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Investigation of End-use Properties of Woven Fabrics with Synthetics Fancy Yarns

Audronė RAGAIŠIENĖ [*], Eglė KUMPIKAITĖ

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

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In this study the change of air permeability and mass loss of woven fabrics with different structure fancy yarns after abrasion test is discussed. One fancy yarn and four cotton yarns in the weft for investigated fabrics in sateen 5/3 weave had been used. The fancy yarns structure was different as well; i. e. fancy yarns with slubs, loops and spiral structure were used. The air permeability of outerwear is very important in the comfort of wear and durability. Abrasion resistance of fabric samples were performed on a Martindale Abrasion and Pilling Tester by varying number cycles. It was estimated that above-mentioned parameters of yarns influence the end-use properties of fabrics with fancy yarns.

Keywords: abrasion resistance, air permeability, fancy yarns structure, mass loss, woven fabric.

INTRODUCTION

Nowadays, the important problem is to create high quality new textile products and to analyse their properties and usage possibilities. Modern-day fashion and popularity of woven and knitted fabrics from fancy yarns requires paying attention to analysis of mechanical and end-use properties of them [1, 2].

Fancy yarns are the textile yarns with virtually unlimited pattern designs. Fancy yarns can give special features such as soft, friability, relief, good permeability features [2 – 5].

End-use properties of textile materials such as air permeability, abrasion resistance, mass and their loss, pilling effect are effected by many factors such as raw material of yarns, fibre fineness, yarn count, yarn type, strength and hairiness of yarn, fabric weave, settings of threads, surface density etc. [6 – 12].

The air permeability of textile fabrics is determined by the rate of flow of air passing perpendicularly through a given area of fabric and it is measured at a given pressure difference across the fabric test area over a given time period. There are many studies where the air permeability is tested like dependence on structure of textile, i. e. of porosity of textile [6, 9, 13]. Baltakytė and Petrulytė stated that air permeability decreased after washing procedure of tested fabrics with hemp and flax [9].

Abrasion resistance shows the fabric ability to keep its strength and appearance during friction effect. Pilling is a fabric defect which is observed as small balls or groups consisting of intervened fibers. The pills are formed during wear and washing, which means that fabrics are affected by friction forces during usage [14, 15].

Nergis and Candan proved that overfeed ratio, the binding yarn's twist direction and twist amount affected the stitch density, thickness and abrasion behaviour of knitted fabrics from bouclé fancy yarns [4]. Ortlek and Ulku have found that material type, twist level and pile length have significant effect on the abrasion resistance of chenille yarns. According to these authors, abrasion resistance of cotton chenille yarns is higher than of acrylic or viscose chenille yarns [5].

The aim of this study is to investigate the influence of abrasion on change of air permeability and mass loss of woven fabrics with fancy yarns.

MATERIALS AND METHODS

The object of this research is the woven fabrics with fancy yarns of different structure in the weft. Fancy yarns with slubs, loops and spiral structure were used. Fancy yarns were produced by one process method using fancy-twisting machine Jantra-PrKV 12 (Bulgaria) with hollow spindles of the type FAG (Germany). The components and structure of fancy yarns used for weaving are presented in Table 1.

Table 1. Components and structure of fancy yarns used in the weft

Var. Nr.	Core component	Effect component	Binder component	Type of fancy yarns
1.	Multifilament textured PES yarns, 16.7 tex	Multifilament textured PES yarns, 16.7 tex	Multifilament PES yarns, 5.6 tex	Yarn with slubs
2.				Yarn with loops
3.	Blended yarns from PES and viscose fiber, 12 tex × 2	Multifilament textured PES yarns, 16.7 tex	Multifilament PES yarns, 5.6 tex	Spiral structure yarn

The investigated fabrics were woven in Technical University of Lodz, Institute of Textile Architecture, Poland with Picanol Gama rapier loom from PES 16.7 tex multifilament textured yarn in the warp and cotton 20 tex × 2 yarn and fancy yarn in the weft. One fancy yarn and four cotton yarns in the weft of woven fabrics had been used. Fabrics were woven in sateen 5/3 weave. Warp setting was 300 dm^{-1} and weft setting was 120 dm^{-1} for all investigated fabrics.

