

Structures for Woven-Like Knitting Fabrics Made on Circular Knitting Machines

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Abstract — In this article, options for woven-like knitting structures on a crochet basis are considered worked on circular knitting machines. Technical and technological parameters for their production are described. Nine variants to achieve knitting on type of a double-faced and an interlocking basis have been developed. In both groups, sub-variants with the presence or absence of press elements are proposed. The cylinder and disc rows with two types of needles – short and long are presented in tabular form. The all structures were successfully knitted on the circular knitting machine.

Keywords — low elasticity knitting, round knitted fabric, woven-like knitting structure.

I. INTRODUCTION

Knitted fabrics made with a single-face single-thread knit on linear or circular knitting machines with a single needle bed are easily deformed (stretched) in width and length. This means that the stitches have great freedom of movement. The bending resistance of the thread that formed the stitch is negligible and a large slippage is possible at the contact points where the stitches are joined. In longitudinal stretching, the loops lengthen due to the narrowing of their arcs, and in transverse stretching, the loops widen due to the shortening of their hips [1]-[3].

Single-thread double-face knits can have a completely identical or different appearance on both sides. This depends on the combination of the front and back stitches when knitting. The two types of stitches are arranged in

separate stitch columns and in the knitting one or more front stitches alternate with one or more back stitches. Such knits have a high compressibility in width, which is why in a relaxed state two adjacent front stitches (when alternating one front stitch with one back stitch) touch and cover the back stitch knitted between them. As a result, only the front stitches remain visible on both sides of the knitting, with the back stitches being hidden between them. However, when the knitting is stretched, the back stitches between the front stitches are also revealed [4]-[6].

In knitted fabrics made in a smooth double-faced single-thread knit on double-row circular knitting machines, the number of stitches along the width of the fabric is doubled. As a result, a thread of a correspondingly longer length is incorporated into them, which allows for greater stretching of the fabric and from there – of the product made from this fabric. In order to knit the stitches easily, the following general rule must be observed when pulling and shaping them - when a needle begins to push the thread caught by its hook through the old stitch, the opposite needle adjacent to it must already have pushed and pulled its stitch. By following this rule, the goal is to prevent two or more needles from simultaneously being in the position of threading and pulling the thread, because this would make knitting difficult on the one hand, and on the other hand, the thread itself is subjected to tension and friction in a couple of needles, which leads to increased fragility during knitting.

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Knitting in which the stitches are drawn in and out of the two rows of needles alternately is called sequential knitting. Sequential knitting without welding multiple needles in simultaneous knitting is only done on coarser machines, where the needles are spaced farther apart [7], [8]. As a rule, this knitting principle is applied on linear knitting machines (with a maximum fineness class of E12).

On finer machines, such as modern large-diameter circular knitting machines (with fineness class E16 - E32), sequential knitting is not suitable, since many needles will always be overlapped during the knitting process. As a result, uneven knitting, thread breakage, etc. will result. Therefore, on finer machines, knitting from both rows of needles is done in the so-called distributive way. Knitting in this way is done twice. First, the needles from one row knit their stitches, while the needles from the other row only catch the thread. After a few stitches from the first row of needles have been knitted, the needles from the second row thread and knit their stitches. Since a thread is needed to knit these stitches, and the thread guide has already passed, the thread is taken from the opposite previously knitted stitches, which are pulled out significantly longer for this purpose. In this way, the stitches on both rows of needles are aligned, the thread is distributed equally between them and the knitting becomes more uniform. With this knitting, much denser knits can be obtained than with sequential knitting.

There are two possible needle arrangements on a circular knitting machine:

1) elastic, sometimes called in practice “*crochet*” – when a cylinder needle lies in front of a rib on the disc or opposite – „rib against needle“;

2) interlock – when the mutual arrangement of the cylinder and the disc is such that their needle distribution is “needle against needle”.

Interlock circular knitting machines are loaded with short and long cylinder needles and with short and long disc /rip/ needles, the normal loading being interlock, i.e. needle against needle. In addition, rip needles /short and long/ can be with low and high heels. In this case, all the channels of the cylinder are the same and the loading is unlimited, while the disc long needles are through one, i.e. the standard loading is “short-long”.

Despite this specificity, which largely limits the sampling possibilities, the loop formation process is the same as in other circular knitting machines. It is carried out by both rows of needles and, as already mentioned, the knitting principle is distributive.

To reduce the stretchability of double-faced single-thread knits, it is often necessary to exclude needles in one or both needle beds. The knitted fabrics thus obtained have reduced elasticity and successfully replace a number of woven fabrics.

The term “fabric-like knits” was originally used for plain interlock fabrics made of wool, later it was used for double-face knits with single-face rows, for double pique, for single pique and “*texi-pique*” structures made of any

material suitable for outerwear [9]. The term is also used for colored double relief jacquard and “*cloquet*” type fabrics. The general name “fabric-like knits” is applicable to cross-knit fabrics made on a double-face or interlock basis, the construction of which is designed to reduce the natural extensibility of the structure [10].

