ISSN 1392–1320 MATERIALS SCIENCE (MEDŽIAGOTYRA). Vol. 18, No. 4. 2012

The Influence of Stabilisation on the Structure of Knits and Tensile Properties of Their Yarns

Rasa TREIGIENĖ [*], Ginta LAURECKIENĖ

Department of Textile Technology, Kaunas University of Technology, Studentų 56, LT-51424 Kaunas, Lithuania

http://dx.doi.org/10.5755/j01.ms.18.4.3096

Received 24 May 2011; accepted 01 December 2011

Plated jersey knits of different composition were knitted and stabilised under hydrothermal conditions of 85 °C for 10, 20 or 30 min in steam ambience. The influence of stabilisation duration on knit structure was estimated as well as change of mechanical properties of the yarns. The obtained data show that 10 min of stabilisation influenced markedly the structure of plated jersey knits comparing with the same effect of 20 min and 30 min. The results of specific breaking force of polyester, cotton and wool yarns show decrease in their strength due to knitting and hydrothermal stabilisation processes.

Keywords: hydrothermal stabilisation, plated jersey knit, stitches density.

1. INTRODUCTION

The changes of knit dimensions during wear or care can create major problems. Some appropriate finishing processes and suitable conditions are used to avoid this negative change.

High temperature and long pressing duration seem to have a positive effect on sock dimensional stability but long exposure to high temperature can cause serious damage to textile fibe such as cotton yellowing. Pressing at low temperature preserves textile fibre but leads to incomplete relaxation and stabilisation of the socks [1]. The alternative to heat setting is steam that may be the best solution. The segment mobility of the polymer chains is substantially increased by the presence of water [2].

It is rarely possible to achieve perfect setting but an acceptable degree of stability to garment making, wear and washing can be attained [3]. The shrinkage value of ready to use knitted fabric must not exceed 3 % [4]. The type of material, the liner density of the yarns, the type of fabric pattern, the tightness factor, finishing processes and their complex can have a principal value to cotton knitted fabric shrinkage index [5].

The mechanical properties of weft knitted fabrics are strongly related to fabric structure and tensile properties of yarns from which they are manufactured [6, 7]. It is known that after knitting and finishing processes the yarns change their physical-mechanical properties [8 – 10]. Knitting causes some mechanical deterioration of the yarns and changes in their tensile characteristics were observed [7].

The aim of this work was to establish the influence of stabilisation duration on plated jersey knit structure as well as change of mechanical properties of their yarns. The results of investigations can help to predict the duration of stabilisation at which dimensions of knits stay stable. Moreover, this would help to avoid excessive expensive use of heat energy and time.

2. EXPERIMENTAL

Materials. The plated yarn for all investigated knits was compound of elastane (2.2 tex) and PA6.6 (8.8 tex). The linear density of such EL/PA yarn was 10 tex. Face yarn for 1st knit was 25 tex PES black (Dacron®) yarn, for 2nd knit was 25 tex PES white (Coolmax®) yarn, for 3rd knit was 25 tex PES beige (Dacron®) yarn, for 4th knit was 29.4 tex cotton black yarn, for 5th knit was 29.4 tex cotton white yarn, for 6th knit was 33.3 tex wool black yarn, for 7th knit was 33.3 tex wool white yarn. Respectively face yarn of 1st knit is denoted as 1st yarn, of 2nd knit as 2nd yarn and so on. The latter denotes are used in 3.2 part of this paper there are presented the results of tensile properties of the yarns. Cotton and wool yarns were pure and combed. All knits were knitted on a Sangiacomo Fantasia 2C, 36 gg, 3”3/4 diameter 156 needles socks knitting machine at the same knitting conditions.

Procedures. All plated jersey knits were stabilised under hydrothermal conditions of 85 °C for 10, 20 or 30 min in steam ambience in autoclave device. Stabilised samples were cooled and dried 24 h in room conditions in a flat state.

Tests. All knits before structure measurements and tensile properties tests were kept under standard textile testing conditions of 20 °C ±2 °C and 65 % ±2 % relative humidity for 24 h. The structure parameters, such as course P_v (cm^{-1}) and wale P_h (cm^{-1}) densities were estimated (LST EN 14971 standard) and stitches density Sd (cm^{-2}, product of P_v and P_h) was calculated for knits before (0 min) and after stabilisation (10, 20, 30 min) procedures. Coefficient of variation of all knits mentioned structure parameters didn't exceed 5 %. Stitches density change (Std, %) of knits upon the stabilisation time was calculated using the following equation:

$$Std = \frac{Sd_{tr} - Sd_0}{Sd_0} \cdot 100\,\% , \qquad (1)$$

where Sd_0 is the stitches density (cm^{-2}) before further treatment; Sd_{tr} is the stitches density (cm^{-2}) after treatment.