[*] Corresponding author. Tel.: +370-37-353862; fax: +370-37-353989.
E-mail address: *audrone.ragaisiene@ktu.lt* (A. Ragaišienė)

In this study such end-use properties of woven fabrics with fancy yarns in the weft as air permeability, mass loss and abrasion resistance were analysed and forecasted.

The yarns were tested on a standard test equipment using standard test methods. Abrasion resistance of fabric with fancy yarns samples were performed on a Martindale Abrasion and Pilling Tester MESDAN-LAB, Code 2561E (SDL ATLAS, England), in accordance with the standard [16]. Conventional wool abradant fabric was used. The pressure imposed on the fabric during rubbing was 9 kPa, as indicated for clothing. In the beginning probationary measurement was done that shows how many cycles sustain investigated sample until disintegration. To show the abrasion kinetics at various stages, the number of cycles differed widely, ranging from rather low values to large values. So, after probationary measurements received number of cycles was brought under approximately on the 7000 cycles of interval. After each interval the abrasion machine was stopped and testing indices were measured, i. e. air permeability and mass.

The air permeability was measured using D-69450 Weinheim air permeability tester (Karl Schroder KG, Germany), as specified in the standard [13], at a pressure drop of 100 Pa. Testing area was 5 cm^2 for all samples.

Air permeability in mm/s was determined:

$$R = \frac{\bar{q}_v}{A} 167 , \qquad (1)$$

were: $\bar{q}_v$ is an arithmetical average of debit of air flow, dm^3/min (1/min); A is testing area, cm^2; 167 is coefficient of conversation from $dm^3/cm^2 \cdot min$ or $1/cm^2 \cdot min$ to mm/s.

The microscopy analysis of fabrics before and after abrasion was performed using a SMZ 800 Nicon Stereoscopic Microscope and Coolpix 4500 Digital Camera.

The cut samples were weighted by an EW 150-3M electronic balance (Kern & Sohn GmbH, Germany) at the beginning and after a certain number of abrasion cycles. All samples of fabrics were of the same area (5 cm^2). Because of this reason it was not necessary mass of these samples to recalculate into area density.

The fabrics were conditioned at a temperature and relative humidity of 20 °C ±2 °C and 65 % ±2 %.

Statistical and regression analysis was done using Microsoft Excel Analysis Tool Pak.

RESULTS AND DISCUSSIONS

Such end-use properties as abrasion resistance, change of air permeability and mass loss during wear are very important for outerwear fabrics with fancy yarns. Therefore, the abrasion tests were done for researched fabrics with fancy yarns of different structure on purpose to establish abrasion resistance of these fabrics. The results are shown in Fig. 1. The fabrics with loop fancy yarns have the highest abrasion resistance (27000 cycles), the fabrics with slub fancy yarns have the lowest abrasion resistance (23666 cycles). So, the values of abrasion resistance of above-metioned fabrics differ in 12 %. The abrasion resistance of fabrics with spiral structure fancy yarns differs from abrasion resistance of fabrics with slub fancy yarns in 5 %, i. e. of little account because the variation coefficient of abrasion resistance was 7 %. The dimensions of effects and regularity of their distribution in fancy yarn can influence this result. When effects are larger (slub fancy yarns), they fray and break faster. Similar results were established by Ortlek and Ulku [5], who investigated the influence of pile length of chenille yarns in upholstery fabrics on abrasion resistance of these fabrics. Nergis and Candan [4] have found that different parameters of fancy yarns structure also influence structure and properties of knitted fabrics from boucle yarns. Omeroglu and Ulku [8] and Can [10] investigated abrasion resistance and pilling of fabrics with conventional and compact ring-spun yarns and also established that yarns structure influence the abrasion resistance of fabrics investigated. Valasevičiūtė, Milašius and Abraitienė [11, 12] investigated the abrasion resistance of woven fabrics for protective clothes and have established that fabric structure also influences wear properties of fabrics investigated. Similar results are given by Kaynak and Topelbekiroglu [15].