Knitted fabrics for outerwear and sportswear are of particular interest. The development of this part of knitwear production is determined by the following factors: favourable loop structure, properties of the processed material, modern technical solutions in dyeing and finishing, high productivity and small installation area, leading to a small number and low capital investment, expanded sampling capabilities of modern circular knitting machines, etc.

With the mass introduction of high-performance modern circular knitting machines into knitwear production, the question of the optimal use of synthetic and natural raw materials, i.e. their appropriate combination both in share participation and in suitable knitted structures, is relevant. Double-row circular knitting machines have a wide range of options for manufacturing two-component two-layer circular knitted fabrics in fabric-like knits. In two-layer circular knitted fabrics, the inner layer is made of cotton and cotton-type yarns, and the outer layer is made of synthetic textured silks. The fabrics produced by this technology have extremely high hygiene and performance indicators. This group of knits is called fabric-like, due to the alternation of single-face and double-face rows, in which some of the stitches are extended and provide stability in the direction of the stitch column, and the presence of underlays - in the stitch row. The use of synthetic silks also provides good dimensional stability with appropriate finishing.

Characteristic features of these settings are the relatively high material consumption (220 – 300 g/m²) and residual shrinkage along the stitch column (e.g. up to 12% for PA-s). The increased specific area density is primarily due to the lower classes machines on which these settings are worked (E18 and E20) on the one hand, and the linear density of the raw materials used – cotton 20*tex* and 25*tex*. The high residual shrinkage depends in principle on two factors: the tendency of the hips of the press stitches to open and deform the stitches supporting them and the heat setting of the synthetic component. It should be known that the polyester component is fixed better than the polyamide one.

The aim of this article is to present the possibilities for obtaining some fabric-like knits on a *crochet* basis, made on circular knitting machines. In this way, it is possible to optimally select an option for the production of knitted fabric according to the specifics of its purpose.

II. MATERIALS AND METHODS

Fig. 1 and Fig. 2 show relatively mass-produced two-layer fabrics in a fabric-like knit on a double-faced base with and without fang elements and alternative knitting of the rip needles. The thread feeding schedule is: the odd systems (first and third) knit with cotton (P) 100%, and the

even ones (second and fourth) – with textured polyamide silk (PA-s).

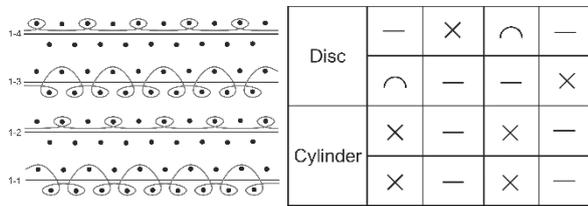


Fig. 1. Fabric-like knit on a double-faced base.

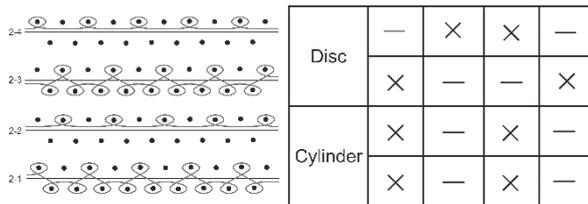


Fig. 2. Fabric-like knit on a double-faced base with fang elements.

Fabric-like knits, in addition to the property of reduced stretchability, also allow for the placement of materials in different planes of the fabric. The so-called two- and more layered effect is obtained. This is due to the presence of single-face and double-face stitch rows, in which the material with a higher linear density is knitted in single-face rows. This specificity of the structure determines a significant improvement in the physiological hygienic qualities that are crucial for sports products. There are two main groups of fabric-like knits: on a double-face crochet base and on a double-face interlock base. Each of these groups has numerous derivatives depending on the ratio of single-face and double-face rows in the repeat, the sequence of knitting the needles and the presence of fang elements. Variation with these parameters affects the performance of the knitted fabric. Taking these influences into account, the following knitting structures were selected for experimentation:

A. On a double-faced basis:

1) with press elements

a) with successively alternating double-faced one-sided half-thinned on the reverse side stitch rows and single-faced reverse stitch rows with successive knitting of the disc needles – Fig. 1.;

b) with successively alternating double-faced one-sided half-thinned stitch rows with alternative knitting of the disc needles – Fig. 2.;

2) without press element:

a) with successively alternating double-faced one-sided half-thinned on the reverse side stitch rows with alternative knitting of the disc needles – Fig. 3.;

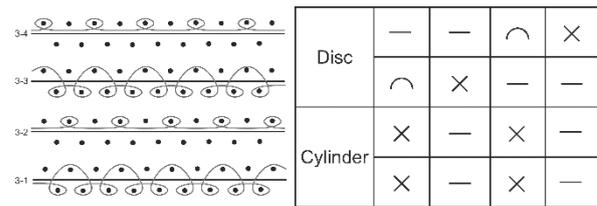


Fig. 3. Fabric-like knit with press elements.

b) with successively alternating double-faced one-sided half-thinned on the reverse side stitch rows and single-faced reverse stitch rows with successive knitting on the disc needles – Fig. 4 and Fig. 5;

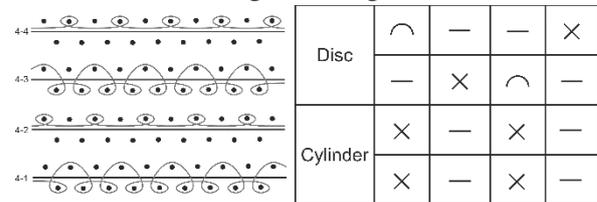


Fig. 4. Fabric-like knit with press elements.

