DOI: 10.25140/2411-5363-2023-4(34)-129-137
УДК 677.494

Viktoriia Plavan[1], Natalia Tarasenko[2], Iryna Lisovska[3]

[1]Doctor of Technical Sciences Professor, Department of Chemical Technologies and Resource Saving
Kyiv National University of Technologies and Design (Kyiv, Ukraine)
E-mail: plavan.vp@knutd.edu.ua. **ORCIDID**: https://orcid.org/0000-0001-9559-8962
ResearcherID: I-5852-2015. **SCOPUS Author ID**: 6603130130

[2]Senior Lecturer, Department of General and Inorganic Chemistry
National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” (Kyiv, Ukraine)
E-mail: tarasenko.nv@ukr.net. **ORCIDID:** https://orcid.org/0000-0003-1062-5533
Researcher ID: J-7632-2017

[3]Associate professor, Department of General and Inorganic Chemistry
National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” (Kyiv, Ukraine)
E-mail: lisovskayai@ukr.net. **ORCID**: https://orcid.org/0000-0001-6099-5976
ResearcherID: J-8005-2017

APPLICATION OF FIBROUS MATERIALS WITH SORPTION PROPERTIES IN WATER PURIFICATION TECHNOLOGIES

The algorithm for the technological process of obtaining a chemisorption composite material based on waste chemical fibers filled with clay powders for the purification of wastewater from heavy metal ions has been developed. Non-woven materials obtained from polyurethane-polyamide chemical fiber waste were used as a basis in the work. To increase the mechanical strength, they were fastened by the needle punching method with a knitted fabric with a surface density of 240 g/m2, which was made by plaited weaving using cotton yarn with a linear density of 25 tex and polyethylene complex threads with a linear density of 16.5 tex on a single-font circular knitting machine of the MS type. To strengthen the sorption capacity, clay powders of the montmorillonite type were introduced into the fibrous base in the form of filled dispersions of starch (2-3 %) or polyvinyl alcohol (3%) in the amount of 5 to 10% of the mass of the dispersion.

Sorption-filtering fibrous material filled with clay minerals can be used for wastewater treatment of light and chemical industry enterprises. The use of clay minerals through their introduction into the fibrous base will reduce the hydraulic resistance of the sorbent layer, without using a sorbent of coarse fractions, which will preserve the area of the active absorbing surface. Wastewater treatment can be carried out by passing water through a sorption-filtering element. Cleaning installations can accommodate several sorption-filtering elements at the same time, which increases the efficiency of water purification. It is possible to use chemisorption composite material for cleaning silted drains without the threat of adsorbent clogging, and in return water supply systems, which will reduce the risk of depositing mineral salts on the walls of water purification equipment and ensure high-quality operation of treatment facilities.

Keywords: *water purification technologies; chemisorption composite material, sorption-filtering element; non-woven materials; clay minerals; starch; polyvinyl alcohol.*

Fig.: 2. Bibl.: 13.

Introduction. The post-war reconstruction of Ukraine will inevitably lead to an increase in the use of natural resources and consumer waste, which in turn will increase the anthropogenic load on the environment. Reducing the volume of waste generation and advancing its processing; reuse based on innovative technologies and production is one of the tasks of achieving sustainable development of Ukraine. In addition, the country's water management complex requires improvement, primarily taking into account the need to achieve a balance in the processes of use and reproduction of water resources, in order to provide the population and industrial users with water of appropriate quality.

Currently, there is growing interest among researchers in the use of sorption and filter materials for wastewater treatment. water purification technologies based on sorption and filter materials are distinguished from other technologies by their high efficiency and versatility. They combine filtration and sorption processes to remove not only mechanical impurities from water, but also heavy metal ions and organic substances that can be harmful to the environment and human health.

Clay minerals are actively used as adsorbents for the removal of dangerous chemical products of organic and inorganic origin in water purification technologies due to their specific layered structure, large surface area of particles, porosity, presence of active centers, high cation exchange capacity [1].

Bentonite clays in their natural or activated form, that is, after chemical treatment with acids, have good adsorption properties and are widely used as a natural adsorbent for cleaning products of the oil refining, by-product coke, and food industries. Thus, with a fraction size of 0.5-1 mm, the absorption capacity of heavy metal cations of natural montmorillonite bentonite is 1821 mme/100g [2]. Bentonite is used in the mining industry for the preparation of drilling fluids, as well as a natural adsorbent, filler.

