IMPROVED COMFORT CHARACTERISTICS FOR WORSTED WOOL YARNS

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REZUMAT: O caracteristică importantă a produselor de îmbrăcăminte este de a oferi un confort adecvat. S-a efectuat un studiu privind variațiile pilozității unui fir de lână în diferite condiții de frecare. Numărul de fibre proeminente de pe suprafața firelor poate fi optimizat, numărul de fibre scurte trebuie să fie ridicat pentru crește gradul de moliciune, iar numărul de fibre lungi ar trebui să fie redus pentru a evita disconfortul.

Cuvinte cheie: confort, îmbunătățirea pilozității, condensare

ABSTRACT: An important role of garments is to provide adequate comfort. A study was undertaken of the hairiness variations of a worsted wool yarn in different friction conditions.The number of protruding fibres on the yarn surface can be optimized , the short fiber number should be high in order to give softness and the long fibers hairs should be reduced to avoid discomfort.

Keywords: comfort, hairiness improvement, condensation

INTRODUCTION

Over the last few years, there has been growing interest in knitted fabrics due to its simple production technique, low cost, high levels of clothing comfort and wide product range. Knitting technology meets the rapidly-changing demands of fashion and usage. Knitted fabrics not only have stretch and provide freedom of movement, but they also have good handle and easily transmit vapour from the body. That’s why knitted fabrics are commonly preferred for sportswear, casual wear and underwear.

The demands from fabrics have changed with developments in textile technology and the rise of people’s living standards. Now the requirement is not only style and durability, but also clothing comfort. Clothing comfort includes three main considerations: psychological, sensorial and thermo-physiological comfort. The thermo-physiological comfort, the subject of this research, entails both thermoregulation and moisture management

It is known that fibre type, yarn properties, fabric structure, finishing treatments and clothing conditions are the main factors affecting thermo-physiological comfort. In this study, we investigated the effect

A couple of simple concepts lead to an understanding of skin comfort of wool garments:

• As a biological material, wool samples always contain a mixture of fibres of different thicknesses or diameters. As well as the average diameter value, the spread in diameter values is commonly reported in one of two ways, namely the standard deviation (SD) or the coefficient of variation of diameter (CVD).

• Fibre ends in contact with the skin during wear, as depicted in Figure 1, invariably protrude above the fabric surface in a garment and during wear these fibre ends will be pressed against the skin.

These short protruding fibre ends on the inside surface of a next-to-skin garment obey the laws of physics, that is, under compression between the fabric and the skin surface, they remain rigid up to a threshold force but are unable to sustain a larger force, and buckle. The threshold force for buckling is highly dependent on fibre diameter. For some wools and fabric constructions the buckling forces for the coarser diameter fibres in the naturally occurring diameter distribution are sufficient to trigger nerve ends under the skin and cause discomfort. This mechanism is depicted in Figure 1.

1. FRICTION OF YARNS – THEORETICAL APPROACH

At the contact between the fiber bundle and the friction surface it can be considered that the bundle of fibers is non-extensible, has a bending and torsional rigidity. Thus, in the contact area, quite short, the bundle can be assimilated without extensibility and the theory of non-extensible wire wrapped on a fixed cylindrical body can be applied.

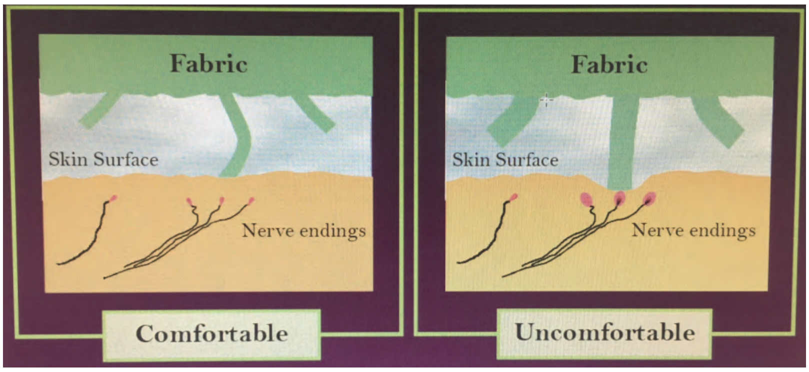

Fig. 1: The interaction between fabrics and the skin during wear [1]

In current practice, situations often occur when using yarns, bands or cables passed over a piece of rough cylindrical shape (spindle, pig-tale, etc.) fixed and required so as to exhibit a relative movement tendency between the pig-tale and the yarn or strip by the forces and applied to the two ends. (Figures 2; 3).

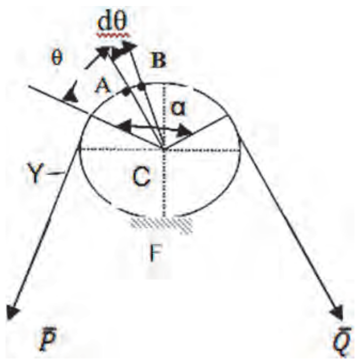

Fig. 2. Contact point[3]

Where:

- A;B- the ends of the thread element
- AB - the elementary length of the thread
- α - friction angle
- θ - some friction angle
- dθ - elementary friction angle
- C F -fixed surface
- Y - thread
- P;Q -forces at the ends of the thread
- dF - the elemental force of friction
- dT - stretch force
- dT - elemental stretch force

To determine the equilibrium conditions of such a yarn, it will be considered an infinitely small element (Figure 3) on which the forces act on both ends, the normal reaction, as well as the friction force. These forces are supposed to be competing at point A0 located at the middle of the yarn element, given the very small dimensions of the element.

