THE INVESTIGATION OF WARP KNITTED FABRIC WITH ELASTOMERIC THREAD

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Abstract: *An expansion and improvement of the textile's assortment is received special attention in the face of rapid scientific and technological progress, which is a part of the human society evolution. Therefore, the development of new knits for the prevention and recovery of an anatomical form and a function of the human body is an important issue. To this end, the possibilities of the knitted fabric's manufacture for special purposes, as prevention bandage, are studying. A selection of raw materials is due to the using conditions and to the product properties. The nylon threads are most used for the manufacture of special knitted fabrics. Form stability and extensibility of fabrics is ensured by the introduction into the knitted structure elastomeric threads. They are needed to be securely fastened in the structure without contact with the external layers. In addition the surface of knit fabric should be smooth to avoid any uneven compression of the skin.*
Warp knitted fabrics, which were made on warp knitting crochet machine, have been selected as the subject of studies. Four guide bars are using for producing the samples. One is for chain loops from nylon treads. Second is paving the elastomeric longitudinal thread with a preliminary elongation. Elastomeric longwise threads are providing the necessary strain of knitted fabric. Two other guide bars are laying transverse weft from nylon treads too. They cross-connect the single chains into a fabric and create a smooth surface in addition. The authors have researched the structure parameters and properties of warp knitted fabric. The influence of elastomeric thread on physical and mechanical properties has been established.

Key words*: warp knitted fabric, chain, longitudinal thread, elastomeric thread, structure parameter, strain*

1. INTRODUCTION

An expansion and improvement of the textiles assortment is received special attention in the face of rapid scientific and technological progress, which is a part of the human society evolution. In the modern world it is possible to observe the use of knitted fabrics in almost every area of human life: in engineering, building, automotive, ship and aircraft industry, space technology, medicine, etc.

The use of knitted fabrics in the medical field is steadily expanding. The formation of new knitted materials for using in the bandage for the reconstruction of anatomic form and function of internal organs is an especially actual now. Bandage is a special medical product, which is put on the body for its stabilization, unloading or correction of pathological deformation and is used to restore the body after treatment and during sports for prevention a possible injury. Such product can be further strengthened by additional elastic bands at the front or the back surface depending on the design. Depending on the purpose bandages have a different design to ensure compliance form prophylactic articles of anatomy and function of the human body [1]. Bandages are usually differ by raw materials composition, by color, by degree of hardness, which are not only depend on the constructional features but and on the amount of insertions and on the corset's height.

2. THEORY

Modern market of raw materials, especially polymeric and synthetic fibers, can help meet the growing demand for materials with specific properties. The use an elastomeric yarn, which is capable after charge-discharge cycle to recover its original size and having a breaking elongation more than 100%, in knitted fabric is leading to the establishment of new types of textile fabrics. They have got a feature of extensibility, elasticity, compressive capability for use in a stretched condition. Fabrics containing elastomeric yarn are very stretchable (an elongation of more than 200%) and these properties are

preserved during exploitation. [2]. For the consumer the use of elastomeric threads in the knitwear means an article is a good fit, has dimensional stability and comfort.

The modern market of elastomeric yarn presents the filaments and reinforced threads, which are produced by wrapping an elastomeric core by threads and fibers of different origin [3]. From an economic point of view it is advisable to use elastic monofilaments in knitted fabric, but it is difficult because of their low knit ability, namely the occurrence of considerable friction in feeder and in knitting systems, which may lead to thread breakage [4].

It is known that the elastomeric yarn can be fixed in knit structure as filling or in-laid yarn or can be knitted into a loop [5]. The choosing of a fixing method of the elastomeric yarn is depend on requirements that apply to the preventive goods: the stable fixing, the structures uniformity and the fabric elasticity. Besides, the elastomeric yarn should be positioned inside of the knit structure, in order to avoid its contact with the human body.

The filling yarns are positioned in the structure as additional yarns. When used as such an elastomeric yarns, the elastic properties of the basic interlooping are increase in in-laying direction [6]. It is known that elastic properties of elastomeric yarn are exhibited better when it is inserted into weft knitted fabric. The using of elastomeric yarn as in-lay lets create a fabric with a lower consumption of materials compared to other ways of its fixing.

The stable fixing of elastomeric yarn in the structure is due to the presence of the contact points with the filaments which are forming the basic interlooping. When weft knit structure are used as a basic intelooping it is possible presence of such a defect as a "runaway" of elastomeric yarn in the case of its breaking during the manufacturing of the knitwear. The use warp knit structure as a basic interlooping provides reliable wrapping an elastic thread by loops. Furthermore, the drop of stitch in such structure is smaller than in weft fabric. Most of warp knit structures can not be de-knitted. The necessary flexibility and extensibility of knitted fabrics are caused by the pre-stretching of elastomeric yarns and their relaxation after the removal of the draw-off force.

3. METHODS

The main purpose of this work is to investigate the influence of elastomeric yarn on the structures parameters and properties of warp fabrics. To achieve this purpose warp knit fabric with various conditions of elastomeric yarn in-laying were produced; the structure parameters and the deformation properties of warp knitted fabrics have been investigated.
The standard tests methods were used for experimental research of the properties of elastic warp knit fabrics.