Some known sorbents [3] often do not have the necessary sorption capacity to bind metals to a sufficient extent, for example, from highly concentrated or low-concentrated solutions or from strongly acidic solutions, in particular, also in the presence of alkali or alkaline earth metal ions. In addition, the previously known sorbents are often not stable in the entire pH range from 0 to 14. Due to the almost always unsatisfactory sorption capacity of known sorbents, a large volume of sorbent is often required, or the process must be repeated many times, for example, to ensure obtaining water that does not contain heavy metals. As a result, metal bonding processes are very time-consuming and expensive.

The study [4] considers the use of combined filtration and sorption systems for the manufacture of pleated filters. The researched materials consist of several structural layers — a filter membrane made of polymer nanofibers, an adsorbent containing nanofibers of activated carbon or porous silicon dioxide, a supporting or covering non-woven two-component fabric. The layers are connected only by pressure at high temperature without the use of binders. Centrifugal spinning has been shown to produce flexible, compact and uniform filtration membranes with good separation properties of submicron particles.

The composition of the filter material for drinking water purification, which contains a mixture of cotton and wood cellulose, glass fiber, activated carbon and melamine formaldehyde resin, is known. This mixture is treated with binder and latex. The proposed composition of the filter material allows to reduce the amount of suspended substances, active chlorine and dyes in the water [5]. The main disadvantage of this material is that it shows insufficient water purification efficiency, in particular in relation to iron and manganese compounds.

Target setting. The purpose of the work is to develop an algorithm for the technological process of obtaining chemisorption composite material based on waste chemical fibers and introducing it into wastewater treatment systems in order to reduce the pollution of water resources by salts of heavy metals.

Research methodology. Based on the results of theses [6], a method of obtaining a composite material with sorption properties on a fibrous base filled with clay powders is proposed (Fig. 1). Non-woven materials obtained from waste polyurethane-polyamide chemical fibers were used as the fibrous base, and to increase mechanical strength, they were fastened by the needle punch method with a knitted fabric with a surface density of 240 g/m^2, which was made by plaited weaving using cotton yarn with a linear density of 25 tex and of polyethylene complex threads with a linear density of 16.5 tex on a single-thread circular knitting machine of the MS type.

To strengthen the sorption capacity, clay powders of the montmorillonite type were introduced into the fibrous base in the amount of 5 to 10% of the weight of the non-woven material in the form of saturated aqueous dispersions of starch (2-3 %) or polyvinyl alcohol (3 %). Filling with clay powders makes it possible to improve the sorption capacity of the material due to the increase of the specific surface area and the phenomenon of chemoadsorption on the active centers of clay minerals, which will increase the efficiency of wastewater treatment of light and chemical industry enterprises.

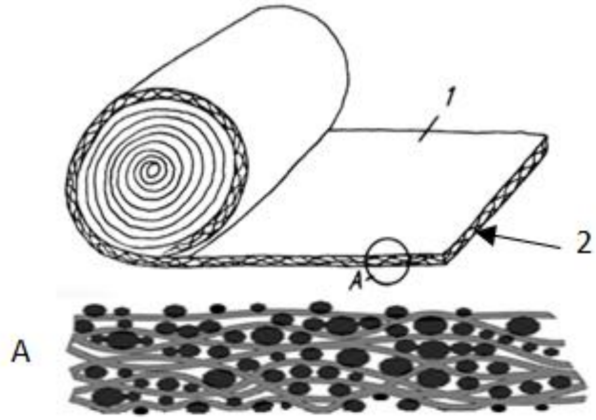

Fig. 1. Scheme of chemisorption composite material filled with dispersions of clay minerals, based on waste polyurethane-polyamide chemical fibers:
1 – knitted base; 2 – non-woven material from polyurethane-polyamide chemical fibers filled with clay minerals (A)

Increasing the amount of clay powders in the structure of fibrous material by more than 10 % is not rational, because it does not lead to a significant increase in the sorption capacity of the obtained materials due to a decrease in the surface area and pore volume of the obtained materials.

Reducing the concentration of solutions of polyvinyl alcohol and starch to 0.5 % to obtain filled dispersions does not ensure the fixation of clay powders in the structure of the fibrous material, which leads to the deterioration of its sorption characteristics. An increase in the concentration of solutions of polyvinyl alcohol and starch above 3 % leads to obtaining viscous dispersions, which complicates the uniform application and distribution of clay powders in the structure of the fibrous material and worsens its sorption and filtration properties.

Filled dispersions of starch and PVA can be applied to the surface of the fibrous base by the spreading or rolling method. After application, the resulting composite material must be dried for 60 minutes at t=100˚C. For use in water purification technologies, the obtained material is placed in plastic lattice housings by repeated bending and twisting.

