

Prospects of using basalt fibers in light industry

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Abstract. The paper considers the use of basalt ore - natural raw materials of volcanic origin - in Uzbekistan, as well as the wide use of basalt fibers in various sectors of the economy and their further prospects. Basalt rocks are raw materials for production of fibers and ultrafine fibers, belong to magmatic rocks and possess high natural chemical and thermal stability. Basalt rocks are single-component raw materials that have been enriched, melted and homogenized by ancient volcanic activity. However, the main energy input for the primary melting of basalts was carried out by nature. Basalt is a natural raw material ready for fiber production. The article describes the technological process from extraction of fibers from basalt rocks to their spinning and weaving, obtaining finished fabrics. Laboratory analyses to determine their resistance to tearing, stretching and compression are conducted. The possibility of sewing work clothes from basalt fabrics is considered.

1 Introduction

Significant reserves of basalt ore - natural raw material of volcanic origin - in Uzbekistan open wide prospects in the field of production of composite materials. Chemical resistance of composite reinforcement made of continuous basalt fibers, when reinforcing concrete and asphalt concretes will considerably increase resistance of concrete to destruction. At the same time, one ton of basalt fiber products can replace 8-10 tons of steel reinforcement.

The local rock in the Osmonsay deposit will find wide application in composite construction materials as an additive in the composition of concrete, tiles, paving tiles and asphalt, railway sleepers, etc., where a minor reinforcing additive to the base material is required. In addition, basalt fibers can be actively used in the manufacture of automobile brake pads and pads with a long service life. Chemical treatment of the rock surface will make it possible to use it as a cord for automobile tires as well as for making bulletproof vests, replacing much more expensive Kevlar [1-3].

Today the sphere of application of materials and products based on basalt fiber has significantly expanded. They are used in automotive industry, power engineering, chemical and petrochemical industry, metallurgy, agriculture, hydraulic engineering, construction of port facilities, offshore platforms, firefighting materials in construction of high-rise buildings and important industrial structures, bridges, dams tunnels, railroads. Cheapness of the

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material, simplicity and reliability, ease of operation - these factors in the coming years will contribute to its transformation from an innovative product into a consumer product [4].

The key to success in production is the use of continuous fibers and chemistry of world-famous brands, qualitative foreign equipment from Russia, Germany, Austria, Ukraine, Italy and Turkey as well as, qualified specialists in the sphere of composite materials.

2 Materials and methods

The prospect of further development is the construction of enterprises for the production of basalt fabric (cloth). Basalt fabrics allow to achieve economy at the expense of durability of material and increases safety of operation of industrial objects, it is used for protection of hot surfaces (protection of ceilings from hot pipes, fire protection of walls around furnaces and fireplaces), as thermal insulation at welding works, for manufacturing of fireproof clothes, shells for heat-insulating materials [6,7].

They can replace obsolete asbestos, silica fabrics in all areas of their application. Basalt fabrics made of one-component raw materials have a number of unique properties, including: ecological purity of the material, has a natural stone formula - basalt, non-carcinogenic in contrast to asbestos fabrics is one of the best heat insulators.

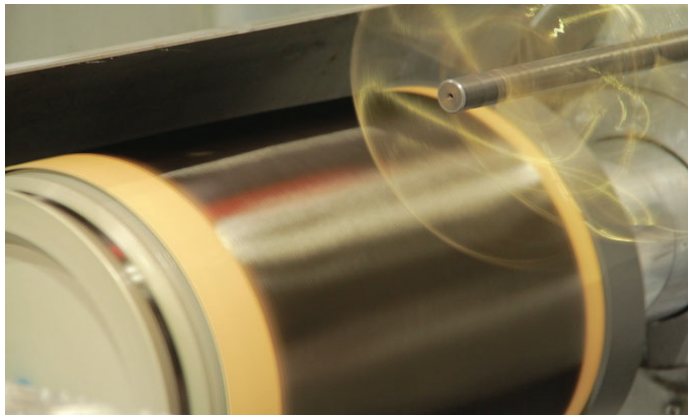


Fig. 1. Basalt fiber.