4. RESULTS AND DISCUSSION

Warp knitted fabrics, which are used for the manufacture of medical bandages, have been produced. Taking into account the special requirements four guide bars of 15 gauge Crochet knitting machine have been used. The chain with closed loop is used as the basic interlooping with full drawing of guide-bar. Elastomeric yarn is laid in a walewise direction and is feeding with the extension to ensure the elastic properties of knitted fabrics. Wales of chain loop are connected into the fabric by weft yarns, which are laid on the entire width of the fabric at the different sides of fabric in order to full cover the elastomeric yarn. The linear density of weft yarn is exceeding the linear density of ground yarn for chain in order to create a dense lay which prevents the output of the elastomeric yarns on the surface of the fabric (table 1). In-layed yarn and weft yarns are positioned between the underlap and overlap of chain loop, which is dense wrapped around them and holds them in the structure. Such warp knit structure has high dimensional stability and provides comfort, because elastomeric yarn is located inside of the knitted fabric and has not negative influence on human skin.
It can be assumed that the change in pre-stretching the elastomeric yarn will also change the parameters of the structure and properties of the jersey. In this regard the samples were manufactured warp knitted fabric in which the thread length loop of longitudinal weft was varied on three different

levels (see Table 1) by changing its tension than with a linear density of thread is not changed. It can be assumed that the changes in pre-stretching of the elastomeric yarn will also inflow on the structure parameters and the properties of the knit fabric. In order to study this influence the warp knit fabric has been manufactured with variation of elastomeric yarn feeding tension on three different levels. Linear density of elastomeric yarn is constant. Therefore three variants of warp knit fabric (see Table 1) have different length of elastomeric yarn per course. It can be seen, the length of weft yarn per wale is constant because the weft yarn is laid over the entire width and is uniformly distributed in the fabric structure. The loop length of the chain is changed by 14%: an increase in pre-tension of elastomeric yarn promotes increased consumption of ground yarn.

Table 1: Producing data

Fabric	Linear density, tex			Diameter of in-lay elastomeric thread, mm	Length of yarn per unit, мм			
	Chain	Weft yarn 1	Weft yarn 2		Chain loop	Weft 1 per wale	Weft 2 per wale	In-lay per course
1	18 Nylon	34 x 6 Nylon	34 x 6 Nylon	0,6	7,22	1,68	1,68	0,80
2	18 Nylon	34 x 6 Nylon	34 x 6 Nylon	0,6	7,48	1,68	1,68	0,70
3	18 Nylon	34 x 6 Nylon	34 x 6 Nylon	0,6	8,41	1,68	1,68	0,64

It is can predict that the pre-tension of the elastomeric yarn will change the structures parameters of the warp knitted fabric (see table 2). The loop step is the exception because this parameter depends on gauge of knitting machine first of all. Thus increasing of the elastomeric yarns length promotes an increase of the course height and correspondingly decreases the number of courses per 100 mm, which is 20% in this experiment. At same time the thickness of warp knit fabric decreases that can be explained by a lower degree of the elastomeric yarns relaxation. The chain loop prevents such process. Besides the chain loop moves in structure horizontally under the elastomeric yarns pressure. Decrease in the elastomeric yarn length per course leads to an increase of basic weight.

Table 2: The structure parameters of knitted fabrics

Fabric	Thickness, mm	Number of wale per 100 mm	Number of courses per 100 mm	Loop step, mm	Course height, mm	Basic weight, g/m^2
1	1,58	58	122	1,72	0,82	652,3
2	1,68	58	142	1,72	0,73	709,1
3	1,83	58	151	1,72	0,66	799,8

Feature of the use of such warp knit fabrics is the need to support tensile loads. The processes with an alternation of loading, unloading and rest affect the structure of fabric, which is being deformed and changes the original shape and size. Therefore of considerable interest is to study the mechanical characteristics of the fabrics in a cycle of "tension-discharge-rest". The results of this research are presented at table 3.

Table 3: Deformation properties of knitted fabrics

Fabric	Full stretch	Parts of full stretch, %			Parts' quota		
		elastic	plastic	residual	elastic	plastic	residual
	ε,%	ε_1,%	ε_2,%	ε_3,%	$\varepsilon_1/\varepsilon$	$\varepsilon_2/\varepsilon$	$\varepsilon_3/\varepsilon$
1	85,8	82,9	0,9	2,0	0,97	0,01	0,02
2	114,8	112,7	0,7	1,4	0,98	0,01	0,01
3	115,8	112,7	0,6	2,5	0,97	0,01	0,02

The full stretch of warp knitted fabrics is 85.8 - 115.8%, while the elastic part of it is constitute 97-98%. This means that almost all samples at 2-5 seconds restore its original size and shape. Residual part of full stretch is less than 2.5%. It should be noted, that the change of the elastomeric yarns pre-tension significantly (up to 25%) affects the deformation properties of warp knitted fabric. Reducing the value of full stretch with increasing of elastomeric yarn length is due to more oriented position of chain loop to walewise direction. As result low-extensible interlooping chain prevents the appearance of the deformation properties of elastomeric yarn.

5. CONCLUSION

The use of elastic warp knitted fabrics for the manufacture of bandage products is promising way. Investigations of warp knitted fabric with elastomeric thread showed that the pre-stretching of an elastomeric yarn during the knitting greatly affects the structure parameters and properties of knit fabric. Thus the loop length is reduced with increasing stretching of the elastomeric thread, which leads to an increase of thickness, of loop length of chain and of basis weight. The loops in such structure less oriented in walewise direction therefore the full streight of warp knit fabric increases. It's observed, that the use of an elastomeric yarn in structure provides good formstability of warp knit fabric.

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