JEE Journal of Ecological Engineering

Journal of Ecological Engineering, 2025, 26(7), 146–156
https://doi.org/10.12911/22998993/203364
ISSN 2299–8993, License CC-BY 4.0

Received: 2025.03.09
Accepted: 2025.04.30
Published: 2025.05.15

Potential of reused textile and cartridge-based filter for enhanced water filtration efficiency

Oleksandr Haiduchok[1*], Oleksii Shestopalov[2], Nadiia Kanunnikova[3], Roman Tomashevskyi[4], Antonina Sakun[2], Bohdan Vorobiov[5], Hanna Kniazieva[6], Valeriia Kriuchkova[2], Sergii Kulinich[2], Andrii Titov[1]

[1] Department of Water and Wastewater Engineering, O.M. Beketov National University of Urban Economy in Kharkiv, 17, Chornoglazivska Str., Kharkiv, 61002, Ukraine
[2] Department of Chemical Engineering and Environment Protection, National Technical University Kharkiv Polytechnic Institute, 2 Kyrpychova Str., Kharkiv, 61002, Ukraine
[3] Department of Technical Electrochemistry, National Technical University Kharkiv Polytechnic Institute, 2 Kyrpychova Str., Kharkiv, 61002, Ukraine
[4] Department of Industrial and Biomedical Electronics, National Technical University Kharkiv Polytechnic Institute, 2 Kyrpychova Str., Kharkiv, 61002, Ukraine
[5] Department of Automated Electromechanics Systems, National Technical University Kharkiv Polytechnic Institute, 2 Kyrpychova Str., Kharkiv, 61002, Ukraine
[6] Department of Materials Science, National Technical University Kharkiv Polytechnic Institute, 2 Kyrpychova Str., Kharkiv, 61002, Ukraine
* Corresponding author's e-mail: oleksandr.haiduchok@kname.edu.ua

ABSTRACT

This study examines the efficiency of combining reused textile materials (cotton, satin) with cartridge filters in mechanical water purification processes. Experiments were conducted on model suspensions with varying particle size distributions and concentrations. The findings demonstrate that an additional textile layer enhances fine-particle and adhesive contaminant retention, increasing overall filtration efficiency by 15–20% and preventing rapid pore clogging of the cartridge filter. It was shown that cotton and satin fabrics improve water quality and reduce operational and replacement costs for the primary filter element. Prospective research directions include developing standardized methods for fabric selection, evaluating textile filter durability under actual conditions, and improving end-of-life management strategies. Using reused textiles in water treatment systems proves to be both eco-friendly and cost-effective, especially in resource-constrained settings or emergencies.

Keywords: reused textile, cartridge filter, mechanical water purification, solid phase, fine particles, environmental safety.

INTRODUCTION

One of the main tasks in achieving sustainable development goals No 6 (Sustainable Development, 2015) is ensuring water resource availability and sustainable management. In addition to the consequences of industrial activities, long-term military operations significantly affect the state of water bodies (Kanunnikova et al., 2024; Vladlenov et al., 2024). As a result, light-dispersed suspended particles, oil products, and heavy metals have repeatedly entered natural water bodies. Based on this, creating effective and environmentally safe methods of purifying water from these substances is a priority task in environmental protection.

Surface and underground sources can contain suspended substances of various dispersion, poorly soluble iron compounds, calcium salts, magnesium, other elements, phyto- and zooplankton in varying quantities (Martynov et al., 2023; Bilotta et al., 2008). Suspended solid impurities present in natural waters consist of particles of clay, sand, silt, suspended organic and inorganic substances, plankton, and various microorganisms (Epoyan et al., 2020). The concentration, amount and chemical composition of fine particles in water depends on their origin and the characteristics of the natural reservoir. Suspended particles affect the transparency of water and can pose a health hazard if ingested with drinking water (Poliakov and Martynov, 2023), so the first stage of drinking water purification is the removal of suspended particles. The research (Mulligan et al., 2009) shows that removing suspended particles is a critically important stage of water purification, as this process not only ensures transparency and reduces chemical oxygen demand (COD), but also helps restore the natural balance of aquatic ecosystems.

Our research (Tomashevskiy et al., 2024), which is aimed at developing a portable device for purifying water to drinking quality and ensuring sustainable water consumption in areas with extreme conditions or in zones of military conflicts, has shown that the first stage of purification should be filtration. Filtration is a key stage in water preparation for drinking water supply, as it allows removing mechanical impurities, suspended particles, organic and chemical contaminants. However, filtration efficiency may decrease due to clogging of the filter pores during the filtration process. As a result, the quantity and quality of drinking water for people who need it will decrease. Therefore, filter materials play a key role in ensuring the quality and reliability of the final result (Karahiaur et al., 2023;).

The choice of filter loading is based on the nature of pollutants, the degree of water contamination and the required level of purification. A correctly selected filter element provides a high-quality result and contributes to the rational use of resources. This approach corresponds to the principles of sustainable development, aimed at protecting the environment, preserving natural resources and ensuring environmentally safe water purification. The use of such solutions not only meets modern requirements for water purification, but also contributes to the formation of an environmentally responsible society. Modern research explores various technologies and materials for water purification that can effectively remove organic and inorganic contaminants.