As a result of the research, results were obtained regarding the influence of the mechanical activation process on the dimensional characteristics and shape of particles of clay powders of the montmorillonite and palygorskite types [7]. It was established that the reduction of the average values of the equivalent diameter of particles in the process of mechanical impact (~ by 14–15 %) is realized mainly due to the destruction of their largest aggregates. At the same time, the intensity of this process is significantly higher for clay of the montmorillonite type. It is shown that for both studied samples that the process of mechanoactivation leads to an increase in the average values of the particle shape indicator (the shape is approaching spherical, characterized by a higher surface area) and an increase in the homogeneity of their distribution according to this indicator. Acid activation of clays also significantly increases their sorption capacity due to an increase in the specific surface area of the sample, as well as due to the phenomenon of chemoadsorption on the cationic centers of clay minerals [8-9].

The concentration of the polymer binder and the amount of mineral sorbent affect the surface density and mechanical characteristics of fibrous materials impregnated with dispersions of starch and PVA [10]. The application of 3 % water-polymer dispersion of PVA or 2–3 % starch dispersion with the introduction of 5 % clay by mass of the binder ensures the production of sufficiently elastic fibrous materials with good strength indicators. In addition, taking into account the previously obtained results that the treatment of the fibrous base with 3 % dispersions of PVA and starch filled with clay minerals helps to increase the sorption capacity of the obtained materials, these fibrous composites can be recommended for water purification technologies.

Results and discussion. The algorithm of the technological process of obtaining chemisorption composite material based on waste polyurethane-polyamide chemical fibers, developed based on the results of the author's thesis [6], is shown in Fig. 2.

Based on the results of the research, it can be stated that the proposed algorithm describes an effective and efficient method of obtaining a chemisorption material suitable for the purification of wastewater from heavy metal ions. The implementation of this algorithm can have a significant impact on improving the quality of wastewater, reducing environmental pollution and ensuring the sustainability of water resources.

Parameters of the technological stages of obtaining a chemisorption composite material based on waste chemical fibers:

Waste polyurethane-polyamide chemical fibers. Non-woven materials obtained from waste polyurethane-polyamide chemical fibers, which are formed during the production of hosiery products, were used as the fibrous basis of chemisorption composites in the work. The combined yarn waste consisted of complex fibers Lycra 162 C, linear density 4.4 tex (PU) and textured complex fibers Nylon 6.6 f 20/1, linear density 3.3 tex (PA-6.6) in a ratio of 70/30 by weight, %.

Preparation of fibrous raw materials. Fibrous waste PU/PA-6,6 was pre-shredded on a staple machine with rotary knives. The cutting length was 30 mm. Next, the staple fibers were mixed with additional fibrous components in certain ratios. A ChBV carding machine was used to form the fibrous web. In the course of combing, fibers are distributed across the width of the sample, their mixing and a certain parallelization in the direction of combing occurs. After preliminary combing, the canvas was removed from the receiving drum (diameter 200 mm). Depending on the composition and quality of the obtained material, the combing operation was repeated 2-3 times until the formation of a homogeneous fibrous material in which the fibers are sufficiently evenly distributed.

Fastening the canvas by needle punching. The needle punching method is based on binding the fibrous canvas with its own fibers. The fibrous material is passed through the rolls of the needle punching machine. The prepared canvas of fibers is stitched on a needle punching machine with needles with serrations at the ends, which carries out stitching of the canvas.

Increasing mechanical strength. Fastening by the needle punch method with a knitted fabric with a surface density of 240 g/m^2. In this way, mechanical strength is ensured, while the elasticity of the fabric is preserved, which allows producing of sorption-filtering elements of complex geometric shapes.

Preparation of natural mineral clays. The initial powdered clay sample was previously sieved through sieve No. 0071 to remove coarse impurities. Next, the clay was washed with distilled water in the ratio of solid and liquid phases of 1:100 with thorough mixing using a mechanical stirrer. After settling the resulting suspension for 24 hours, the highly dispersed fraction was decanted with a siphon into another container. The sample cleaned of impurities was centrifuged for 30 minutes and dried at 80°C in an oven to a constant weight. The obtained samples were ground in a porcelain mortar and sieved to obtain a fraction of $\leq$ 0.20 mm.

