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THE BEHAVIOUR OF THE 2:2 RIB STRUCTURES MADE OF 100% COTTON YARNS, NM 40/1, AFTER KNITTING PROCESS

SZABO Monica, MULLER Valentin, BARBU Ionel, JITARU Laurenţiu

Aurel Vlaicu University, Engineering Faculty, AIITT Department, Revolutiei, 77, 310130, Arad, Romania

Corresponding author: Ionel Barbu, ionelbarbu@yahoo.com

Abstract: *Researches made on the 2:2 rib structures have demonstrated that for obtaining knits with maximum dimensional stability it is necessary that in their structure to be introduced tensions with the lowest values, structures to balance dimensionaly from the relaxation phase after knitting, and the dimensional modifications on the stitch course direction and stich course in vertical direction to be minimum. It is well-known that the 2:2 rib structures are relatively unstable form dimensional point of view due to the rib platinum loop, in a different plan from the two plans of the knit, and also due to the small number of thread-thread contact points with consequences on the relatively high sliding of the yarns in the structure. The influence of the technological knitting process is imposed by the correlation of the processed yarn characteristics, together with the technical characteristics of the knitting machines, with the technological parameters of knitting operation and with the structural parameters of knitted fabrics which are to be obtained.*
The study concerns the dimensional changes of the 2:2 rib structures during relaxation after knitting. The dimensional changes are analyzed in their complexity, both on the stich course direction and also on the stich courses in vertical direction, proposing a mathematical model for the study of these changes.

Key words: *2:2 rib structure, dimensional stability, relaxation of the knits, technological parameters of the knitting operation*

1. INTRODUCTION

The issue of the dimensional stability of knitted fabrics is a complex one. In order to obtain knitted fabrics wish a good dimensional stability, and due to the fact that the dimensional changes are within ±2%, it is necessary the involvement of several factors, starting with the yarns form which the knitted fabrics are produced and finishing with the relaxation processes, where can actually be found the data related to the dimensional stability [1]..

The influences of the quality yarns on the dimensional stability of the knitted fabrics is given by the obtaining process of these and by the quality of the fibres from which the yarns are spin [2,3].

The influence of the technological knitting process is imposed by the correlation of the processed yarn characteristics [4], together with the technical characteristics of the knitting machines, with the technological parameters of knitting operation and with the structural parameters of knitted fabrics which are to be obtained [5,6,7].

2. MATERIALS AND METHODS

2:2 Rib knitted fabrics made of yarns with 40/1 metric count of yarns made of 100% cotton yarns were made on circular knitting machines with large diameter MAYER & CIE TIP FV-20. The technical characteristics can be found in table 1.

Table 1. *Technical characteristics of the knitting machine MAYER & CIE TIP FV-20*

Crt. no.	Type of knitting machines	**Technical characteristics of the knitting machines**				Yarn type	Metric count of yarn [Nm]	Fabric structure
		Needle bar diameter [“]	Finenss [E]	Number of systems	Number of needles			
3	MAYER & CIE TIP FV-20	20”	16E	42	2x1008	100% cotton	40/1	rib 2:2

The structures undergoing researtch were detailed analyzed, and the rezults of the practical determination were statistically processed. For the statistical processing of the results, for all the knitting structures, was proposed am experimental program with two variables x1 and x2, which represent the entry data (x1 – represents the wale density on the knitting machine[stitches/cm], and x2 – represents the turn of the needle bar [rotations/minutes]).

There were determined the coefficients of regression ecuation, the ecuations were writtens and the response surface was graphically represented for each case, as well the sections through the response surface. After knitting process, the 2:2 rib structures were put in folded position for relaxation 24 hours in standard condition.

There have been studied the dimensional changes which have appeared after the relaxation process. To determine the influence of the knitting parameters on the dimensional change, it was established a mathematical model of correlation between contraction during relaxation which is considered as a dependence variable (response) and the wale density and the turn of the needle bar, which are considered independent. The proposed program is a central mathematical rotatable model composed by two variables. The meaning of the coefficients was tested with test T, and the adequacy of the coefficients with test Student.

In table no.2 are represented the encoded and real values for the independent variables, and also the responses for the 2:2 rib structure made of 100% cotton yarns, with metric count of yarn 40/1.

Table 2. *Real and coded values of variables*

Crt. No.	x_1 enclosed	x_2 enclosed	Wale density [stitches/cm] (x1 real)] (x_1 real)	Turn of needle bar [rot/min] (x_2 real)	Dimensional changes during relaxation on stitch course direction [%]	Dimensional changes during relaxation on stitch course in vertical direction [%]
1	-1	-1	8,79	22,92	-5,30	-5,10
2	1	-1	10,20	22,92	-3,20	-3,50
3	-1	1	8,79	37,07	-5,80	-5,60
4	1	1	10,20	37,07	-3,50	-3,60
5	-1,414	0	8,50	30,00	-6,90	-6,50
6	1,414	0	10,50	30,00	-2,90	-3,90
7	-1	-1,414	9,50	20,00	-4,40	-4,50
8	1	1,414	9,50	40,00	-5,30	-4,90
9	0	0	9,50	30,00	-5,10	-4,20
10	0	0	9,50	30,00	-4,75	-4,50
11	0	0	9,50	30,00	-4,60	-4,80
12	0	0	9,50	30,00	-4,50	-4,70
13	0	0	9,50	30,00	-5,20	-4,30

Study on the dimensional changes on stitch course direction during relaxation in raw condition for the 2:2 rib structures made of 100% cotton with metric count 40/1.