The study (Idris and Debi Eyu, 2017) on using palm fruit fibers and palm nut shells to remove pollutants from water has shown that such materials are affordable and environmentally friendly, as they are secondary products of agriculture. Palm fibers absorb organic pollutants better, while shells effectively remove inorganic particles. The main disadvantage is their limited durability and the need to combine them to achieve optimal results.

The research (Yasui et al., 2016) on waste fiberglass reinforced plastic (GFRP) presented an innovative approach to creating ceramic filter materials. The materials demonstrate high porosity and efficiency in removing suspended particles from turbid water. The advantages include using waste GFRP, which helps reduce the environmental burden. However, the disadvantage is the dependence of the strength of the materials on porosity, which may limit their use at high pressures.

The study by Qi shows that using materials such as graphene oxide (GO) and chitosan (CS) in sponges for removing dyes from water has high adsorption capacity and stability. The sponges demonstrate efficiency in removing methylene blue and the possibility of regeneration, which reduces operating costs (Qi et al., 2018; Kumar et al, 2018). Disadvantages are the adsorption capacity's dependence on the environment's parameters and the complexity of manufacturing.

The development of paper filter materials using palygorskite and cellulose phosphate ester has significantly improved the sorption properties of the materials (Zahorodniuk et al., 2019). Such materials are economical to manufacture and effective for removing iron ions. At the same time, they show limited effectiveness for other types of contaminants and have a short service life.

A general review of research indicates the diversity of materials and technologies used in water filtration. Natural materials, such as palm fiber or cellulose, are affordable and environmentally friendly but have a limited range of applications and insufficient durability. Modern nanomaterials, particularly graphene oxide and chitosan, demonstrate high efficiency, but their production is resource-intensive. Ceramic materials based on GFRP show potential for widespread use due to their high porosity, but their strength is a critical factor.

To improve filtration efficiency and protect against the filter element's clogging, combining fabric-filtering natural materials with filter elements is advisable (Saidani-Scott et al., 2009; Zaschepkina et al., 2012; Li et al., 2017; Mane et al., 2024). One such means can be filter materials based on natural fibrous materials obtained from textile waste. A characteristic feature of natural, chemical, and synthetic fibers is their well-developed porous structure and significant surface area, which makes them promising sorbents for removing oil products and heavy metal ions from aqueous solutions. In the context of the critically low level of processing of textile materials, the secondary use of fibrous waste is of significant environmental and economic importance. Using waste will allow the textile industry to reduce the cost of purchasing sorption materials and ensure more rational use of resources. The relevance of such technology is due to the need to recycle textile waste on the one hand, and develop alternative water treatment methods on the other.

Unlike standard filter materials, textile fibers have several advantages, including lower density, resistance to mechanical damage, corrosion resistance, ease of production, availability of raw materials and low cost.

An important factor is that textile elements can have some unique properties, such as fire and heat resistance, dirt repellency, resistance to chemically active compounds, and antibacterial, sorption, and heat-shielding properties. However, using textile materials as filter elements also has certain disadvantages. The main problem is the need to dispose of used filter fibers, which can create an additional environmental burden. In addition, the lack of a developed system for managing textile waste significantly complicates the stable supply of raw materials for the production of filters. This requires creating and implementing an adequate infrastructure for collecting, sorting and processing textile waste, which would ensure the sustainability and reliability of the raw material base.

A well-developed textile waste management system can ensure stable access to cheap raw materials to produce filter materials and significantly reduce the amount of textile waste going to landfills. This will contribute to the development of a circular economy and support the principles of sustainable development, while providing economic, environmental and social benefits. Thus, the study of the filtering properties of the filter element and fabric materials in order to create a portable mechanical water purification unit is a relevant scientific and technical task. This increases the filter cycle time and reduces the number of stops for cleaning and filter replacement.

This study aims to determine the filtering properties of a laboratory filter unit using a cartridge filter and natural filter fabrics. This is necessary to create a filter eluent for a portable drinking water purification and disinfection unit. To achieve this goal, the following tasks could be solved:

- create a laboratory installation and investigate its efficiency in filtering light particles of model suspensions;
- investigate the filtering properties of natural fabric materials;
- investigate the efficiency of combining a filter element with a fabric filter material.

MATERIALS AND METHODS OF RESEARCH

The study of the filtration process is aimed at determining the ability of the filter to clean water from suspended particles of different hydraulic sizes and concentrations. Our research was conducted on model suspensions with controlled parameters, synthesized by mixing a sample of the solid phase in water with subsequent filtration and analysis of the rate of solid phase retention on a laboratory filtration unit (Fig. 1).

During the research, the model suspension for further filtration was poured into the upper container, from which it flowed onto a filter element with a pore size of about 10 μm, to which a pump was connected. During the filtration process, the pump supplied the filtrate into the lower container, which could be used for recirculation and further research. The filtration efficiency results were evaluated by the residual concentration of the solid phase in water by settling the solid particles of the filtered water using a laboratory centrifuge, drying the sediment to a constant mass, and weighing the dry residue.

To prepare the model suspensions, a portion of the solid phase was weighed on a laboratory scale of a specific concentration, mixed with water and poured into a filtration unit.