Materials of basalt are durable, have high chemical resistance to alkaline and acid environments. The material is vibration-resistant and can be used for turbine insulation. It does not succumb to the influence of various microorganisms.

There are several types of looms that use looms to weave basalt fibers.

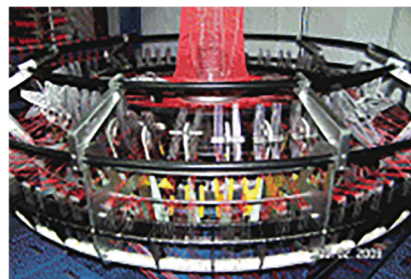


Fig. 2. Weaving and circular looms.

Basalt fabrics are made by weaving complex twisted basalt threads, enriched and combined.

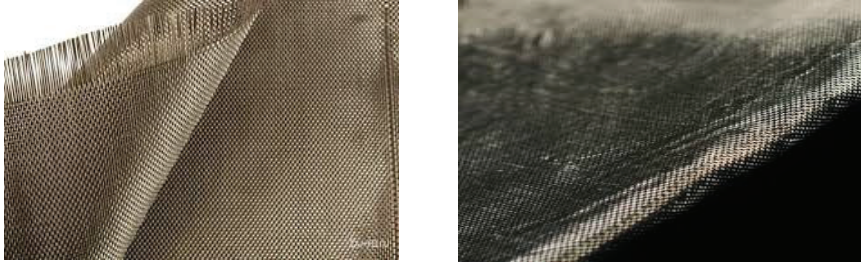


Fig. 3. Basalt fabrics.

The wear and tear of clothing is mainly caused by the forces of stretching, crushing, bending and friction. Therefore, the resistance of the fabric to various mechanical influences is of great importance for the good preservation and long-term durability and shape of the garment.

In order to use basalt for sewing special clothing, we conducted several tests. Testing of fabric samples was carried out in the testing laboratory according to the established list of indicators [8].

Since the main task facing us is sewing work clothes from basalt fabrics, attention is paid to the choice of sewing needles, which, passing through the material, hit the tip of the thread and lead to the destruction of some of the fibers that form the thread.

The needle can pull the threads that make up the fabric or fabric sheet apart and pass between them as it passes through the material. When sewing with a sewing machine, the needle with the sewing thread tucked in its eyelet must pass through the material to be sewn and pass the thread through it. Material fracture does not occur when the needle is able to pull apart the threads that make up the fabric or fabric and pass between them as it passes through the material. A needle passing through the material hits the threads with its point, in which case part of the fibers that form the thread may be destroyed. Partial breakage of a thread is called a concealed cut, while complete breakage is called an overt cut. The presence of cuts along the lines of seams in products worsens their appearance, as individual destroyed fibers after the first wash or water ingress protrude to the surface. Cutting is especially dangerous when sewing basalt fabrics, because the destruction of the thread, even in a single loop, can lead to the unraveling of the buttonhole columns along the entire product [9-11].

On the basis of the above and the laws of the process of sewing material or fabric, conclusions have been made that it is impossible to sew products from basalt fabrics. Experimental studies have been conducted for the first-time using basalt fabrics for the possibility of sewing work clothes from it.

The possibility of a needle entering a thread and partially or completely destroying it depends on a number of factors, the main ones being structure and density, fiber composition and moisture content, material, stitch direction in relation to warp and weft threads in fabrics and finishing operations. In order to avoid material breakage, the sewing process requires that the needle be correctly selected according to the thickness of the material (in terms of the thickness of the needle shaft and the angle of sharpening) and the sewing thread according to the needle. Increasing the number of simultaneously sewn layers of material and the pressure of the sewing machine foot on the material contribute to the destruction of the material. The stiffer the material structure, the less the threads are pushed apart by the needle point and the more the needle can penetrate the threads.

For sewing workwear made of basalt fabrics, the medium rounded point/mediunballpoint (SUK) is rounded and designed for coarse knitwear and elastic materials like basalt fabrics.