The regression equation which describes the relaxation process of 2:2 rib structure made of 100% cotton with metric count 40/1, on stitch course direction is given by the following relation:

$$f(x,y) := -4.83 + 1.257\cdot x + 0.071\cdot y - 0.259\cdot x^2 + 0.096\cdot y^2 + 0.05\cdot x\cdot y \quad \textbf{(1)}$$

In fig. 1. there are presented sections through response surface, which represents the dependence y= f(x1, x2), for the relaxation shrinkage on stitch course direction for 2:2 rib knitted fabrics studied.

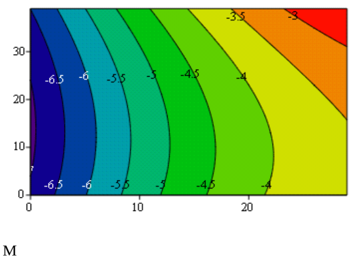

Fig. 1*: Sections through response surface in the relaxation shrinkage, on stitch course direction, for the 2:2 rib structures made of 100% cotton yarns, Nm 40/1*

From the graphic representation from fig.2, results that: the level curves represent parts of hyperbolas; while the wale density increases, the relaxation shrinkage decreases; the structures have different behavior in the area of higher desity compared to the ares of lower desity; in the areas of lower densities, the level curves represent a maximum point of contraction, while in the area of higher densities the relaxation shrinkage is descending.

In fig. 2 is represented the dependence of y=f(x1) for x2=constant.

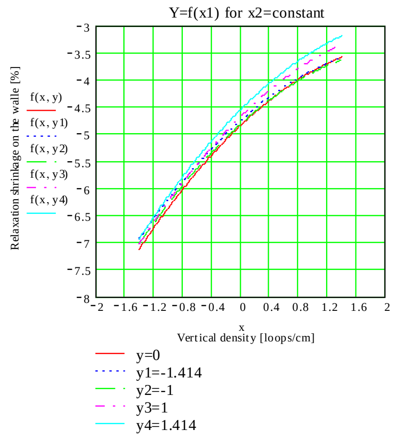

Fig.2*: Variation of y=f(x_1) pentru x_2 constant in case of dimensional changes after relaxation, on stitch course direction, for the 2:2 rib structures, made of 100% cotton yarns Nm 40/1*

From the graphic analyze from fig.2 results that: together with the increase of wale density, the shrinkage relaxation decreases; the decrease of the shrinkage relaxation is more intense in the area of high densities than in the area of low densities; the switch from one level to another is made easier in the area of high densities than in the area of low densities;

In fig. 3 is represented the dependence $y=f(x_2)$ for (x_2) constant.

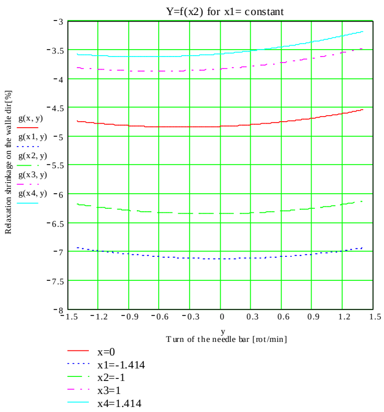

Fig. 3: *Variation $y=f(x_2)$ pentru x1 in case of dimensional changes during relaxation, in the direction of vertical stitches courses, for 2:2 rib strucutres made of 100% cotton yarns, Nm 40/1*

From the graphic analyze from fig.3, results the following:

- The relaxation shrinkage on the stich course direction for the studied structure, varies in lower limits together with the turn of the needle bar;
- For the higher turns of the needle bar, the shrinkage relaxation modifies within [0-0.5%];
- Due to the variation of the turn of the needle bar, there are obtained variations of the shrinkage relaxation, which are lower than through wale density variation across the field.

Dimensional changes study on stitch course in vertical direction, during relaxation in raw condition, for the 2:2 rib structures, made of 100% cotton yarns, Nm 40/1

The regression ecuation which describes the relaxation process of the 2:2 rib knitted fabrics made of 100% cotton, 40/1 metric count of yarn, on stich course in vertical direction is given by the following relation(2):

$$f(x,y) := -4.5 + 0.91\cdot x - 0.225\cdot y - 0.146\cdot x^2 + 0.025\cdot y^2 + 0.1\, x\cdot y \quad \textbf{(2)}$$

In fig. 4 are represented the sections through response surface, which is the dependence $y=f(x_1, x_2)$, in the shrinkage relaxation situation, on stitch course in vertical direction for the 2:2 rib knitted fabrics studied.