Suspensions consisting of solid silicon carbide particles (SiC) and polydisperse mixtures containing talcum powder and natural clay were used as model mixtures (Fig. 2). The choice of such substances for model mixtures was based on the fact that silicon carbide is not hydrolyzed and does not clump; talcum powder has sizes from 1 to 10 μm and is hydrophobic; the clay mixture is polydisperse from 0 to 50 μm and has properties to swell in water.

The effectiveness of fabric filter materials was carried out on fabric samples, as shown in Fig. 3.

Figure 1. The laboratory setup for filter element research

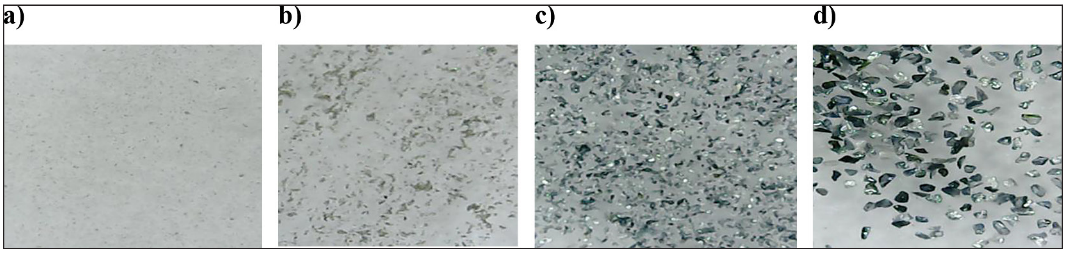

Figure 2. Microscopic photographs of light particles for model mixtures of different sizes of SiC: (a) 3/2 μm, (b) 10/7 μm, (c) 40/28 μm, (d) 80/60 μm

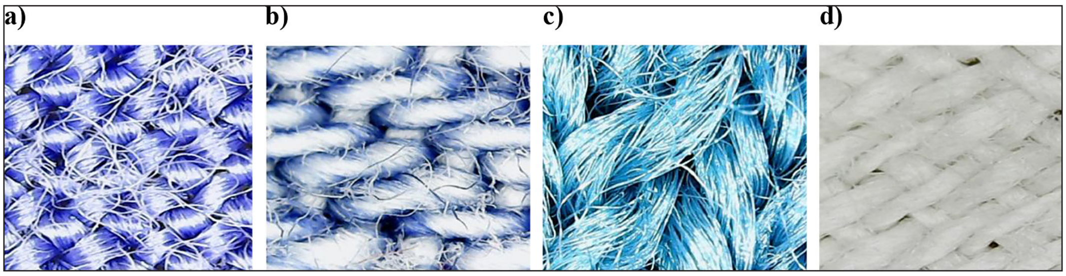

Figure 3. Microscopic photographs of the researched fabric materials: (a) cotton, (b) denim, (c) wool, (d) satin

In series of experiments, model suspensions were filtered through a layer of fabric placed in a filter funnel of a PVF-35PP vacuum filtration device. After that, the mass of the solid phase was determined in the filtrate.

RESULTS

The results of filtering dispersed silicon carbide particles showed that particles larger than 10 μm, in this case, larger than the pore size of the filter element, are completely retained in the filtration process. Filtration of 2–3 μm particles almost does not retain solid particles in the filtrate. The particle retention rate did not exceed 5–7% and is more related to the sedimentation of particles on the filter element body.

The results of the study of the filtration of particles of 7–10 μm and talcum, depending on the concentration, are presented in Figure 4. As the concentration increases from 0.5 to 9 g/l, the particle retention rate of silicon carbide increases from 53 to 66%. This happens due to the clogging and overlapping of the pores with particles close to the diameter of the holes, the formation of a sediment film on the surface of the filter element and retention in the pores. At the concentration above 9 g/l, the filtering process did not occur, due to the clogging of the pipes in front of the filter with sediment and increased hydraulic resistance on the filter.

In general, it can be observed that water is filtered at low concentrations (Fig. 4), while the holes' size is smaller than the size of the retained particles. With increasing concentration, film filtration occurs. In this case, the filter structure is covered with a film of solid particles. This allows particles that are smaller than the size of the filter holes to be retained. An inevitable solid phase retention rate increase was also observed when filtering talcum. However, the filter holes were clogged with adhering talcum particles, creating a continuous layer and slowed filtration. Washing the filter under water and mechanically allowed us to isolate the contamination of the filtering surface (Fig. 5).

However, it should be noted that clogging of the pores of the filter element with solid particles that can get stuck in the holes or stick can interfere with the filtration process. This effect can be observed even with a small concentration of suspended particles in the event of their accumulation. Therefore, it is advisable to create an additional protective layer of filter fabric, which will provide additional filtering efficiency and reduce clogging of the pores of the mesh part of the filter.