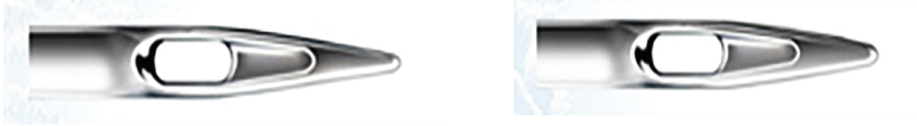


Fig. 4. Jersey/Stretch for sewing jersey, knitwear, knitted and elastic materials, spherical point 130/705 H-S, H-SES, H-SUK/70-90.

a- Needle for embroidery on knitwear and stretch fabrics. This needle features a small rounded tip. This needle easily expands the threads of the fabric and loops and thus passes between the threads without damaging the material.

c- Needle for embroidery on loose knitwear and coarse stretch material. This needle has a medium rounded tip that does not disturb the fabric.

The use of such needles is based on the property of the basalt web to give greater elongation at the first moment of application of even very minor tensile loads than at the subsequent application of increasing loads.

The thickness of the sewing thread and the sewing needle affects the possibility of material breakage during the sewing thread process. If the sewing thread is thicker than the needle is capable of, the thread will protrude from the needle groove, which is designed to keep the thread from coming into contact with the material when it is pierced.

The contact between the sewing thread and the material creates additional tension that can cause the material to break.

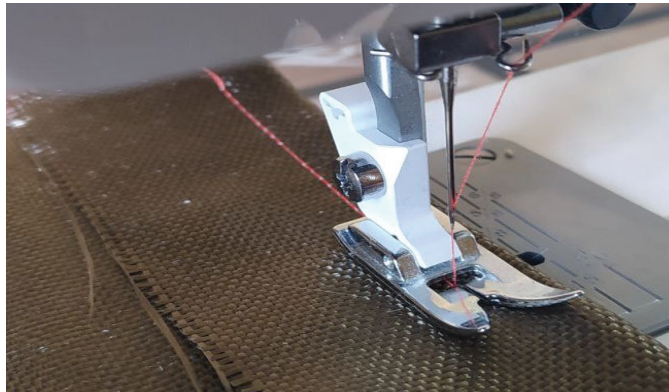


Fig. 5. The process of sewing the basalt fabric.

The disadvantage of basalt fabrics is a low tangent coefficient of resistance of 0.25-0.32, which gives the fabric high shrinkage, instability, warp structure and displacement of warp and weft, which leads to difficulties in sewing clothes.

Thread shedding that occurs at the fabrics' cutting and seam cuts, as well as thread separation in the fabric, is caused by friction and mutual adhesion between warp and weft yarns. This disadvantage can be eliminated by treating the surface of the basalt fabric with an adhesive-containing liquid.

3 Results and discussions

It is at this stage of the technological process - application - that textile materials acquire the properties they need. The appropriate type of modification is carried out depending on the properties and purpose of the basalt. After that, the preparations necessary to achieve these properties are selected. It is necessary to note several important details in the process of

modification of basalt fabrics with the help of adhesive fluid, which indicate the advantages of their use.

Firstly, the adhesive fluid is mainly applied during the surface treatment process, and therefore all the fluid used is transferred to the web and fixed on it, so that there is no waste water. This is a great advantage, both in terms of economy and ecological approach.

Secondly, processing with adhesive-containing liquid-based adhesives takes place in approximately the same conditions and according to one basic scheme (application - drying - fixing). The main component ensuring low shrinkage of the finish in both compositions is the pre-condensate of thermosetting resin, starch acts as an additive, which gives the fabric fullness.

It was found that the fabric treated with the glue-containing liquid acquires a high density.

The finishes are water-based and prevent the fabric from interacting with other chemicals by forming a molecular protective layer of fluorocarbon groups around the fabric fibers. In this way, the technology guarantees maximum protection against fabric shrinkage. Thanks to the fact that the finish does not form a continuous film on the surface of the fabric, the fabric remains fully breathable.

As an alternative, the patent of the authors, N.E. Kovaleva, V.I. Besshaposnikova, M.V. Zagoruiko, E.V. Zhilina on "Composite textile material for protective clothing and technical articles" is provided. The proposed invention relates to duplicated textile-based materials, in particular to a composite textile material consisting of two layers (components) of woven or knitted fabrics connected by glue, and can be used as a basic material or overlapping parts in the production of fireproof overalls (welder, metallurgist, etc.) and technical products.