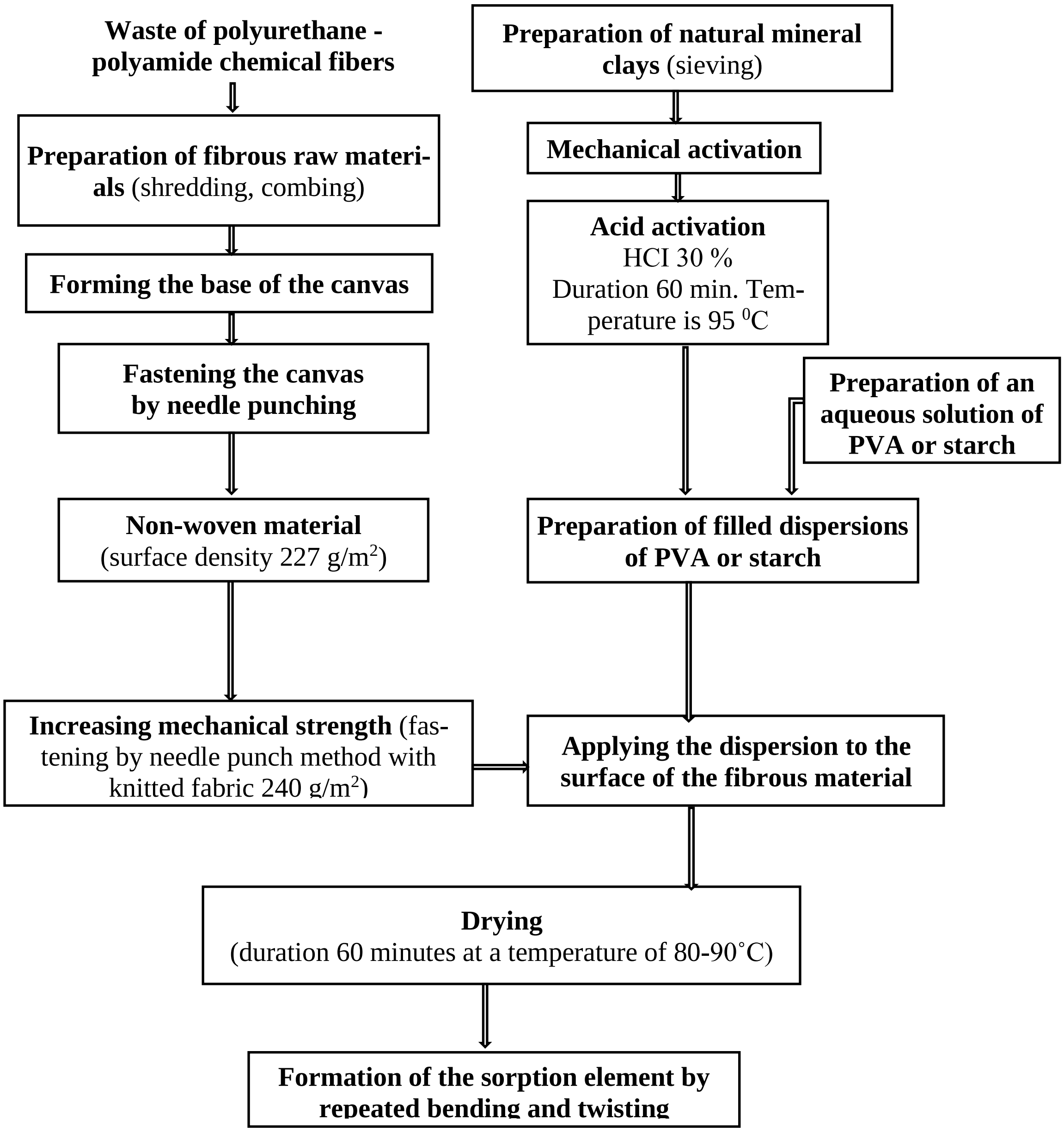

Fig. 2. Algorithm of the technological process of obtaining chemisorption composite material based on waste chemical fibers

Mechanical activation. A laboratory cylindrical ball mill was used for dry grinding of clay powders using 20 mm diameter ceramic balls as grinding elements. The rotation frequency of the mill was 60 rpm, the duration of processing was 20 minutes.

Acid activation. For acid modification of purified clay minerals, a 30 % HCl solution was used with a ratio of solid to liquid phases of 1:1.5, in a water bath at a temperature of 95–100°C with constant stirring. Processing time was 1 hour. After that, the samples were repeatedly washed with distilled water until there was a negative reaction to Cl^- ions in the washing water (quality was controlled using $AgNO_3$ solution). The obtained samples were dried at 80°C in a drying cabinet to a constant mass, ground in a porcelain mortar and sieved through a sieve to obtain a fraction ≤ 0.20 mm.