Analysis of the research (Zhao et al., 2016) shows the potential of using textile materials as

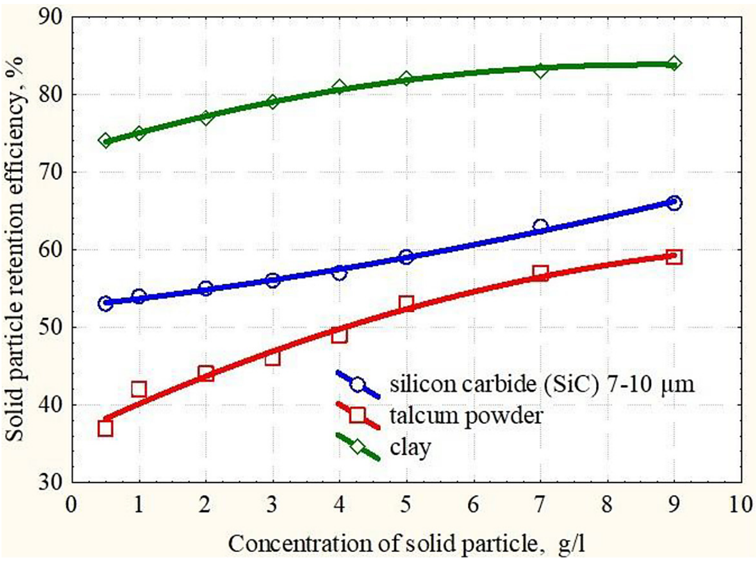

Figure 4. Dependence of filtration efficiency on solid phase concentration

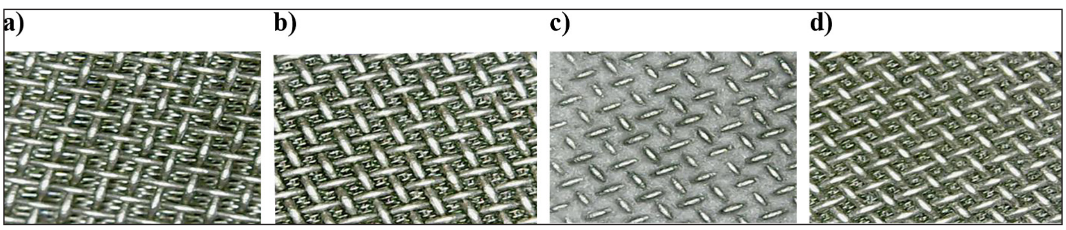

Figure 5. Microscopic photographs of the filter surface: (a) before filtration, (b) after filtration of silicon carbide particles, (c) after filtration of talcum particles, (d) washed filter after filtration of talcum

filtering agents. Due to their developed porous structure, they effectively retain suspended particles. Physical properties, exceptionally high sorption capacity, flexibility and the possibility of easy modification, allow the use of such materials in various filtration systems.

Cotton threads and fabrics have a fibrous structure determining their physical properties and characteristics. Cotton is composed of cellulose fibers that are twisted into yarn. The more tightly the thread is twisted, the firmer and smoother. The strength of a cotton thread depends on the length and quality of the fibers, as well as the degree of twisting. Longer and thinner fibers provide higher strength and better quality yarn.

The density of the thread weave determines the strength of a cotton fabric, that is, the number of threads per square centimeter. The higher the density, the stronger and more durable the fabric. Different types of thread weave exist, including plain, twill, and satin. A satin weave involves one warp thread being overlapped by four or more weft threads, which gives the fabric a smooth and shiny surface.

Satin is a fabric made of cotton threads using a satin weave. A dense warp thread and a thin twisted thread are used for weaving. The silky smooth and shiny front side is obtained precisely due to the twisted thread. The wrong side is dense and slightly rough. The density of satin can be from 85 to 220 threads per square centimeter, which affects its quality and application. The satin fabric has softness, shine, strength, hypoallergenic properties, and high wear resistance.

Usually, filter fabric is made from systems of two threads, perpendicular to each other. Accordingly, a type of weaving is formed, characterized by the value of the rapport (R), i.e., the smallest number of threads, after which the weaving order is repeated. The main types of weaving are plain, twill and satin. In plain weave, $R = 2$. Fabrics with such a weave have a high retention capacity, but have increased hydraulic resistance. Such fabrics are used in filter presses. Twill weave fabrics have $R > 3$. They have a lower retention capacity, but are easier to regenerate. Most filter fabrics have a twill weave. With satin weave, $R > 5$. In terms of strength and retention capacity, they are inferior to plain and twill.

Cotton fibers are hydrophilic due to their high cellulose content, which allows the fabric to pass water effectively. This property is important for the use of cotton materials as filter fabrics. The fibrous structure creates a branched system of micropores through which water passes, while retaining fine particles. Due to their natural structure, cotton fabrics can provide effective mechanical filtration, particularly when purifying water from suspended particles. Plain and twill weaves are suitable for creating strong and durable filter materials, while satin weaves provide lightness and flexibility to the fabric while maintaining water permeability.

The following results were obtained based on the research conducted on the effectiveness of various textile materials in filtering fine particles. The use of textile materials for filtering particles of various sizes of silicon carbide and talc showed that the filtration rate depends on the type of material and the particle size of the filtered substance.

Table 1 shows the results of filtering light particles through a layer of textile materials. When filtering particles with a size of 40/28 μm, the largest number of retained suspended particles was observed, especially in the case of cotton and satin. This indicates that this material has a good ability to retain larger particles. Reducing the dispersion of solid particles in model suspensions to 10/7 μm and 3/2 μm led to decreased retained particles among all materials. This indicates a decrease in their filtration efficiency with a decrease in particle size. The smallest mass loss was demonstrated by cotton and satin, which emphasizes their ability to retain small particles more effectively. The cotton and satin materials used in the experiment are not included in the nomenclature of commonly used filter materials. Their original purpose was focused on household purposes, but even in this case, they demonstrated high efficiency in particle retention. This confirms the potential of such materials for use in filter systems, which is a promising direction for further research.