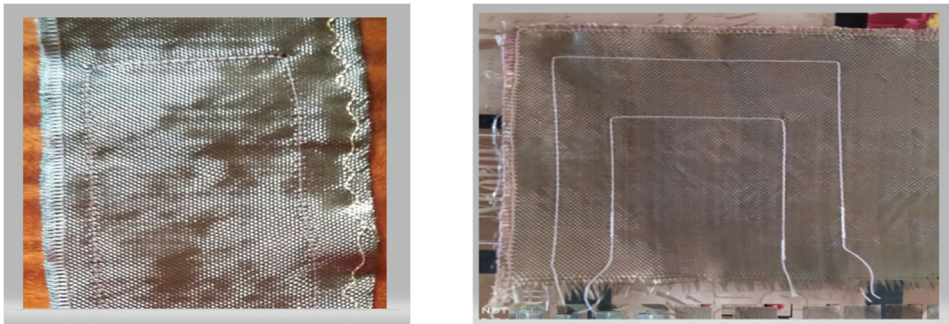


Fig. 6. a) basalt cloth before treatment, b) basalt cloth after treatment.

In our proposed variant, we exclude the method composed of two layers (components) of fabrics, basalt fabric treated with adhesive fluid makes it possible to sew special clothes from this material. After completing the sewing process, the overalls are subjected to a light wash, during which the adhesive liquid is washed off the surface of the overalls.

Production of workwear for welders, metallurgical workers is a separate industry. Certain fabrics with higher characteristics are used for production. The fabric treated with glue-containing fluid is easily confirmed by the sewing process and the use of basalt fiber materials improves the performance characteristics of the workwear. In the basalt cloth jumpsuit the body breathes, the basis is 100% natural material. It does not accumulate static electricity, has a dense base and yet washes well.

4 Conclusion

Thanks to the peculiarities of weaving, the material is wear-resistant and breathable, protects the body from high temperatures, but at the same time allows air to circulate freely, does not

restrict movement and creates comfortable temperature conditions. The dense texture perfectly protects against sparks, slag and metal droplets, the surface is easily cleaned of particles and can be used in the future without loss of external data and performance characteristics.

References

1. S. P. Osnos, M. S. Osnos, *Composite world* **1**, 56-62 (2018)
2. D. D. Djigiris, M. F. Makhova, *Fundamentals of basalt fibers and products production*. Monograph. (Teploenergetik, Moscow, 2002), 416
3. S. I. Gutnikov, M. S. Manylov, Y. V. Lipatov, Effect of the reduction treatment on the basalt continuous fiber crystallization properties **368**, 45-50 (2013)
4. V. Dhand, G. Mittal, K. Y. Rhee, S. J. Park, D. Hui, *Composites Part B* **73**, 166-180 (2015)
5. N. E. Kovaleva, *Composite textile material for protective clothing and technical products* (Ph., 1997)
6. A. S. Zakharchenko, *Justification and development of finishing technologies of textile materials using domestic styrene-methacrylic and urethane polymers* (Ivanovo, 2013)
7. M. F. Avezov, D. R. Kuliyeva, *The use of innovative fabrics for sewing workwear. Technical regulation in the common economic space* (Yekaterinburg, 2021)
8. M. F. Avezov, D. R. Kulieva, *Selection of sewing needles depending on density and mechanical properties of the material*. International Scientific Conference Dedicated to 135th Anniversary of Professor V.E. Zotikov **Part 1** (Moscow, 2022)
9. D. R. Kulieva, M. F. Avezov, Prospects of using basalt fibers in Uzbekistan. *International scientific conference dedicated to 135 anniversary of professor V.E. Zotikov Part 2* (Moscow, 2022)
10. S. Khurramov, F. Kurbanova, *AIP Conference Proceedings* **2637**, 060004 (2022)
11. S. H. R. Khurramov, G. A. Bakhadirov, A. Abdugarimov, *Izvestiya Vysshikh Uchebnykh Zavedenii, Seriya Tekhnologiya Tekstil'noi Promyshlennosti* **1**, 242-247 (2022)