Preparation of an aqueous solution of PVA or starch. Polyvinyl alcohol and starch of different concentrations (from 1 to 3 %) were chosen as water-soluble polymers for impregnating the fibrous base.

Preparation of filled dispersions of PVA or starch. To increase the sorption capacity of materials, montmorillonite-type clay powder in the amount of 5-10% of the mass of the binder was added to aqueous solutions of polymer binders of various concentrations.

Applying a dispersion to the surface of a fibrous material. The resulting dispersion was applied with a squeegee knife to the surface of fibrous materials until a homogeneous continuous coating layer was obtained.

Drying. Duration 60 minutes at 100C.

Formation of a sorption element. A kind of "cassettes" were made from filled fibrous cloths on a knitted basis by repeatedly folding and twisting the material and placing it in a plastic lattice case.

Wastewater treatment with natural sorbents can be carried out by two methods - passing water through a sorbent layer, or mixing water with a sorbent followed by separation [10]. Both methods have their advantages and disadvantages. Passing water avoids the stage of separation of spent sorbent. The disadvantage of this method is the significant hydraulic resistance of the finely ground sorbent layer. It is possible to reduce the resistance by using a sorbent of coarse fractions, but then the area of the active absorbing surface is significantly reduced. In the process of grinding natural sorbents, regardless of the size of the obtained fraction, a certain amount of dusty product is formed, which is washed out with water at the initial stage of processing. In this case, it is necessary to provide for the stage of water purification from finely dispersed sorbent.

The use of clay minerals through their introduction into the fibrous base will allow to reduce the hydraulic resistance of the sorbent layer without using a sorbent of coarse fractions, which will not cause a decrease in the area of the active absorbing surface. The use of clay minerals in the form of dispersions of water-soluble polymers will ensure the formation of a dust-like product at the initial stage of processing, accordingly, there will be no need to purify water from finely dispersed sorbent.

As the results of our research showed, a noticeable decrease in the concentration of heavy metal ions (for example, Cr^{3+}, Fe^{3+}) occurs within 24 hours of processing in static conditions, which does not contradict the results of experiments conducted by other authors [11; 12].

The presence of a fibrous base will allow combining sorption and filtering properties, which will increase the efficiency of wastewater treatment. It is possible to use such an adsorbent for muddy drains without the threat of clogging of the adsorbent. Cleaning installations can accommodate several sorption-filtering elements at the same time, which increases the efficiency of water purification. The cost of natural dispersed sorbents is small, it is impractical to regenerate spent sorbents, since the cost of regeneration will be much higher than the cost of a new sorbent.

At enterprises, the main role in water supply is played by return water supply systems [13]. At the same time, the water repeatedly evaporates, heats, cools, aerates, repeatedly contacts the cooling surface and gradually becomes more mineralized. Often, water quality deteriorates, mechanical pollution and corrosion products gradually accumulate, which can lead to the deposition of mineral salts on the walls of pipes and equipment. Therefore, to restore water quality, the circulating water supply system is fed with fresh water. In normal recirculating water supply systems that do not have specific contaminants, it is possible to prevent the increase in mineralization of recirculating water by cleaning with coagulants and flocculants. The water used for cooling systems through the walls of the heat exchange equipment should not contain hydrogen sulfide or iron, an excess of suspended matter. In addition, corrosion resistance of heat exchange equipment and communications is ensured only with an optimal narrow pH range and a low salt content in water. For such systems, it is recommended to adjust the pH of the circulating water, as well as take measures to reduce the salt content. Depending on the quality of the source water and the requirements for the quality of the consumed water, part of the total consumption of recycled water may undergo additional purification.

Therefore, it is possible to offer created fibrous materials with sorption properties for use in return water supply systems to reduce water pollution by mineral salts, in particular, iron salts, which will reduce the risk of depositing mineral salts on the walls of water purification equipment and ensure the high-quality operation of water purification facilities.

Conclusions. An algorithm for the technological process of creating chemisorption composite materials based on waste chemical fibers filled with clay powders has been developed. Filling with clay powders makes it possible to improve the sorption capacity of the material due to the increase of the specific surface area and the phenomenon of chemoadsorption on the active centers of clay minerals, which will increase the efficiency of wastewater treatment of light and chemical industry enterprises.