In the case of talcum filtration, the highest mass losses were observed in wool and denim, indicating a stable result in their filtration efficiency compared to silicon carbide. The study results indicate that textile materials' efficiency in filtering fine particles depends mainly on the particle size and type of substance (Fig.6, 7). Cotton and satin showed the best results in filtering silicon carbide and talcum, while denim and wool were the least effective materials, regardless of particle size.

To study the efficiency of purifying from light impurities on the filter element of the laboratory installation (Fig. 1), a layer of satin fabric was used, which is thinner and easier to cover the filter (Fig. 8). Figure 9 presents the visual results

Table 1. The results of the filtration process of fine particles throughout the layer of textile materials

Type of textile material	Finely dispersed substance	Mass of suspended particles, g/l	Mass of retained particles on textile material after filtration, g	Detention efficiency, %
Cotton	Silicon carbide (SiC) (40/28 µm)	500	0.41	82
Satin			0.44	88
Wool			0.229	45
Denim			0.36	72
Cotton	Silicon carbide (SiC) (10/7 µm)	500	0.27	54
Satin			0.22	44
Wool			0.11	23
Denim			0.09	18
Cotton	Silicon carbide (SiC) (3/2 µm)	500	0.12	28
Satin			0.19	38
Wool			0.1	19
Denim			0.02	4.8
Cotton	Talcum $Mg_3Si_4O_{10}(OH)_2$	1000	0.62	62
Satin			0.54	54
Wool			0.24	24
Denim			0.34	34

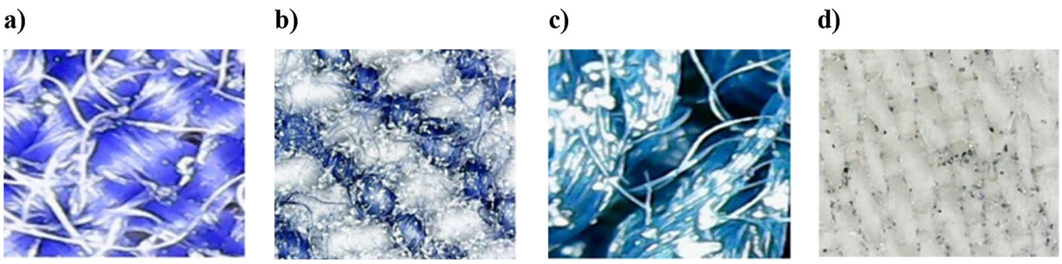

Figure 6. Microscopic photographs of the test fabric materials during silicon carbide filtration 7–10 µm: (a) cotton, (b) denim, (c) wool, (d) satin

of filtered water without (Fig. 9a) and with (Fig. 9b) fabric placed on the filter. The results of the study, shown in Figure 10, indicate an increase in the efficiency of solid phase retention using fabric materials (Fig. 9) due to a double layer of filtration - fabric fibers and a filter element. Thus, not only fine filtration and film filtration occur, but also partial volume filtration: small suspended particles, passing through a layer of filter material, change the direction and speed of movement many times in the gaps between sediment granules, fibers and films of the filter fabric, as well as the cartridge filter material. As a result, the smallest particles, such as colloids, bacteria and finely dispersed clays, are partially retained. The advantage of this water purification method is the

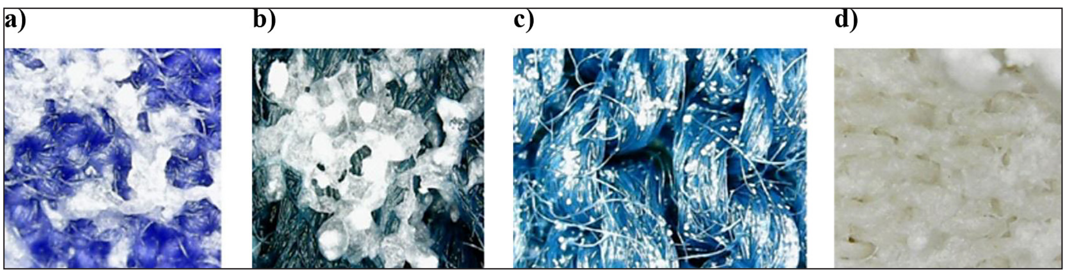

Figure 7. Microscopic photographs of the studied fabric materials during talcum filtration: (a) cotton, (b) denim, (c) wool, (d) satin

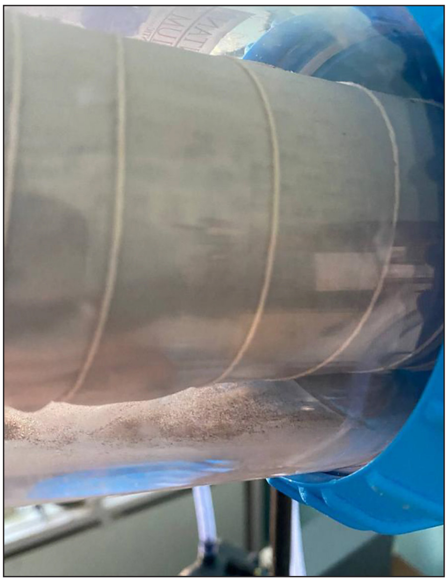

Figure 8. Satin placement on the filter structure

formation of films and the adhesion of small particles to the fabric's surface, which reduces contamination of the filter element and prevents particles from getting stuck in the pores of the metal mesh of the cartridge filter. The filter fabric can be easily replaced with a new one after clogging, which makes the filter easier to operate. Using natural materials for the filter fabrics makes the filter environmentally friendly.

