ANNOTATION

of Ph.D. thesis on specialty 6D073100 - Life safety and environmental protection

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Development of adsorption technology for water purification to drinkable quality

Actuality of dissertation research. The problem of providing the population with fresh water is relevant for many countries, in particular for the countries of the Central Asian region. In Southern Kazakhstan, the provision of quality drinking water along with natural water shortages is exacerbated by the unsatisfactory technical condition of water supply systems, which leads to a deterioration in the sanitary and epidemiological situation. The natural deficit of water resources in Kazakhstan is exacerbated by the unsatisfactory technical condition of water supply and sanitation systems. Due to long-term operation, exceeding of service life and untimely renewal, the main means of water utilities have huge wear.

Settling, filtering, coagulation, disinfection, stabilization and degassing of water, deodorization, softening, desalination and desalination are most often used for water purification.

One of the effective methods of separation and purification of water streams is adsorption, which requires the selection of effective and cost-effective adsorbents. The high specific surface and porosity of adsorbents, which the presence of impurities in water, and the special properties of the boundary interphase layers play a main role in the behavior of adsorption processes. The effectiveness of water purification from pollutants and impurities should be based on physical and chemical processes that ensure rapid adsorption of contaminants and their separation from adsorbents during regeneration.

Activated carbon as an adsorbent is used in such processes as separation, purification and reduction. Agricultural materials such as coconut shells, almonds, hazelnuts, olive, peach, apricot and cherry shells, grape bones, eucalyptus leaves, mango shells, coconut shells and palm leaves are used as raw materials for the production of activated carbon because of the good carbonaceous structure.

At factories for the production of edible oils and fruit canned food, the fruit-seed shell is a large-tonnage waste. Widely distributed in Southern Kazakhstan, low cost and high adsorption properties, as well as new methods for regulating the porous structure, it is economically expedient to use them as adsorbents for the purification of natural waters. For researching, we celected a shell of apricot kernels, which is one of the most widespread and porous bones.

New technologies for producing activated carbons based on local production wastes, with a preliminary study of their physicochemical properties and activation of adsorption properties in a given direction, associated with the production of highly active centers on the surface, should improve the technical and economic

performance of treatment facilities, i.e. has a great economic, social and environmental significance.

In connection with the above, this work is devoted to the development of technology for producing activated carbon on the basis of apricot kernels and the technology of its application in the processes of water purification to drinking quality that would meet modern requirements.

The work was carried out in accordance with the plan of the state budget scientific research work B-FTC-5-96 “Production of activated carbon by mechanical, chemical and thermal activation and its application for the purification of water streams”.

The aim of the work. Ecological assessment of the state of water objects and development of adsorption technology of water purification to drinkable quality.

To achieve this goal, the following tasks were set:

- environmental assessment and sanitary and hygienic analysis of the state of water objects before and after the introduction of adsorption water purification;
- development of the activation mode and technology for producing activated carbons with specified properties, high adsorption capacity and characteristics;
- development of measures to ensure the safety of the technological process and the impact on the environment in the production of activated carbon;
- experimental substantiation of the adsorber construction and detection of regularities in the adsorption of pollutants from the water stream using the developed activated carbon;
- ecological modeling of adsorption water purification to drinkable quality, taking into account complex assessment according to the criteria of harmfulness;
- pilot industrial verification of the reliability of the main provisions and conclusions.

Scientific novelty of the work:

- mechanism is established for increasing the total porosity and volume of micro, meso and macropores, depending on the thermal activation regime and the ratio of the flow of carbon dioxide and water vapor;
- regularities of adsorption of residual chlorine and iron by activated carbon are established depending on various factors of the purification regime and an adsorption technology for efficient water purification to drinkable quality has been developed;
- adsorber has been developed, additionally equipped along the axis of the apparatus with a vertical contact chamber of the adsorbent with a flow having a circular cross-section and connected to a branch pipe to drain the flow and supply the regenerating agent. The effect of the internal contact chamber of the adsorbent on the degree of processing of adsorption capacity of the adsorbent in the layer is established;
- environmental assessment of the environmental impact and safety of the technological process in the production of activated carbon from apricot kernels is given. The influence of gas purification systems, operation of the developed

technology, on all discarded substances, groups of sums and dusts of concentration on the boundaries of the sanitary protection zone, which belong to a class with a SPZ size of at least 100 m, is determined.

Practical value

- the result of an environmental assessment was carried out before and after the introduction of the adsorption method of water purification and indicators of ecological well;

- practical recommendations on the rational choice of design and operating parameters of the adsorber operation, which can be used to create adsorption equipment for water purification;

- practical expediency of use instead of imported, expensive adsorbents of the activated coals on the basis of a shell of apricot kernels for water purification is established.

The connection of this work with research programs.

Research work was carried out within the framework of the grant financing project of the Ministry of Education and Science of the Republic of Kazakhstan No. 339 "Obtaining Activated Coal by Mechanical, Chemical and Thermal Activation" and the funded project "Stimulation of Productive Innovations" APP-SSG-16 / 0477P "Production of Activated Carbon and Stone Oils from Fruit Bones ".

Structure and scope of the dissertation. The thesis is presented in 128 pages of typewritten text. It consists of an introduction, the main part, which includes 4 sections, 28 figures, 45 tables, conclusions, a list of used sources of 139 names and applications on 17 pages.

In the first section, a literature review of the current state of production of activated coals was made. The analysis of the prospects of adsorption treatment of water to drinkable quality and environmental assessment of water objects and the impact of technology for producing activated carbon on the environment.