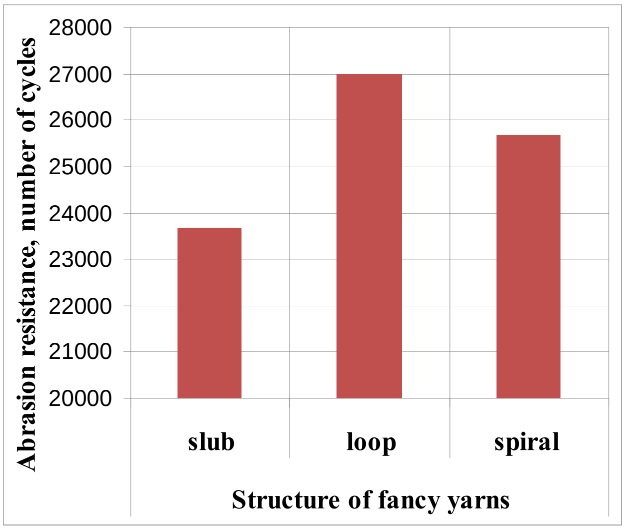

Fig. 1. Abrasion resistance of fabrics with fancy yarns of different structure

The appearance of fabrics after abrasion differs as well (Fig. 2). Threads become thinner and breaks, the holes appear in surface of fabric.

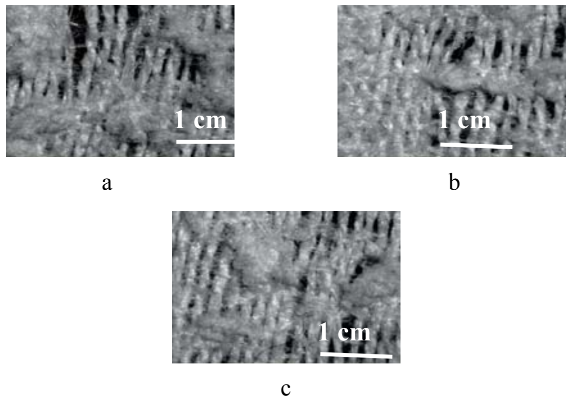

Fig. 2. View of fabrics with different fancy yarns structure after abrasion: a – with slub fancy yarns; b – with loop fancy yarns; c – with spiral structure fancy yarns

Such properties of fabrics as air permeability and mass loss change as well. These changes influence the wearing comfort and appearance of fabrics. The change of air permeability of fabrics with fancy yarns is shown in Fig. 3. It can be seen that fabrics with loop fancy yarns have the highest air permeability before abrasion (912 mm/s), the fabrics with spiral structure fancy yarns have the lowest one (835 mm/s), though the air permeability before abrasion of fabrics with slub and spiral structure fancy yarns differs slightly (just 10 mm/s). The variation coefficient of air permeability tests was 6 %. The air permeability of fabrics decrease from 43 % for fabrics with loop fancy yarns to 37 % for fabrics with slub fancy yarns, i. e. of little account. The air permeability of fabrics with spiral structure fancy yarns decreases in 39 %. So, it can be said that the air permeability of fabrics with fancy yarns decrease after abrasion in similar magnitude and the structure of fancy yarns have not large influence to this property. Olšauskienė and Milašius [1] have obtained the similar results investigating technical woven fabrics from PES yarns of different structure parameters. They established that the yarn structure does not influence the air permeability values, and the air permeability of fabrics depends on fabric structure parameters. However, Padleckienė and Petrulis [6] have found different tendencies of air permeability of breathable-coated fabrics after cycling stretching. They established that the air permeability increase, when the number of stretching cycles increase. It can be influenced by the structure of yarns and fabrics used for experiments. Baltakytė and Petrulytė [9] established that the air permeability of terry fabrics decreases after water/heat/mechanical impacts, i. e. these results are similar.