[*]Corresponding author.Tel.:+370-37-300218, fax: +370-37-353989, E-mail adress: *rasa.treigiene@ktu.lt* (R. Treigienė)

The tensile properties of initial yarns (initial) and yarns obtained after deknitting only (0 min), deknitting and stabilisation (10, 30 min) were tested. The tests were carried out according to LST EN ISO 2062, 1995 standard using ZWICK/Z005 testing equipment. Specific breaking force change (*Sbf*, %) of the yarns due to knitting and stabilisation procedures was calculated using the following equation:

$$Sbf = \frac{Sbf_{tr} - Sbf_0}{Sbf_0} \cdot 100\,\%, \qquad (2)$$

where Sbf_0 is the specific breaking force (cN/tex) before further treatment; Sbf_{tr} is the specific breaking force (cN/tex) after treatment.

The positive values of stitches density change or specific breaking force change indicate an increase in density or breaking force after treatment. The negative values represent a decrease of mentioned parameters after treatments. The coefficient of variation of specific breaking force of all yarns didn't exceed 5 %.

3. RESULTS AND DISCUSSION

3.1. Knits structure changes

The data presented in Fig. 1 show the influence of stabilisation time on stitches density of PES/EL/PA knits. It is evident that after 10, 20 and 30 min of stabilisation knits became more denser comparing with that unstabilised (0 min) one. 10 min of stabilisation (0 min – 10 min) had the utmost effect of all studied stabilisation times on stitches densities of mentioned knits. 10 min of stabilisation increased densities of knits in 20 % – 22 % (Fig. 2). As the literature [2] indicates saturated steam at 110 °C – 140 °C, according to the fibre to be set, gives uniform setting in 10 minutes.

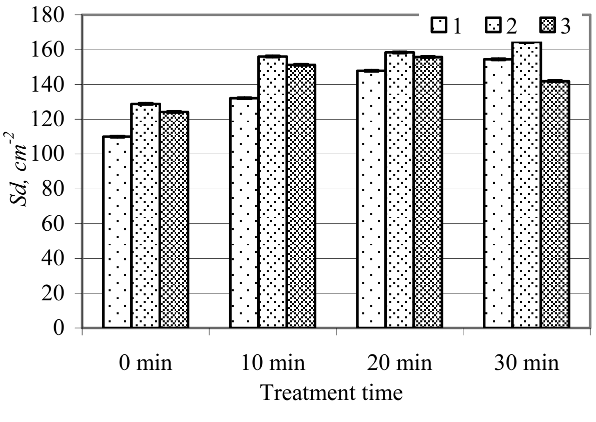

Fig. 1. The influence of stabilisation time on stitches density of PES/EL/PA knits: 1 – 1st knit, 2 – 2nd knit, 3 – 3rd knit

Very similar effect of 10, 20 and 30 min of stabilisation was noticed and for cotton/EL/PA plated jersey knits (Figs. 3 and 4). Stabilisation made stitch wales and rows closer to each other, therefore stitch length reduced and stitch density or fabric area density increased. Cuden, Srdjak et al [10] investigated stitch deformation of Lycra® plated plain knitted fabric during relaxation process. The researchers made the conclusion that the increase of fabric weight during relaxation is due to an increase of fabric wales and course densities. Very similar tendencies noticed and Tezel et al. [11].

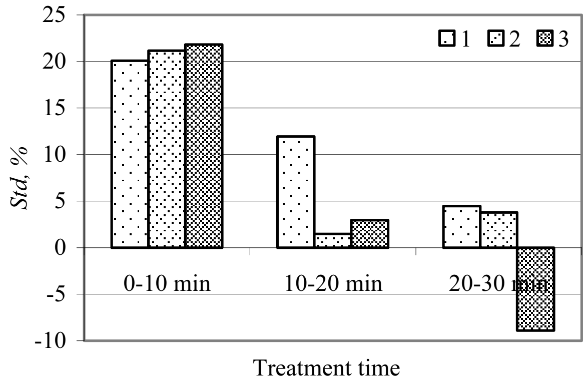

Fig. 2. The effect of treatment on PES/EL/PA knits (marked as in Fig. 1) density change

