THE ROLE OF RAW MATERIALS AND TECHNOLOGICAL EQUIPMENT IN KNITTING PRODUCTION

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Abstract. The knitting industry is a relevant branch of light industry, in which [i]elastic, comfortable fabrics are produced based on natural and synthetic fibers [1] [2] . The article analyzes the types of raw materials (cotton, wool, synthetic fibers) in the production of knitwear and their properties. Also, the technical indicators, efficiency and efficiency of technological equipment such as flat and circular knitting machines are compared with numerical parameters. Modern equipment and materials are studied using examples of best practices in the world and Uzbekistan. Based on the results obtained, scientific and practical recommendations are given on the effective use of cotton and other fibers, the introduction of automated knitting technologies.

Keywords: knitting, raw materials, knitting machines, cotton fiber, synthetic fibers, textile technology.

Аннотация. Трикотажная промышленность является важной отраслью легкой промышленности, в которой производятся эластичные, комфортные ткани на основе натуральных и синтетических волокон [1] [2] . В статье анализируются виды сырья (хлопок, шерсть, синтетические волокна) в производстве трикотажных изделий и их свойства. Также проводится сравнение технических показателей, эффективности и производительности технологического оборудования, такого как плосковязальные и круговые вязальные машины, с числовыми параметрами. Современное оборудование и материалы изучаются на примерах передового опыта в мире и Узбекистане. На основе полученных результатов даются научно-практические рекомендации по эффективному использованию хлопка и других волокон, внедрению автоматизированных технологий вязания.

Ключевые слова: вязание, сырье, вязальные машины, хлопковое волокно, синтетические волокна, текстильные технологии.

Annotatsiya. Trikotaj sanoati engil sanoatning tegishli sohasi bo'lib, unda tabiiy va sintetik tolalar asosida elastik, qulay matolar ishlab chiqariladi [1] [2] .avhum. Trikotaj sanoati engil sanoatning tegishli sohasi bo'lib unda tabiiy va sintetik tolalar asosida elastik, qulay matolar ishlab chiqariladi [1] [2] . Maqolada trikotaj ishlab chiqarishdagi xom ashyo turlari (paxta, jun, sintetik tolalar) va ularning xususiyatlari tahlil qilinadi. Shuningdek, tekisavhum. Trikotaj sanoati engil sanoatning tegishli sohasi bo'lib, unda tabiiy va sintetik tolalar asosida elastik,

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qulay matolar ishlab chiqariladi [1] [2] . Maqolada trikotaj ishlab chiqarishdagi xom ashyo turlari (paxta, jun, sintetik tolalar) va ularning xususiyatlari tahlil qilinadi. Shuningdek, tekis va dumaloq trikotaj mashinalari kabi texnologik uskunalarning texnik ko'rsatkichlari, samaradorligi va samaradorligi raqamli parametrlar bilan taqqoslanadi. Zamonaviy asbob-uskunalar va materiallar jahon va O'zbekistonning ilg'or tajribalari misolida o'rganilmoqda. Olingan natijalar asosida paxta va boshqa tolalardan samarali foydalanish, to'qishning avtomatlashtirilgan texnologiyalarini joriy etish bo'yicha ilmiy va amaliy tavsiyalar berilmoqda.

Kalit so'zlar: trikotaj, xom ashyo, trikotaj mashinalari, paxta tolasi, sintetik tolalar, to'qimachilik texnologiyasi.

INTRODUCTION

The knitting industry is an integral part of the modern clothing and home goods market [1] . The elasticity and softness of knitted products are due to the looped yarn, which makes them different from other fabrics [2] . Knitting is currently widely used in the production of sportswear, home goods, and technical fabrics. The knitting industry around the world requires advanced technologies and high-quality materials. Uzbekistan has become one of the largest cotton producers in recent years, and by 2023, it will turn 100% of its cotton into yarn and remove it from export [3] . In addition, about 3,900 circular knitting machines have been installed and put into operation in the country [4] . This is helping to increase the volume and quality of knitted products. The purpose of the article is to analyze the types of raw materials and technological equipment in the knitwear industry, and compare their characteristics with tabular and numerical indicators.

METHODS. The study used a literature review and analysis of available statistical data. National and international sources on knitting and textile technologies were studied. Accurate quantitative data on raw materials and equipment were collected: information on the physicochemical properties of cotton and other fibers, as well as technical parameters of various knitting machines were taken from literature and production reports [5] [6] . Based on this data, appropriate comparisons and tabular presentations were carried out. Also, the experience of Uzbekistan (artists' reports, government publications) was compared with examples of well-known manufacturers in foreign countries (such as Maer & Cie) [3] [7] . The results of the analysis were summarized using tables and diagrams (technical indicators).