The second section presents the characteristics of raw materials and objects that are sources of a large-tonnage waste from the shell of apricot kernels to produce activated carbon. To implement the proposed developments for the production of activated carbon, there is a production room with the necessary infrastructure and area. Quality parameters of the initial water of the Torlan reservoir are given, which is a source of drinking water in the territory of the South-Kazakhstan region in the Suzak region of Sholak-Korgan village. Complexes of classical and modern methods of analysis, as well as methods for studying physical-chemical and structural-sorption properties, are considered and briefly characterized. To solve the problems, research methods based on the study of individual regularities were chosen. Methods are presented for calculating harmful emissions into the atmosphere by various industries, calculating the concentrations of harmful substances in the air emissions from enterprises, assessing the risk to the health of the population from environmental pollution. The system of classification of water quality assessment and methods of mathematical modeling of adsorption water purification to drinkable quality is given.

The third section presents the characteristics of the apricot kernels shell as a large-tonnage waste of existing canning and fat-and-oil industries. A method for producing activated carbon from the fruit-seed shell by their carbonization and activation, where a mixture of carbon dioxide and water vapor in a ratio of 85:15, or flue gases at a temperature of 800°C for 1 hour, is used as the activating agent. In the development of technology for producing activated carbon, the composition of materials identifies potentially possible directions for changes in the components of the surrounding and socio-economic environment and the consequences they cause in the life of society and the environment as a result of the investment activity. Based on the preliminary assessment of the impact of the planned activity on the environment, we can conclude that the stability of the surrounding and socio-economic environment. The characteristic of gas emissions shows that when cleaning gas emissions after the scrubber and adsorber, the actual concentration of harmful components does not exceed the MPC norms. The results of calculations for the operation of the developed technology for producing activated carbon, for all discarded substances, groups of summation and dust concentrations in any calculated point do not exceed the MPC and indicate compliance with hygienic air quality standards. The size of the sanitary protection zone for the developed technology for producing activated charcoal from the shell of apricot kernels is proposed to be set at a radius of 100 m. According to the calculations performed, if the requirements are met, the excess of the regulatory indices for hazardous factors at the border of the sanitary protection zone and in residential buildings is not expected.

In the fourth section, the design of the adsorber is described, which contains a housing, an adsorbent contact chamber with a cleaned flow, connections for flow and discharge, connections for the supply and removal of a regenerating agent, a branch pipe connecting the flow and supply connection of the regenerating agent, hatches for loading and unloading adsorbent, as well as it is additionally provided with a vertical contact chamber of the adsorbent installed on the apparatus axis with a flow having a circular cross-section and connected to a branch pipe for discharge of flow and supply of regenerating agent, wherein the lower portion of the walls of the inner chamber is solid. By installing an additional installation of a coarse filter and an authorized internal contact chamber of the adsorbent with the cleaned flow, the efficiency of the apparatus increases, the utilization factor of the useful volume of the apparatus increases, and the degree of processing of the adsorption capacity of the adsorbent in the bed, the stability of the quality of the purified stream is maximized with maximum compactness of the apparatus. The influence of cleaning time and water flow rate on the absorptivity of residual chlorine was studied. The dependence of the chlorine adsorption on the equilibrium concentration is determined, as well as the dependence of the adsorption of iron on activated charcoal on the basis of apricot kernels. A sufficient amount of adsorption on chlorine is equal to 0.035 mg/g and on iron is equal to 0.8 mg/g was achieved. The kinetics of the adsorption purification of the waters of the Torlan reservoir is considered, which makes it possible to obtain water of drinkable quality. A quantitative and qualitative ecological assessment of surface

water pollution has been carried out. Dependences of the concentration of sulfates in purified water on the equilibrium concentration, the adsorption of fluorides on concentration and duration, the influence of water flow rate on the degree of water purification from fluorides were determined. The proposed adsorption technology for surface water treatment allows reducing the concentration of pollutants up to MPC norms. Ecological assessment of the degree of pollution and quality of drinkable water for hydrochemical and environmental-sanitary indicators, physical and organoleptic properties was carried out. The quality of potable water meets the requirements of GOST 2874-82 and WHO standards. The proposed activated carbon retains a great service life and provides an adsorption value of 98% turbidity and 80% chromaticity. A mathematical model of the anthropogenic load on the environment is proposed, taking into account the efficiency of adsorption purification, which makes it possible to obtain the conditions for forecasting, managing and controlling the pollution of water resources.

In the fifth section, an assessment of the technical and economic efficiency of the implementation is given. The expected ecological and economic effect from the introduction of this work results is 114 000 000 tenge per year.

In conclusion, brief conclusions are given on the results of dissertational studies, assessment of the completeness of solutions to the tasks assigned, recommendations and initial data on the specific use of the results are developed, the technical and economic efficiency of the implementation and the scientific level of the work performed are compared with the best achievements in this field.

Publications. The main provisions, results and conclusions of the thesis are set out in 10 scientific papers, including 1 article in the magazine included in the Scopus database, 1 article in a foreign journal, 3 articles in the national scientific journals recommended by the Committee for Control in Education and Science MES of RK; 3 articles in the materials of international conferences of the far and near abroad; 1 patent of the Republic of Kazakhstan (№2016/0369.2 от 02.07.2016), 1 application for invention of the Republic of Kazakhstan No.2017/0481.1 (notification on positive result of formal expertise from 08.11.2017).