Within the framework of experiments with model solutions containing 2 g/l of clay, it was found that cotton fabric, used as an additional filter layer, effectively retained fine particles during the filtration of the first 7.5–15 l of water. After the specified volume, the liquid flow rate decreased by an average of 20%, which is explained by the accumulation of particles on the surface and in the micropores of the fabric. Satin fabric, under

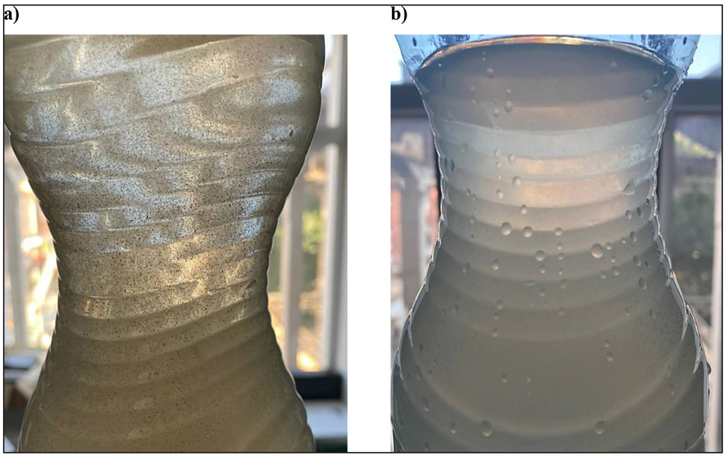

Figure 9. Visual results of filtered water: (a) without placing fabric on the filter, (b) with placing fabric on the filter

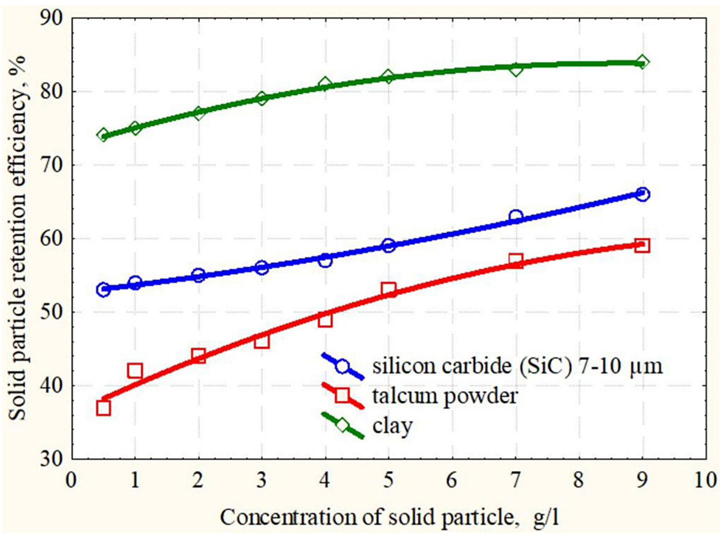

Figure 10. Dependence of filtration efficiency on solid phase concentration

similar conditions, had a slightly longer resource. However, it also began to clog faster in the event of an increased concentration of suspended impurities (over 5 g/l). When the load on the filter increased, the retention efficiency deteriorated significantly, which required additional activities (washing or complete textile replacement). The critical volume of filtered water depends directly on the textile material type and the initial concentration of suspended substances.

Comparing Figure 10 with the data of Figure 4 and Table 1, it can be stated that the efficiency of solid phase retention is not the sum of the efficiencies of different filter materials. This is explained by the fact that the dispersed suspension of model liquids has a polydisperse composition of solid particles, which can clump into aggregates, swell, and coagulate. Such particles settle more easily on the first layer of filter material. Statistical processing of the results of experimental data for clay particles, which are more typical of natural reservoirs, in the concentration range up to 9 g/l revealed the following equation:

$$E = 73.1537 + 3.5086 \cdot C - 0.1552 \cdot C^2 \quad (1)$$

where: E – efficiency of retention of solid clay phase, %; C – solid phase concentration, g/l.

Analysis of the surface of the filter fabric (Fig. 11) after clay filtration shows both retention of relatively large particles and clumping clay particles on the surface of the fibers.

It should also be noted that natural waters have significantly less water pollution (by two orders of magnitude) from suspended particles. However, even visual observation in Figure 8 indicates the possibility of purifying very extremely dirty water to turbid due to the filter element, which can be helpful in the development of a portable water treatment device in emergency and extreme conditions.