RESULTS

Types of raw materials and their comparison: The main raw materials in the production of knitwear are cotton, wool and synthetic fibers. Cotton fiber is

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distinguished by its easy breathability, good moisture permeability (moisture absorption ~ 8.5%) [8] . Cotton has an average breaking strength (15–40 cN/tex) and elongation (6–10%) and is quite elastic [5] [9] . Wool fiber has high elongation (25–45%) and moisture absorption (about 16%) [5] [8] . Synthetic fibers, in particular polyester (recycled nylon), have very high strength (35–60 cN/tex) and elongation (15–30%), but practically do not retain moisture (~ 0.4%) [5] [8] . The following table presents the mechanical and physical properties of the main fibers:

Table 1

Mechanical and physical properties of staple fibers

Raw materials	Fiber type	Strength (cN / tex)	Elongation (%)	Humidity weight (%)
Cotton	| Natural |	15–40[5]	6–10[9]| 8.5[8]	8.5[8]
| Wool	Natural	12–18[5]	25–45[9]|	16.0[8]
Polyester (synthetic)	Artificial	35–60[5]	15–30[9]	0.4[8]

Features of knitting machines: In modern knitting production, flat and circular knitting machines are widely used. Circular knitting machines are particularly productive. For example, the 30-inch (~76.2 cm) circular knitting machine of the Relanit 4.0 UHS model, manufactured by the German company Maer & Cie, operates at a speed of 70 rpm and produces ~1500 kg of staple fabric per day [6] . Another high-performance model is the Maer S4-3.2 R II, which reaches a speed of 39 rpm on a 30-inch circular machine (which corresponds to a speed of ~1.56 m/s) [10] . The Maer OVJA 1.6 EM machine, designed for medical and home textiles, operates at a speed of 24 rpm on a 38-inch (~96.5 cm) diameter [11] . A local example is a 64-system circular knitting machine (needle diameter 500 mm) that produces 1,600 light loops per minute on a 1 m wide fabric [12] . The following table lists several machine models and their technical specifications:

Table 2

Machine models and their technical specifications

Machine (Model)	| Type	| Diameter (cm)	Speed (rpm)	Daily working output (kg)
Mayer Relanit 4.0 UHS	| Round (single)	76.2	70[6]	1500[6]
Maer S4-3.2 R II	Round (single)	76.2	39[10]	-
Maer OVJA 1.6 EM	Round (single)	96.5	24[11]	-

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64-system round car	Round (single)	50.0	25[12]	-

As can be seen from the table, modern machines provide high rotation speeds and large fabric masses [6] [12] . This increases the efficiency of production in the industry. At the same time, very thin needles are used in fine carpet knitwear (for example, for sportswear) that require a high gas (manoz) number (thread density).

DISCUSSION. In world experience, innovations in the knitwear industry initially appear in industrially advanced countries such as Germany and Italy. For example, the machines of the Maer & Cie company with huge production capacity attract attention with their high technical indicators [6] [11] . Also, advanced technologies such as matrix (jacquard) and 3D-printing are used in Europe and Asia. With the emergence of fibers such as protein acrylic in the world , the use of mixed fibers in knitted fabrics has also expanded. In accordance with current trends, research centers and enterprises in Uzbekistan are also engaged in projects aimed at optimizing nanofibers and natural fibers. The knitwear industry is also developing rapidly in Uzbekistan. In recent years, the country's exports of knitwear to the member states of the Economic Union and the Middle East have increased significantly [13] . For example, local knitwear companies are widely introducing cotton and synthetic blended yarns for the production of sportswear and workwear [14] . New modern equipment is being installed due to international cooperation and investments. Therefore, Uzbekistan is now becoming a center in Central Asia for the production of not only raw materials, but also high-value-added products [7] . According to the TextileExpo 2025 exhibition, the knitwear industry is one of the fastest growing and export-oriented sectors of the country, with manufacturers increasing production volumes and introducing new technologies [7]. In foreign experience, automation and digital control systems are widely used in knitting machines. These include unique technologies - computer-aided pattern design, semi-automatic and robotic systems [1] . In recent years, Uzbekistan has also adopted technological modernization programs: through the cluster system, cotton cultivation and textile integration, and innovations are being implemented through the establishment of export-oriented workshops [3] [7] .

CONCLUSION. The main results obtained from the research are as follows. Cotton and other natural fibers are the main raw materials in the production of knitwear, and their high moisture absorption and high elongation properties have a positive effect on the quality of the product [5] [8] . However, synthetic fibers (polyester, acrylic, etc.) are also widely used in accordance with the various needs of knitwear; taking into account their strength and elasticity, the technical and aesthetic properties of the products are optimized. Flat and circular knitting

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machines allow the production of knitted fabrics in various patterns and structures. Modern high-speed machines significantly increase production efficiency [6] [11]. Currently, the textile industry in Uzbekistan has reached the level of a world leader in the processing of domestic cotton [3] . In the field of knitwear, joint ventures and export projects are increasing. In the future, new results can be achieved in the knitwear sector by introducing special types (seamless, 3D knitwear), increasing the use of environmentally friendly fibers, and encouraging the import of high-tech equipment. It is also important to develop quality control, innovative design, and certification systems in accordance with international standards to improve the quality of knitted fabrics in Uzbekistan.

Recommendations and conclusions: It is necessary to improve quality and productivity by combining cotton and synthetic fibers in the production of knitwear, and to master new seamless technologies. The introduction of computer-aided design (CAD) and automatic control systems based on international experience, as well as testing innovative fibers (for example, organic cotton, functional rubber fibers) in the conditions of Uzbekistan, have become urgent issues in recent years. At the same time, it is important to allocate investment in education and personnel training, and research and development for the development of the knitwear industry.

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