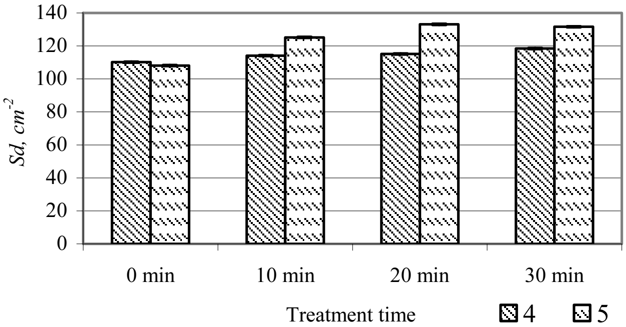

Fig. 3. The influence of stabilisation time on stitches density of cotton/EL/PA knits: 4 – 4th knit, 5 – 5th knit

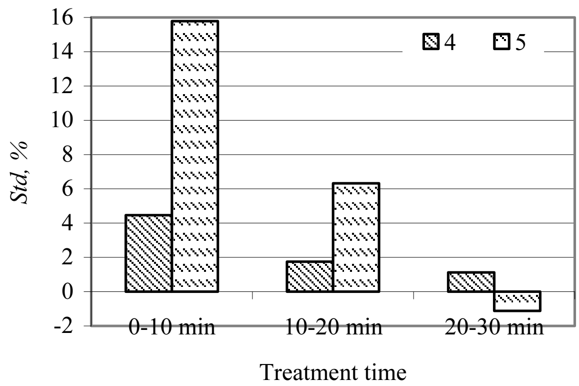

Fig. 4. The effect of treatment on cotton/EL/PA knits (marked as in Fig. 3) density change

The densities of wool/EL/PA plated jersey knits were influenced of stabilisation time as well (Figs. 5 and 6). The same utmost effect of 10 min of stabilisation was noticed. Wool knits during these first 10 min of stabilisation changed their densities and therefore they shrunk in 20.5 % – 21.9 %. However after 20 min of stabilisation stitches densities of both investigated knits decreased and after 30 min increased again in 8 % – 5 %.

Our obtained results were similar to results of other researches [1] which estimated that wool socks (66 % wool, 32 % PA, 2 Lycra®) exhibited shrinkage in 22 % after pressing operation.

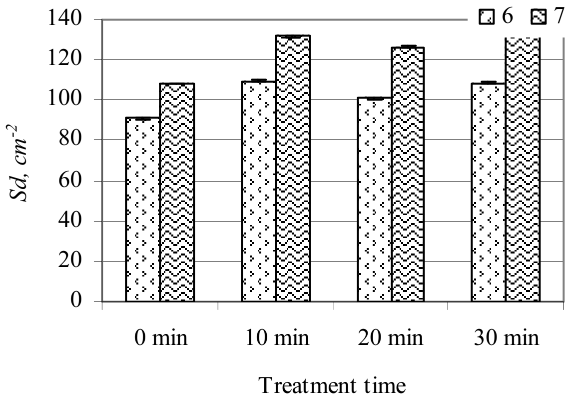

Fig. 5. The influence of stabilisation time on stitches density of wool/EL/PA knits: 6 – 6th knit, 7 – 7th knit

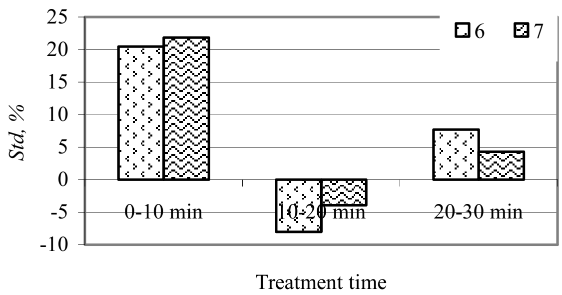

Fig. 6. The effect of treatment on wool/EL/PA knits (marked as in Fig. 5) density change

3.2. Tensile properties of the yarns

The data of specific breaking force of special PES yarns are presented in Fig. 7. The obtained results show the high specific breaking force of initial PES yarns. The knitting process affects the tensile properties of the yarns. The yarns were stressed and had friction to parts of knitting machine during knitting therefore it was noticed deterioration of specific breaking force due to knitting (0 min) comparing with that of initial yarns (Fig. 8). It was noticed a positive effect of 10 min of stabilisation onto specific breaking force because the values of specific breaking force change of 1st and 3rd yarns increased accordingly in 28.5 % and 17.5 %. However the 30 min of stabilisation had the negative influence on the values of specific breaking forces of all PES yarns.