DISCUSSION

The research results indicate the prospects of reusing textile materials, mainly cotton and satin, in mechanical water purification systems. Due to the fibrous structure and high hydrophilicity, such materials effectively pass through water, retaining suspended particles in micropores. Their physicochemical properties (flexibility, sorption capacity, and the possibility of quick replacement) make textiles an attractive option for both mobile and stationary filtration systems (Saidani-Scott et al., 2009; Zaschepkina et al., 2012; Zhao et al., 2016; Li et al., 2017; Mane et al., 2024).

In particular, fabrics with a plain and twill weave provide the necessary strength and durability, while the satin structure provides additional flexibility while maintaining water permeability. Although these materials were initially developed for domestic use, the successful results of their application in filtration systems indicate the wide possibilities for the secondary use of textiles in water treatment. In addition, using used fabrics is economically beneficial and ecologically appropriate because it reduces costs and the volume of textile waste (Zaschepkina et al., 2012; Li et al., 2017). Such fabrics also serve as a preliminary barrier to retain large particles, which prevents rapid clogging of the main filter element (Zhao et al., 2016).

At the same time, the filtration method using textile materials is accompanied by several problems. In particular, one of them is the limited durability of the fabrics, which may require frequent replacement and create additional waste. Use in highly loaded systems can lead to accelerated clogging and increased hydraulic resistance, especially in the presence of hydrophobic and sticky components (e.g., clay particles). In addition, given the diversity of origin and condition of used fabrics, their properties can vary

Figure 11. Fabric after filtering clay samples

significantly, which makes it difficult to standardize and predict the filtration results. After the resource is exhausted, such filter materials require appropriate methods of disposal or recycling to prevent the formation of secondary waste.

The experimental data obtained on model suspensions demonstrated the incomplete ability of the mesh material of the cartridge filter to remove the tiniest particles (less than 10 μm). Hydrophobic impurities, mainly clay, further complicate the filtration process due to sticking and contamination of the filter surface. The use of additional textile layers significantly increases the efficiency of removing these particles; however, finely dispersed impurities remain in the filtered water, which affects its color and requires additional purification (for example, coagulation or adsorption). A limitation of the study is the laboratory scale of experiments without auxiliary purification and disinfection units, which may affect the assessment of actual performance indicators in more complex systems.

Future research opportunities include determining the operational life of textile filters under real-world conditions, developing clear standards for material selection and improving recycling methods. An extra area of the research is the evaluation of the possibilities for regenerating used textile filters. Preliminary pilot experiments have shown that washing the fabrics under water pressure and subsequent drying partially restores their filtration properties. However, more in-depth research is needed to determine the optimal cleaning regimes, including the type of washing medium, temperature and duration of the regeneration cycle.

Our future plan is to develop a three-layer filter to implement our idea of creating the compact portable device for water purification (Tomashevskiy et al., 2024). It will consist of a metal cartridge filter element wrapped in filter fabric and supplemented with granular filter material (sand or anthracite). The passage of water through three layers of filter material will ensure the effective retention of suspended particles in the pores of filter materials. Solving these issues will create more reliable, affordable, and environmentally friendly water purification systems, especially relevant in limited resources or emergencies.

CONCLUSIONS

Thus, the laboratory studies showed that cartridge filters effectively retain mechanical impurities of more than 10 μm, but have limited capabilities for fine and sticky particles. It was found that an additional layer of textile material increases the overall degree of purification by an average of 15–20% and prevents rapid clogging of the pores of the cartridge element, while extending its service life. Among the natural fabrics studied (cotton, satin, denim, etc.), cotton and satin materials demonstrated the best retention rates for light particles. Due to their hydrophilic structure and branched micropore system, they effectively retain suspended particles and reduce hydraulic resistance. It was found that the secondary use of textiles is not only economically beneficial, but also increases the environmental sustainability of the water treatment system.

For practical implementation of the obtained results in actual conditions, it is advisable to develop standardized approaches to the selection and preparation of fabrics, to study the durability of textile filters under different operating conditions and to improve the methods of utilization or regeneration of spent fabric layers. In addition, it is promising to integrate mechanical filtration with other purification methods (coagulation, adsorption, etc.) to improve the final water quality. The tasks performed, including the creation of a laboratory installation, the study of the filtration properties of fabrics and the assessment of the combination of textiles with a cartridge element, confirmed the potential of used textile materials as an additional barrier for fine contaminants, which can form the basis for the development of affordable and environmentally safe water purification technologies in conditions of limited resources or emergencies.