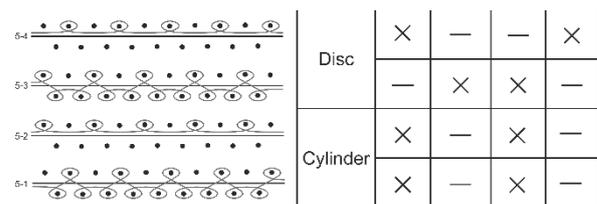


Fig. 5. Fabric-like knit with press elements.

B. On an interlock basis

1) with press elements

a) with alternating interlock rows, semi-raised single-faced reverse rows and one-sided press needles – Fig. 6.;

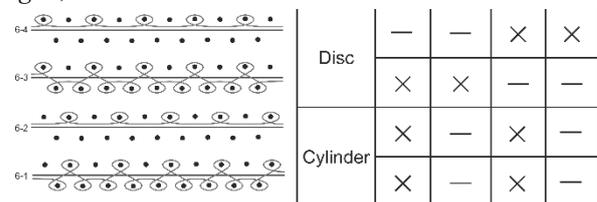


Fig. 6. Fabric-like knit on interlock basis with press elements.

b) with alternating interlock rows, semi-sparse single-faced reverse rows and single-sided press interlock rows with sequential knitting of the disc needles – Fig. 7.;

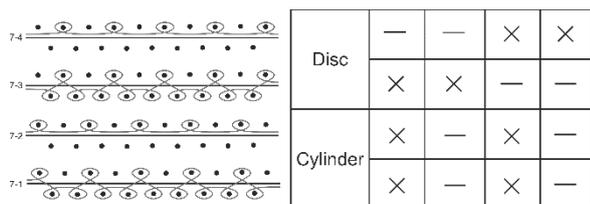


Fig. 7. Fabric-like knit on interlock basis with press elements.

2) without press elements:

a) with alternating interlock rows and half-thinned single-face reverse rows with sequential knitting of the disc needles – Fig. 8;

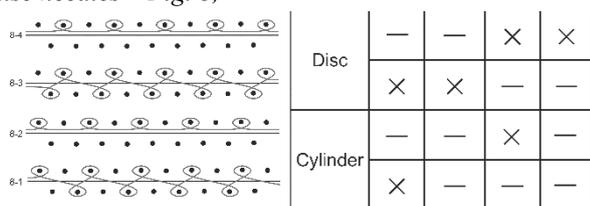


Fig. 8. Fabric-like knit on interlock basis without press elements.

b) alternating two interlock rows and single-faced, reverse, semi-spaced rows – Fig. 9.

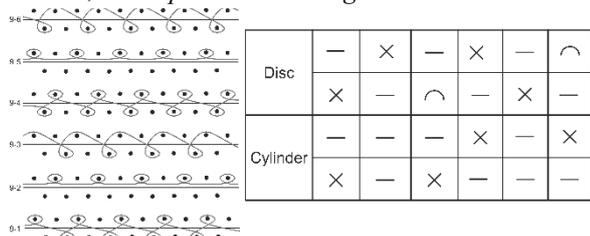


Fig. 9. Fabric-like knit on interlock basis without press elements.

It should be noted that the design of the structural parameters of fabric-like knits, based primarily on geometric models, is inapplicable to these multilayer composite knits. The main reason for this is the simply interaction between the elements of the structure, which determines their shape and mutual arrangement in the repeat.

III. RESULTS AND DISCUSSION

The knitted structures shown in Fig. 1 – Fig. 9 were successfully knitted on the circular knitting machine “Multikarat” E20, 30”, 48f. Several clarifications should be made for the listed knits. The selected technological equipment allows for easy and convenient sampling, especially when choosing cylinder needles. They can be selected in any order due to the presence of additional selection levers and selectors in the appropriate spacing. The most convenient in this case is the sequential loading of the selectors. In addition, the needles can be raised

(working or knitting position), half-raised (press or fan position) or not work. A combination with the capabilities of the selectors and the functions of the individual system is also possible (e.g. conditionally odd ones to knit, and even ones to fang, or in another order). In tabular form, the figures are presented with the cylinder and disk rows with two types of needles – short and long, respectively cylinder and disc. This is the standard arrangement in most circular knitting machines. Regarding the needle arrangement – crochet and interlock: all machines, except for strictly interlock ones, are usually fixed in crochet arrangement. In this position, they can produce both types of knits. This is because the transfer from one needle arrangement to another is associated with precise machine centering, especially when increasing the fineness of the machine.

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