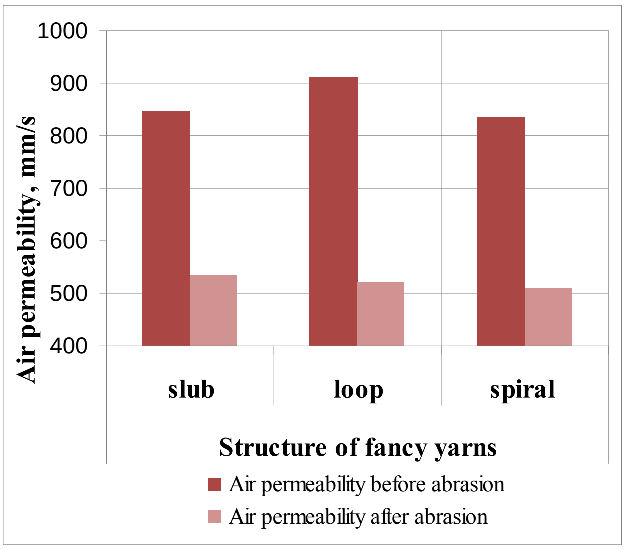

Fig. 3. The air permeability change of fabrics with fancy yarns of different structure after abrasion

The mass loss of fabrics with fancy yarns of different structure after abrasion was established during investigation. The results are shown in Fig. 4. The fabrics with loop fancy yarns have the highest mass (0.224 g) and the fabrics with slub fancy yarns have the lowest one (0.219 g). These results show that structure of fancy yarns has not large influence on fabric mass, because the results of fabrics with different structure differ just in 2 %, i. e. of little account because the variation coefficient of mass was 6 %. The mass of fabric after abrasion decreased from 14 % for investigated fabrics with spiral structure yarns to 12 % for investigated fabrics with slub and loop fancy yarns. So, it can be said that fabric mass after abrasion changes in similar magnitude (differs just in 2 %) and yarns structure does not influence magnitude of this change. Nergis and Candan [4] established that the structure parameters of boucle yarns influences mass loss of knitted structures from these yarns, i. e. the results differs from described in this article. However, the results of Ortlek and Ulku [5] are similar, i. e. mass loss of fabrics with chenille yarns decreases, when the number of abrasion cycles increases.

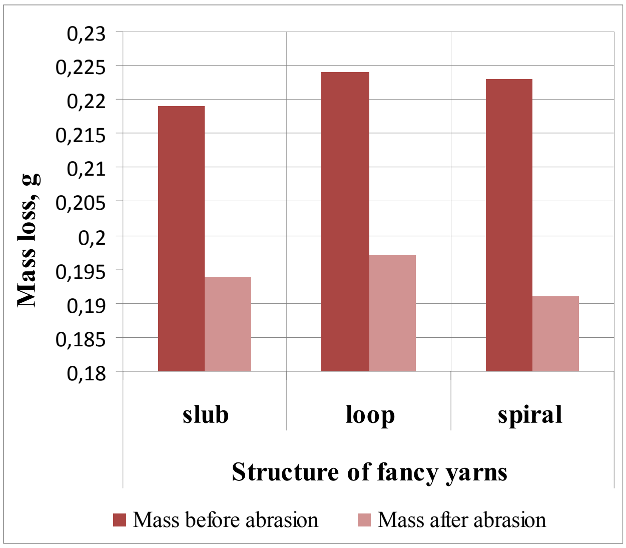

Fig. 4. Mass loss of fabrics with fancy yarns of different structure after abrasion

Though it was established during investigation that structure of fancy yarns has not large influence on fabrics air permeability and mass, but it can be analysed how the yarns structure influences the character of this change.

The dependences of air permeability of fabrics with fancy yarns of different structure on number of abrasion cycles are shown in Fig. 5.