REFERENCES

1. Bilotta, G., & Brazier, R. (2008). Understanding the influence of suspended solids on water quality and aquatic biota. *Water Research*, *42*(12), 2849–2861. https://doi.org/10.1016/j.watres.2008.03.018
2. Epoyan, S., Syrovatsky, O., Haiduchok, O., & Titov, A. (2020). Effect of technological parameters on clarification low-concentration suspension by dissolved air flotation. *IOP Conference Series Materials Science and Engineering*, *907*(1), 012084. https://doi.org/10.1088/1757-899x/907/1/012084
3. Idris, J., Osman, S. F., Gaius, E., & Christian, C. (2017). A comparison study of water filtering materialsmade from extracted palm fruit fibreand palm kernel shell. *Environmental Engineering and Management Journal*, *16*(12), 2657–2663. https://doi.

org/10.30638/eemj.2017.276

4. Kanunnikova, N. O., Haiduchok, O. G., Tomashevskyi, R. S., Vorobiov, B. V., Kniazieva, H. O., Sakun, A. O., & Shestopalov, O. V. (2024). The current state of water resources in the Dnipro basin compared to other countries. *Ukrainian Journal of Natural Sciences*, 9, 314–322. https://doi.org/10.32782/naturaljournal.9.2024.32
5. Karahiaur, A., Syrovatskyi, O., Titov, A., & Lukashenko, S. (2023). Reasoning of the efficiency of consistent filtration on rapid filters. *Municipal Economy of Cities*, *3*(177), 125–133. (in Ukrainian). https://doi.org/10.33042/2522-1809-2023-3-177-125-133
6. Kumar, S., Garg, A., & Chowdhuri, A. (2018). Effect of concentration variation in graphene oxide (GO) membranes for water flux optimization. *AIP Conference Proceedings*, *1953*, 030280. https://doi.org/10.1063/1.5032615
7. Li, F., Xia, Q., Cheng, Q., Huang, M., & Liu, Y. (2017). Conductive cotton filters for affordable and efficient water purification. *Catalysts*, *7*(10), 291. https://doi.org/10.3390/catal7100291
8. Mane, P. V., Rego, R. M., Yap, P. L., Losic, D., & Kurkuri, M. D. (2024). Unveiling cutting-edge advances in high surface area porous materials for the efficient removal of toxic metal ions from water. *Progress in Materials Science*, *146*, 101314. https://doi.org/10.1016/j.pmatsci.2024.101314
9. Martynov, S., Orlova, A., Zoshchuk, V., Zoshchuk, N., & Minaeva, N. (2023). Groundwater treatment using polystyrene foam filters with upflow filtration. *IOP Conference Series Earth and Environmental Science*, *1254*(1), 012076. https://doi.org/10.1088/1755-1315/1254/1/012076
10. Mulligan, C. N., Davarpanah, N., Fukue, M., & Inoue, T. (2008). Filtration of contaminated suspended solids for the treatment of surface water. *Chemosphere*, *74*(6), 779–786. https://doi.org/10.1016/j.chemosphere.2008.10.055
11. Poliakov, V., & Martynov, S. (2023). Substantiation of technological parameters of granular filters operation. *AIP Conference Proceedings*, *2928*, 060021. https://doi.org/10.1063/5.0122842
12. Qi, C., Zhao, L., Lin, Y., & Wu, D. (2018). Graphene oxide/chitosan sponge as a novel filtering material for the removal of dye from water. *Journal of Colloid and Interface Science*, *517*, 18–27. https://doi.org/10.1016/j.jcis.2018.01.089
13. Saidani-Scott, H., Tierney, M., & Sánchez-Silva, F. (2009). Experimental study of water filtering using textiles as in traditional methods. *Applied Mechanics and Materials*, *15*, 15–20. https://doi.org/10.4028/www.scientific.net/amm.15.15
14. *Transforming our world: the 2030 Agenda for Sustainable Development | Department of Economic and Social Affairs*. (2015). https://sdgs.un.org/2030agenda
15. Tomashevskyi, R., Vorobiov, B., Kanunnikova, N., Shestopalov, O., Haiduchok, O., & Kniazieva, H. (2024). Portable Device for Purifying and Disinfecting Water in Extreme Conditions. *Proceedings of the 2024 IEEE 5th KhPI Week on Advanced Technology (KhPIWeek)*, 1–5. https://doi.org/10.1109/khpiweek61434.2024.10877947
16. Vladlenov, D., Trembitska, O., Zhuravel, S., Stoliar, S., Bilotserkivska, L., Vasylenko, O. (2024). *The development of technical, agricultural and applied sciences as the main factor in improving life*. https://doi.org/10.46299/isg.2024.mono.tech.2
17. Yasui, K., Goto, S., Kinoshita, H., Kamiunten, S., Yuji, T., Okamura, Y., Mungkung, N., & Sezaki, M. (2016). Ceramic waste glass fiber-reinforced plastic-containing filtering materials for turbid water treatment. *Environmental Earth Sciences*, *75*(15). https://doi.org/10.1007/s12665-016-5933-6
18. Zahorodniuk, K., Voitsekhovsky, V., Korobochka, A., Hrynzovskyi, A., & Averyanov, V. (2019). Development of modernized paper filtering materials for water purification, assessment of their properties. *Eastern-European Journal of Enterprise Technologies*, *1*(10 (97)), 6–13. https://doi.org/10.15587/1729-4061.2019.156534
19. Zaschepkina, N., Dregulas, E., & Konakhevich, N. (2012). Textiles for environmental protection. *Bulletin of KNUTD Materials science, light and textile industry*, *4*, 112–115. (in Ukrainian)
20. Zhao, F., Weng, F., Xue, G., Jiang, Q., & Qiu, Y. (2015). Filtration performance of three dimensional fabric filter in a membrane bioreactor for wastewater treatment. *Separation and Purification Technology*, *157*, 17–26. https://doi.org/10.1016/j.seppur.2015.11.022