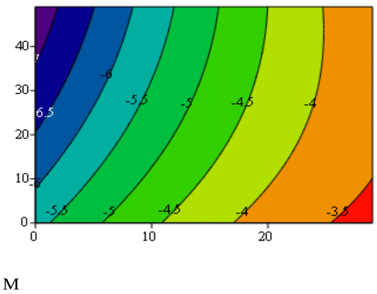

Fig.4*: Sections through response surface in shrinkage relaxation situation, on stitch course in vertical direction, for 2;2 rib structures structures, made of 100% cotton, 50/1 metric count of yarn*

From the graphic representation of sections through surface response from fig. 5, results that: together with the increase of wale density, the shrinkage relaxation on stich course in vertical direction decreases; the level curves present the same evolution on the entire variation files of the wale density; on entre variation field of wale density, it can be observed that shrinkage relaxation appear on the stich course in vertical direction, and in no situation is with elongation.

In fig.5 is represented the dependence $y=f(x_1)$ for x_2=constant.

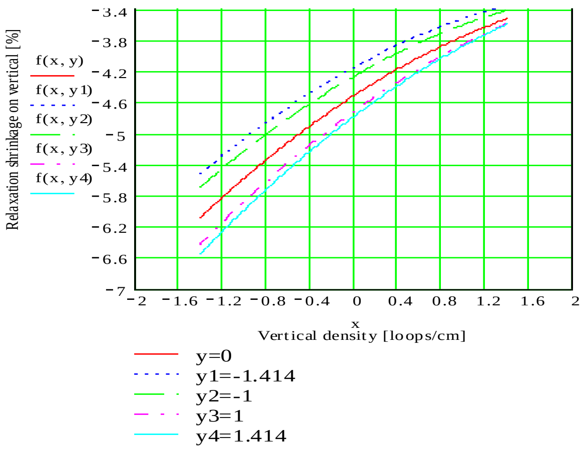

***Fig.5**: Variation Z=f(y) for x=constant in case of dimensional changes during relaxation, on stitch course in vertical direction, for the 2:2 rib structures, made of 100% cotton yarns, Nm 40/1*

From the graphic representation form fig. 6 results the following: the wale density has a determinant influence on the relaxation shrinkage in the stich course in vertical direction, for the 2:2 rib structures studied; together with the increase of the wale density, the shrinkage relaxation decreases with real values of –6,6% to –3,4%; the influence of the wale density is higher in the lower density area and decrecreases in the high density areas.

In fig. 6 is represented the dependence $y=f(x_2)$ pentru x_1=constant

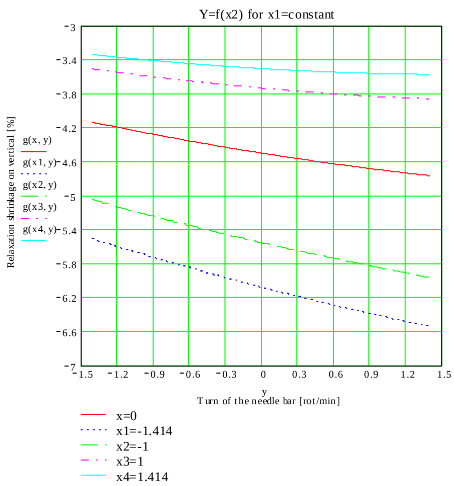

***Fig.6**: Variation $y=f(x_2)$ pentru x_1 in case of dimensional changes during relaxation on stitch course in vertical direction, for 2:2 rib structures made of 100% cotton, 40/1 metric count of yarn*

From the graphic anlayze from fig.6 results that: the turn of the needle bar influences in a lower manner the shrinkage relaxation of 2:2 rib structures; the shrinkage relaxation on the stich course in vertical direction for the 2:2 rib knitted fabrics studied, increases together with the increase of the turn of the needle bar, which is a big disadvantage; the influence of the turn of the needle bar on the shrinkage relaxation is stronger in the sections with lower turns and decreases together with the decrease of this.

3. CONCLUSIONS

1. After the relaxation of the knitted fabrics, after the knitting procces, there can be observed, mostly elongations on the stitch course direction and cotractions on the stitch course in vertical direction.
2. All processes within a technological process must be conducted with minimum stress finishing of knitted fabrics because any tension inserted can relax only partially after each stage of the process flow.
3. The program is designed such in a matter, that the dimensional changes after knitting, finshing and knitting relaxing can be foreseen, depending in the wale density values and turn of the needle bar, for the kntting machines on which the structures were made.
4. The originality of the porposed program consists in the fact that can be obtained knits with the same dimensional stability, by modifing the wale density on the knitting machine, or the turn of the needle bar.
5. The results have practical effects, because knowing the technical characteristics of the knitting machine, the turn of the needle bar, the finess of the 100% cotton yarns, the wale density on the knitting machine, there can be determined the dimensional changes of the knits after knitting process.

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