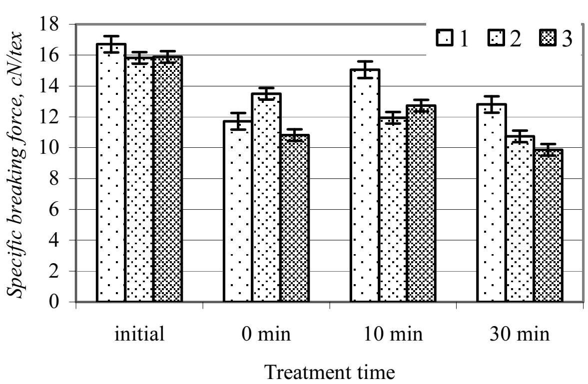

Fig. 7. The influence of treatment on PES yarns specific breaking force: 1 – 1st yarn, 2 – 2nd yarn, 3 – 3rd yarn

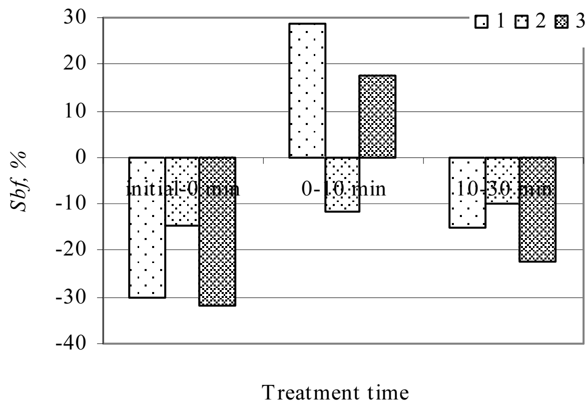

Fig. 8. The influence of treatment on PES yarns (marked as in Fig. 7) specific breaking force change

The data presented in Figures 9 and 10, show the effect of knitting and stabilisation processes on the cotton yarns breaking force and it changes. The highest (*ca.* 30 %and 17 %) deterioration of specific breaking force was estimated for cotton yarns after knitting (initial – 0 min). 10 min of stabilisation decreased tensile parameters as well but this reduction was not so significant as it was due to knitting (0 min).

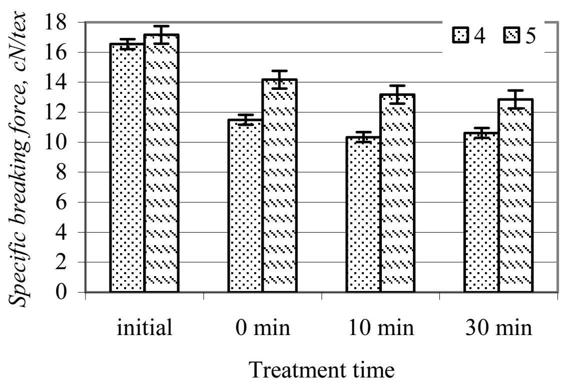

Fig. 9. The influence of treatment on cotton yarns specific breaking force: 4 – 4th yarn, 5 – 5th yarn

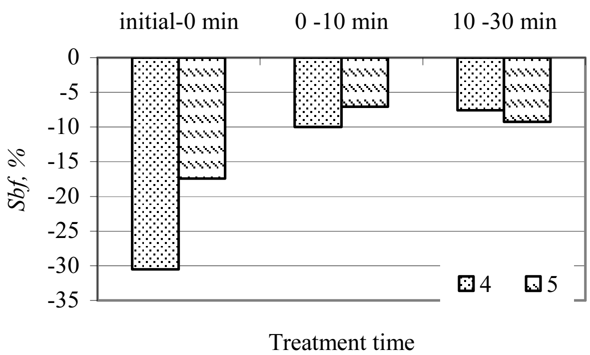

Fig. 10. The influence of treatment on cotton yarns (marked as in Fig. 9) specific breaking force change

Wool yarns felt some deterioration of specific breaking force during knitting and stabilisation as well. This show the data presented in Figures 11 and 12.

The strength of wool/acrylic (50/50 %) and cotton/acrylic (50/50 %) blended yarns was tested in [7].

The researchers made a conclusion that after knitting tested wool/acrylic and cotton/acrylic blended yarns lost their breaking strength and initials elasticity modulus in comparison with initial yarns. The loss of yarn strength increased with intensification of the knitting density.