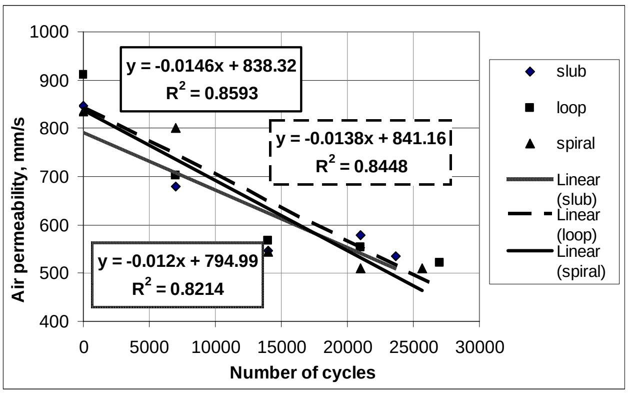

Fig. 5. The dependencies of fabrics air permeability on number of abrasion cycles for fabrics with fancy yarns of different structure

As it can be seen from Fig. 5, the air permeability of fabric decreases in all cases of fancy yarns structure during abrasion, because the fabric surface become raised and the pilling cover the fabric surface. The air permeability of the fabrics increased a little before the end of abrasion because the threads break and the holes appear. The change of air permeability of fabrics with fancy yarns of spiral structure is the least intensive and the curve of air permeability of fabrics with slub fancy yarns changes the most intensively. The magnitude of effects of fancy yarns and regularity of their distribution is the reason of this phenomenon. The effects of slub fancy yarns are the largest and those of spiral structure fancy yarns are the least and their distributed almost regularly. The effects of slub fancy yarns are large, their break faster and cover surface of fabric. Their do not let air to permeate through the fabric surface and the air permeability of fabrics with these yarns changes the most intensively.

The change of mass of fabrics with different structure fancy yarns during abrasion is shown in Fig. 6.

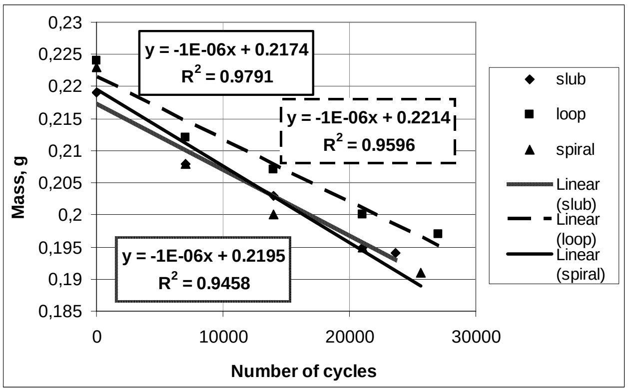

Fig. 6. The dependencies of fabrics mass on number of abrasion cycles for fabrics with fancy yarns with different structure

As it can be seen from the Fig. 6, the mass of fabrics with spiral structure fancy yarns changes the most intensive and this of fabrics with loops and slub yarns changes not so intensive but similar. The structure of spiral structure yarns is the most regularly; the dimensions of effects are the least and these yarns break and fray faster. Because of this reason mass of fabrics with these yarns changes the most intensive. The fabrics with loop fancy yarns have the highest mass.

CONCLUSIONS

1. The structure of fancy yarns influences the abrasion resistance of fabrics with these yarns. The fabrics with loop fancy yarns have the highest abrasion resistance (27000 cycles) and these with spiral structure fancy yarns have the lowest abrasion resistance (23666 cycles).
2. Though the structure of fancy yarns does not have critical influence on the value of air permeability (it changes just in 8 %), but it influences the course of change of air permeability.
3. The air permeability of fabrics with slub changes the most intensive and that of fabrics with spiral structure fancy yarns changes the least intensive.
4. The structure of fancy yarns has not influence on mass loss of fabrics with fancy yarns (it changes just in 2 %), but it influences the course of mass change.
5. The mass of fabrics with spiral structure fancy yarns changes the most intensively during abrasion. The regularity of fancy yarns structure influences this phenomenon.

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