Applying a 3% dispersion of polyvinyl alcohol or a 2-3 % dispersion of starch on a fibrous base with the introduction of 5% clay of the montmorillonite type helps to obtain materials with increased sorption capacity. The introduction of highly dispersed particles of clay minerals into the fibrous base, as chemosorbents, will allow combining absorption and filtering properties.

Wastewater treatment with natural sorbents can be carried out by passing water through a sorption-filtering element. The use of clay minerals through their introduction into the fibrous base will reduce the hydraulic resistance of the sorbent layer, which will not lead to a decrease in the area of the active absorbing surface. The use of clay minerals in the form of dispersions of water-soluble polymers will ensure the formation of a dust-like product at the initial stage of processing, accordingly, there will be no need to purify water from finely dispersed sorbent.

The fibrous base will allow combining sorption and filtering properties, which will increase the efficiency of wastewater treatment. It is possible to use such an adsorbent for muddy drains without the threat of clogging of the adsorbent. Cleaning installations can accommodate several sorption-filtering elements at the same time, which increases the efficiency of water purification.

References

1. Milichovský, M., Češek, B., Filipi, M., Gojný, J. (2014). Cellulosic Sorption Filter Materials with Surface Flocculation Activity–A Hopeful Anticipation of Water Purification. *Journal of Water Resource and Protection, 6*(3), 165–176. https://doi.org/10.4236/jwarp.2014.63022.

2. Duong, D.D. (1998). *Adsorption analysis: Equilibria and kinetics.* Imperial College Press.

3. Morrison, F.A. (2001). *Understanding Rheology*. Oxford University Press.

4. Otrisal, P., Obsel, V., Buk, J., Svorc, L. (2018). Preparation of Filtration Sorptive Materials from Nanofibers, Bicofibers, and Textile Adsorbents without Binders Employment. *Nanomaterials, 8*(8), 564–582. https://doi.org/10.3390/nano8080564.

5. Ternovtsev, O.V., Zorya, O.V., Ternovtsev, V.O. (2002). *Filtruiuche-sorbtsiinyi material dlia ochyshchennia vody (Ukrainskyi deklaratsiinyi patent na vynakhid № 48334 A) [Filtration-sorption material for water purification (Ukrainian declaratory patent for the invention No. 48334 A)]*. Ministry of Education and Science of Ukraine, State Department of Intellectual Property.

6. Tarasenko, N.V. (2023). *Stvorennia khemosorbtsiinykh kompozytsiinykh materialiv na osnovi voloknystykh vidkhodiv dlia ochyshchennia vodnykh rozchyniv vid ioniv vazhkykh metaliv [Creation of chemisorption composite materials based on fibrous waste for purification of aqueous solutions from heavy metal ions]*. [PhD thesis]. Kyiv National University of Technologies and Design.

7. Budash, Yu.O., Tarasenko, N.V., Plavan, V.P., Zatolokin, I.M., Shylintseva, T.M. (2021). Vplyv mekhanichnoi aktyvatsii na rozmirni kharakterystyky ta formu chastynok hlynoporoshkiv riznoho typu [The effect of mechanical activation on the dimensional characteristics and shape of clay powder particles of different types]. *Tekhnolohii ta inzhynirynh – Technology and engineering, 4,* 59-62. https://doi.org/10.30857/2786-5371.2021.4.6.

8. Tarasenko, N.V., Plavan, V.P., Budash, Yu.O., & Tkachenko, I.M. (2021). Doslidzhennia sorbtsiinykh vlastyvostei voloknystykh materialiv, modyfikovanykh hlynystymy mineralamy [Investigation of sorption properties of fibrous materials modified with clay minerals]. *Tekhnolohii ta inzhynirynh – Technology and engineering*, *140*(3), 70-78. https://doi.org/10.30857/2786-5371.2021.3.7.

9. Budash, Y., Plavan, V., Tarasenko, N., Ishchenko, O., Koliada, M. (2023). Effect of Acid Modification on Porous Structure and Adsorption Properties of Different Type Ukrainian Clays for Water Purification Technologies. *Journal of Ecological Engineering*, *24*(5), 210–221. https://doi.org/10.12911/22998993/161691.

10. Plavan, V.P., Ishchenko, O.V., Tarasenko, N.V., Budash, Yu.O., Kolodii, A.I. (2023). Zastosuvannia napovnenykh dyspersii vodorozchynnykh polimeriv dlia funktsionalizatsii voloknystykh materialiv [Application of filled dispersions of water-soluble polymers for functionalization of fibrous materials]. *Tekhnolohii ta inzhynirynh – Technology and engineering, 1*(12), 73-85. https://doi.org/10.30857/2786-5371.2023.1.7.