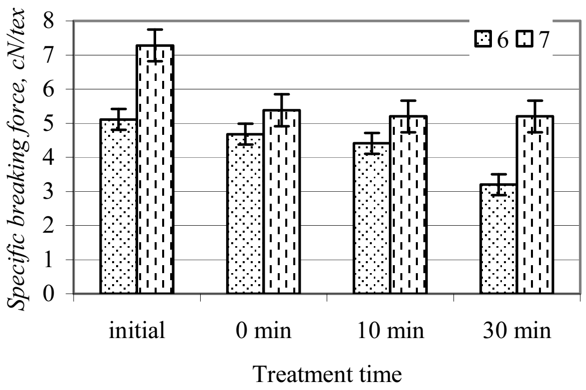

Fig. 11. The influence of treatment on wool yarns specific breaking force: 6 – 6th yarn, 7 – 7th yarn

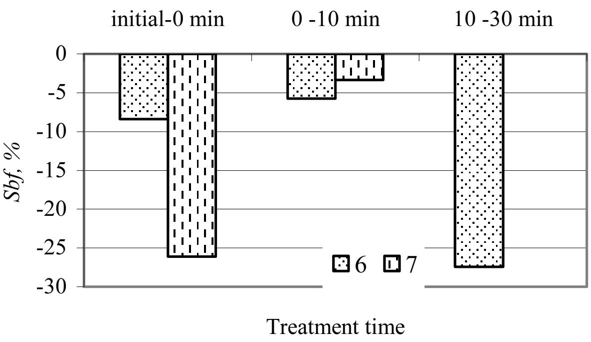

Fig. 12. The influence of treatment on wool yarns (marked as in Fig. 11) specific breaking force change

4. CONCLUSIONS

The data showed that apparent changes of knits structures occurred after the first 10 min of stabilisation. During next 10 min and 20 min of stabilisation structure changes were marginal.

The results of yarns strength investigation showed, that the breaking force of the yarns due to knitting operation significantly decreased. However, the specific breaking force of PES yarns increased after 10 min of stabilisation comparing with that after knitting though it remained lower than of initial PES yarns. Cotton and wool yarns felt deterioration of strength during stabilisation in steam ambience, but it was of moderate value comparing with originated due to knitting.

REFERENCES

1. **Abdessalem, S. B., Abdelkader, Y. B., Mokhtar, S., Elmarzougui, S.** Influence of Elastane Consumption on Plated Plain Knitted Fabric Characteristics *Journal of Engineering Fibres and Fabrics* 4 2009: pp. 30 – 35.
2. **Heywood, D.** Textile Finishing. Society of Dyers and Colourists, England, 2003.
3. **Emirhanova, N., Kavusturan, Y.** Effects of Knit Structure on the Dimensional and Physical Properties of Winter Outwear Knitted Fabrics *Fibers and Textiles in Eastern Europe* 16 (2) 2008: pp. 69 – 74.
4. **Bogstra, F. R., De Vreugol, C. H.** Washing Results as a Function of Process Parameters *Architektura Tekstyliow* 1 – 2 1997: pp. 6 – 7 (in Polish).
5. **Mikučionienė, D.** The Dimensional Change of Used Pure and Compound Cotton Knitwear *Materials Science* (*Medžiagotyra*) 10 (1) 2004: pp. 93 – 96.
6. **Tvarijonavičienė, B., Šaulytė, I., Laureckienė, G.** The Effect of knitting and Wearing Conditions on the Tensile Characteristics of Blended Yarns *Materials Science* (*Medžiagotyra*) 10 (1) 2004: pp. 80 – 84.
7. **Tvarijonavičienė, B., Laureckienė, G., Adomavičiūtė, E.** Study of Changes in Tensile Cyclic Characteristics of Cotton/Acrylic Blended Yarn after Knitting Process *Materials Science* (*Medžiagotyra*) 11 (1) 2005: pp. 64 – 67.
8. **Choi, M. S., Ashdown, S. P.** Effect of Changes in Knit Structure and Density on the Mechanical and Hand Properties of Weft-Knitted Fabrics for Outwear *Textile Research Journal* 70 (12) 2000: pp. 1033 – 1045.
9. **Tadic, T., Miloslalvjevic, S., Stankovic, S., Tisma, V.** Influence of Knitting Conditions on the Change in Yarn Properties *Knitting Technology* 5 1999: pp. 14 – 18.
10. **Cuden, A. P., Srdjak, M., Pelko, H.** Optimisation of the Cotton/Lycra Plain Knitted Fabric Parameters *International Journal of Polymeric Materials* 47 2000: pp. 633 – 648. http://dx.doi.org/10.1080/00914030008031318
11. **Tezel, S., Kavusturan, Y.** Experimental Investigation of Spandex Brand and Tightness Factor on Dimensional and Physical Properties of Cotton/Spandex Single Jersey Fabrics *Textile Research Journal* 78 (11) 2008: pp. 965 – 976. http://dx.doi.org/10.1177/0040517507087685

Presented at the 20th International Baltic Conference "Materials Engineering 2011"
(*Kaunas, Lithuania, October 27–28, 2011*)