |
| on ignition (950 °C) | 36,1 |
| Content, [% (wt.)] ash | 64,8 |
| SiO₂ in ash | 94,0 |
| water-soluble substances | 1,7 |
| pH of aqueous extract | 4,4 |
| Bulk density, [kg/m³] | 532 |
| Residue after sieving with 014 grid sieve, [%] | 0,002 |
| Density, [g/cm³] | 2,1-2,4 |
| Porosity, [%] | 5 |
| Compressive strength, [kg*p/cm³] | 1000-1200 |
| Electrical conductivity, [S/m] | 1500 |
| Thermal conductivity coefficient, [W/ m²·°K] | 5 |

Table 2. Results on the quality control of industrial wastewater of the tire plant for 2017.

| Name of sampling point | Average results of analysis, [mg/dm³] |
|------------------------|--------------------------------------|
|                          | Petroleum products | Suspended solids | Hydrogen index, [units, pH] | Anionic surfactants | Chemical oxygen consumption | Biological oxygen consumption, full | Chlorides | Iron | Dry residue | Ammonia nitrogen | Nitrate ion | Copper | Zinc | Sulphates |
| Technical water coming to the enterprise | 0,084 | 8,3 | 7,5 | 0,074 | 24,9 | 2,93 | 35,4 | 0,101 | 386,7 | 0,20 | 5,39 | 0,007 | 0,006 | 48,7 |
| Industrial wastewater discharged into the reservoir | 0,075 | 9,2 | 8,0 | 0,093 | 27,6 | 3,25 | 35,3 | 0,090 | 398,4 | 0,20 | 4,92 | 0,007 | 0,006 | 47,8 |
Table 3. Results of the analysis of industrial wastewater of the tire plant for December 2017.

| Name of sampling point | Petroleum products | Suspended solids | Hydrogen index, [units. pH] | Anionic surfactants | Chemical oxygen consumption | Biological oxygen consumption$^5$ | Chlorides | Iron | Dry residue | Ammonia nitrogen | Nitrate ion | Copper | Zinc | Sulphates |
|------------------------|--------------------|------------------|-----------------------------|---------------------|----------------------------|-------------------------------|-----------|-----|-------------|-------------------|---------------|--------|------|----------|
| Wastewater discharge in the reservoir | 0.051 | 8.1 | 7.85 | 0.091 | 26.5 | 2.29 | 27.1 | 0.088 | - | - | - | - | 43.9 |
| Wastewater discharge in the reservoir | 0.056 | 9.6 | 8.10 | 0.083 | 21.1 | 2.16 | 28.9 | 0.084 | - | - | - | - | 40.8 |
| Technical water coming to the enterprise | 0.064 | 12.5 | 7.85 | 0.025 | 23.3 | 2.21 | 27.1 | 0.098 | 385.0 | 0.107 | 7.33 | 0.005 | >0.005 | 56.9 |
| Discharge of industrial-storm wastewater into a settling pond | 0.241 | 26.0 | 7.90 | 0.139 | 33.3 | 2.94 | 32.5 | 0.181 | 10.1 | - | 7.37 | - | - | 46.0 |
| Discharge of wastewater before the oil trap | 0.144 | 20.7 | - | - | - | - | - | - | - | - | - | - | - |
| Discharge of wastewater after oil trap | 0.047 | 14.0 | - | - | - | - | - | - | - | - | - | - | - |
| Discharge of wastewater in the reservoir | 0.067 | 14.3 | 7.90 | 0.021 | 28.3 | 2.33 | 30.7 | 0.069 | 390.0 | 6.41 | 0.006 | >0.005 | 45.2 |
Table 4. Report on the efficiency of local wastewater treatment monitoring of the tire plant.

| Name of wastewater local treatment | Actual capacity, m³/year | List of controlled substances | Actual parameters of treatment before treatment, [mg/dm³] | after treatment, [mg/dm³] |
|-----------------------------------|--------------------------|-------------------------------|----------------------------------------------------------|--------------------------|
| Oil trap at the outlet to the reservoir | 4 129 800,0 | 1. Petroleum products | 0,146 | 0,074 |
|                                   |                          | 2. Suspended substances | 16,7 | 9,1 |

The results of analyses of industrial wastewater at the tire plant in 2017 showed that it is necessary to carry out a more thorough purification of wastewater from petroleum products and suspended solids, i.e. the requirements toughening for water quality dictates the search for more and more effective ways of contaminants removing from wastewater and possible return of treated effluents for reuse.

6. Conclusions

Sorption purification of water is one of the most effective methods for increasing the degree of industrial wastewater purification.

The main advantages of the sorption method are:
- the possibility of removing a wide range and nature of impurities to any residual concentration, regardless of chemical stability;
- controllability of the process and secondary pollution elimination.

Thus, it is necessary to organize wastewater monitoring. For this purpose, sampling of wastewater from the receiver tank was carried out. As a sorbent for water purifying from various industrial contaminants, as well as domestic sewage, a granular filter filled with shungite of Novocarbon 10 grade was installed. Since shungites with a carbon content of about 30% have a total porosity of 5-10%, a significant internal surface (in the range of 10-30 m² / g), a bulk density of about 1.1 g / cm³, possess high mechanical strength, electrical conductivity, chemical stability, catalytic and bactericidal properties, it makes shungites an attractive and promising material in the processes of drinking and technical water preparation (both in flow systems and wells), in the processes of filtration and adsorption purification of wastewater from organic and inorganic substances.

7. References

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