11. Sakalova, H.V., Vasylinych, T.M. (2019). *Doslidzhennia efektyvnosti ochyshchennia stichnykh vod vid ioniv vazhkykh metaliv z vykorystanniam pryrodnykh adsorbentiv [Study of the efficiency of wastewater treatment from heavy metal ions using natural adsorbents]*. VDPU im. Mykhaila Kotsiubynskoho.

12. Malyovany, M.S., Sakalova, H.V., Vasylinych, T.M., Bratushchak, A.O. (2016). Doslidzhennia zdatnosti hlynystykh sorbentiv do adsorbtsii ioniv vazhkykh metaliv [Study of the ability of clay sorbents to adsorb heavy metal ions]. In Khlobistov E.V. (Ed.), *Sustainable development of the 21st century: management, technologies, models – Discussions 2016* (pp. 575−585). Chabanenko Yu.

13. Stepova, O.V., Trokhymenko, H.H. (2022). Tekhnolohii zakhystu vodnoho seredovyshcha *[Water environment protection technologies]*. NU «Poltavska politekhnika imeni Yuriia Kondratiuka».

References (in language original)

1. Cellulosic Sorption Filter Materials with Surface Flocculation Activity–A Hopeful Anticipation of Water Purification / Miloslav Milichovský, Břetislav Češek, Michaela Filipi, Jan Gojný // Journal of Water Resource and Protection. – 2014. – Vol. 6(3). – Pp. 165–176. – Accessed mode: https://doi.org/10.4236/jwarp.2014.63022.

2. Duong, D. D. Adsorption analysis: Equilibria and kinetics / D. D. Duong. – Imperial College Press, 1998.

3. Faith, A. Morrison. Understanding Rheology / A. Faith. – Oxford University Press, 2001.

4. Preparation of Filtration Sorptive Materials from Nanofibers, Bicofibers, and Textile Adsorbents without Binders Employment / Pavel Otrisal, Vladimir Obsel, Jan Buk, Lubomír Svorc // Nanomaterials. – 2018. – Vol. 8(8). – 564–582. DOI: https://doi.org/10.3390/nano8080564.

5. Терновцев, О. В. Фільтруюче-сорбційний матеріал для очищення води (Український деклараційний патент на винахід № 48334 А) [Електронний ресурс] / О. В. Терновцев, О. В. Зоря, В. О. Терновцев // Міністерство освіти і науки України, Державний департамент інтелектуальної власності. – 2002. – Режим доступу: https://base.uipv.org/searchINV/search.php?action=viewdetails&IdClaim=74463.

6. Тарасенко, Н. В. Створення хемосорбційних композиційних матеріалів на основі волокнистих відходів для очищення водних розчинів від іонів важких металів : дис. д-ра філософії / Київський національний університет технологій та дизайну. – Київ, 2023.

7. Вплив механічної активації на розмірні характеристики та форму частинок глинопорошків різного типу / Ю. О. Будаш, Н. В. Тарасенко, В. П. Плаван, І. М. Затолокін, Т. М. Шилінцева // Технології та інжиніринг. – 2021. – № 4. – С. 59–62. DOI: https://doi.org/10.30857/2786-5371.2021.4.6.

8. Дослідження сорбційних властивостей волокнистих матеріалів, модифікованих глинистими мінералами / Н. В. Тарасенко, В. П. Плаван, Ю. О. Будаш, І. М. Ткаченко // Технології та інжиніринг. – 2021. – № 3. – С. 14–23. DOI: https://doi.org/10.30857/2786-5371.2021.3.7.

9. Effect of Acid Modification on Porous Structure and Adsorption Properties of Different Type Ukrainian Clays for Water Purification Technologies / Yurii Budash, Viktoriia Plavan, Nataliia Tarasenko, Olena Ishchenko, Maksym Koliada // Journal of Ecological Engineering. – 2023. – Vol. 24(5). – Pp. 210–221. DOI: https://doi.org/10.12911/22998993/161691.

10.Застосування наповнених дисперсій водорозчинних полімерів для функціоналізації волокнистих матеріалів / В. П. Плаван, О. В. Іщенко, Н. В. Тарасенко, Ю. О. Будаш, А. І. Колодій // Технології та інжиніринг. – 2023. – № 1(12). – С. 73–85. DOI: https://doi.org/10.30857/2786-5371.2023.1.7.

11.Сакалова, Г. В. Дослідження ефективності очищення стічних вод від іонів важких металів з використанням природних адсорбентів / Г. В. Сакалова, Т. М. Василініч. – Вінниця : ВДПУ ім. Михайла Коцюбинського, 2019. – 92 с.

12.Дослідження здатності глинистих сорбентів до адсорбції іонів важких металів / М. С. Мальований, Г. В. Сакалова, Т. М. Василінич, А. О. Братущак // Сталий розвиток XXI століття: управління, технології, моделі − Дискусії / за ред. Хлобистової Є. В. – Черкаси : Видавець Чабаненко Ю., 2016. – С. 575−585.

13.Степова, О. В. Технології захисту водного середовища : навчально-методичний посібник / О. В. Степова, Г. Г. Трохименко. – Полтава : НУ Полтавська політехніка імені Юрія Кондратюка, 2022. – 306 с.

Отримано 29.11.2023

УДК 677.494

Вікторія Плаван[1], Наталія Тарасенко[2], Ірина Лісовська[3]

[1]доктор технічних наук, професор, завідувач кафедри хімічних технологій та ресурсозбереження
Київський національний університет технологій та дизайну (Київ, Україна)
E-mail: plavan.vp@knutd.edu.ua. **ORCID**: https://orcid.org/0000-0001-9559-8962
ResearcherID: I-5852-2015. **SCOPUS Author ID**: 6603130130

[2]старший викладач кафедри загальної та неорганічної хімії
Національний технічний університет КПІ ім. І. Сікорського (Київ, Україна)
E-mail: tarasenko.nv@ukr.net. **ORCID**: https://orcid.org/0000-0003-1062-5533
Researcher ID: J-7632-2017

[3]доцент кафедри загальної та неорганічної хімії
Національний технічний університет КПІ ім. І. Сікорського (Київ, Україна)
E-mail: lisovskayai@ukr.net. **ORCID**: https://orcid.org/0000-0001-6099-5976
Researcher ID: J-8005-2017

ЗАСТОСУВАННЯ ВОЛОКНИСТИХ МАТЕРІАЛІВ ІЗ СОРБЦІЙНИМИ ВЛАСТИВОСТЯМИ В ТЕХНОЛОГІЯХ ВОДООЧИЩЕННЯ

Розроблено алгоритм технологічного процесу отримання хемосорбційного композиційного матеріалу на основі відходів хімічних волокон, наповнених глинопорошками, для очищення стічних вод від іонів важких металів. За основу в роботі були використані неткані матеріали, отримані з відходів поліуретан-поліамідних хімічних волокон. Для підсилення механічної міцності їх скріплювали голкопробивним методом з трикотажним полотном з поверхневою щільністю 240 г/м^2, яке було виготовлено платованим переплетенням з використанням бавовняної пряжі з лінійною щільністю 25 Текс та поліетиленових комплексних ниток лінійною щільністю 16,5 Текс на однофонтурній кругов'язальній машині типу МС. Для підсилення сорбційної здатності до волокнистої основи вводились порошки глин монтморилонітового типу у вигляді наповнених дисперсій крохмалю (2-3 %) чи полівінілового спирту (3 %) в кількості від 5 до 10 % від маси дисперсії.

Сорбційно–фільтрувальний волокнистий матеріал, наповнений глинистими мінералами, може бути використаний для очищення стічних вод підприємств легкої і хімічної промисловості. Застосування глинистих мінералів через введення їх у волокнисту основу дозволить знизити гідравлічний опір шару сорбенту, не використовуючи сорбент грубих фракцій, що збереже площу активної поглинаючої поверхні. Обробка стічних вод може здійснюватися пропусканням води через сорбційно-фільтрувальний елемент. Очищувальні установки можуть вміщувати по декілька сорбційно-фільтрувальних елементів одночасно, що підвищує ефективність водоочищення. Можливо застосування хемосорбційного композиційного матеріалу для очищення замулених стоків без загрози забивання адсорбента, та в системах зворотного водопостачання, що зменшить ризик відкладання мінеральних солей на стінках водоочисного обладнання і забезпечить якісну роботу очисних споруд.

Ключові слова: *технології водоочищення; хемосорбційний композиційний матеріал, сорбційно-фільтрувальний елемент; неткані матеріали; глинисті мінерали; крохмаль; полівініловий спирт.*

Рис.: 2. Бібл.: 13.

Plavan, V., Tarasenko, N., Lisovska, I. (2023). Application of fibrous materials with sorption properties in water purification technologies. *Technical sciences and technologies,* 4(34), 129-137.