The equations of equilibrium on the x and y axes (figure 3) are:

On x-axe:

$$T\cos\left(\frac{d\theta}{2}\right)+dF-(T+dT)\cos\left(\frac{d\theta}{2}\right)=0 \quad (1)$$

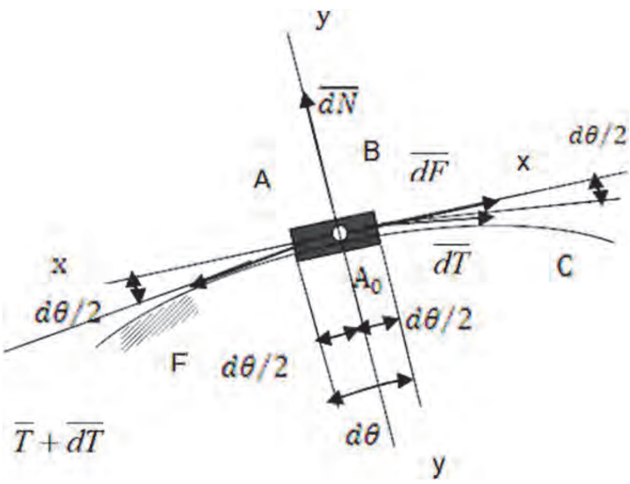

Fig. 3. Forces act on both ends[3]

On y-axe:

$$dN - T\sin\left(\frac{d\theta}{2}\right)-(T+dT)\sin\left(\frac{d\theta}{2}\right)=0$$

Since the angle $d\theta$ is very small, approximation can be made.

$$\cos\left(\frac{d\theta}{2}\right)=1;\sin\left(\frac{d\theta}{2}\right)\approx\left(\frac{d\theta}{2}\right)$$

and the $dT\frac{d\theta}{2}\approx 0$ because dT and dθ are infinitely small.

In this way equation 1 become 2:

$$\begin{cases} dF-dT=0 \\ dN-Td\theta=0 \end{cases} \Rightarrow \begin{cases} dF=dT \\ dN=Td\theta \end{cases} \quad (2)$$

to which is added the condition dF≤ μ dN for equilibrium

$$dT=dF\leq\mu dN \text{ or } dT\leq\mu Td\theta$$

and by separating the variables it is obtained:

$\frac{dT}{T}\leq\mu d\theta$ and by integration it becomes:

$$\int_Q^P \frac{dT}{T} \le \int_0^\alpha \mu d\theta \quad \Rightarrow \text{or} \ (\ln P - \ln Q) \le \mu\alpha$$

then $\ln \frac{P}{Q} \le \mu\alpha$ or $\frac{P}{Q} \le e^{\mu\alpha}$ relationship 3 is Euler's formula for yarn friction

For the other tendency of move of the yarn there is the relation:

$$Q = P \cdot e^{\mu \cdot \alpha} \tag{3}$$

If the two relationships obtained are combined, determine the area in which the yarn no move:

$$e^{-\mu\alpha} \le \frac{P}{Q} \le e^{\mu\alpha} \tag{4}$$

2. EXPERIMENTAL

We have initiated a test on a spinning machine model ZINSER 451 on which we loaded a roving Nm 1.4 made of 100% wool final count Nm 30 with 420 Tpm S.

In order to simulate the modification of hairiness on a worsted yarn, a sample friction device was installed after the spinning triangle, in order to create a friction point between the external layer of the fibers and the metal compacting device during the building up of the twist as you can see in figure 4.

Fig. 4. Compacting device

The role of the compacting device is :

- changing the section of a spun yarn during torsion
- Extra frictions and fibers create a yarn compaction effect
- Yarn stiffness is modified / reduced
- The positioning of the device with the spinning triangle has an effect on the hairiness control

The yarn produced was tested on the following equipments :

- USTER tester 5 for eveness, thin places, thick places and hairiness and

- USTER HL 400 device Optical measuring unit for the determination of the number of protruding fibers at various lengths in staple yarns

The final results are presented in the table 1:

Table 1 **Characteristics of pilozity of yarn**

Variants	**Equipments**				**Uster HL400**				**Uster UT5**
	Characteristics				**S1+2**	**S1**	**S3**	**S10**	**H**
	Coded variables		**Real variables**						**mm/1cm**
	x1	**x2**	**d(cm)**	**gdt**					
Basis of comparison Nm 30 gdt = αm =80					10417	7690	2881	30	7.12
1	-1	-1	2	65	11842	8958	2953	21	8.04
2	1	-1	5	65	10727	8034	2872	24	8.08
3	-1	1	2	90	9774	7504	2592	17	6.5
4	1	1	5	90	9481	7159	2471	19	6.56
5	-1.414	0	1.5	80	9365	6427	2660	48	8.08
6	1.414	0	5.5	80	9753	7398	2654	26	6.83
7	0	-1.414	3.5	60	12488	9403	2853	26	8.61
8	0	1.414	3.5	100	10212	7699	2483	18	6.26
9	0	0	3.5	80	10132	7816	2449	13	6.83
10	0	0	3.5	80	8764	6549	2301	26	6.76
11	0	0	3.5	80	10787	7969	2657	24	7.04
12	0	0	6.74	3.5 80	9863	7393	2918	29	6.74
13	0	0	6.82	3.5 80	9616	7205	2562	22	6.82

Good values compared to the base of comparation

Weaker values compared to the base of comparation

Where:

d - distance between the device(figure 2) and the front cylindrer of the spinning machine

$g_{dt}=\alpha_m$ - metric torsion degree;

S_{1+2} - pilosity of 1+2 mm;

S_1 - pilosity of 1 mm;

S_3 - pilosity of 3 mm;

S_{10} - pilosity of 10 mm;

H - index of pilosity (total length of pilosity per1 cm of yarn).

Analisys of pilosity (S_{10})

1. Equation of pilosity (S_{10}) in function of (d) and (α_m):

$$H=24,807-3,264\cdot X_1-2,893\cdot X_2+3,656\cdot X_1^2-3,342\cdot X_2^2 \qquad (5)$$

Where:

X_1 - variable of (d) and X_2 - variable of (α_m) from table 1.

The critical point is for X_1 = 0.446 and X_2 = -0.433 gives pilosity for (S_{10}) of 24.705, figure 5.

Hairiness index depending on the degree of metric torsion (αm) varies by relationship 6:

$$H=6,84-0,208\cdot X_1-0,798\cdot X_2+0,27\cdot X_1^2+0,26\cdot X_2^2 \quad (6)$$

The variation of degree of metric torsion is presented in figure 6.

The minimum point is: $X_1 = 0.387$ and $X_2 = 1.537$ gives H= 6.182

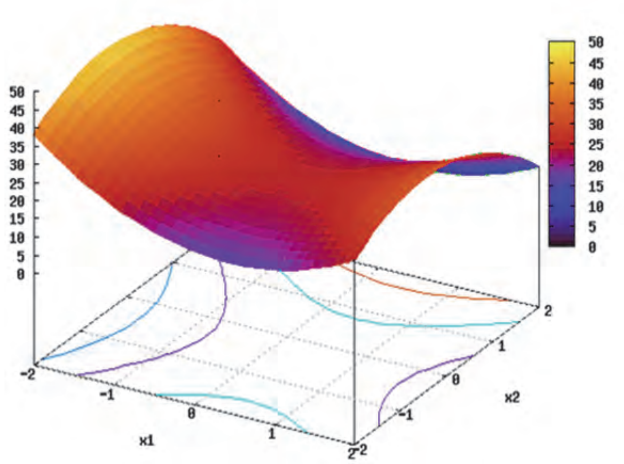

Fig. 5 . Variation of (S_{10})

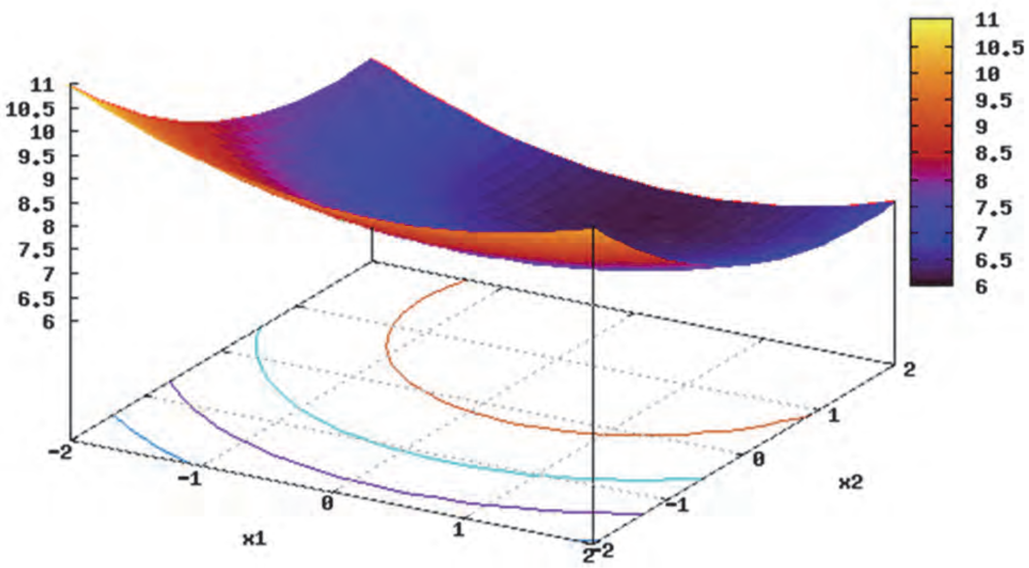

Fig. 6. Graphic of (H) in function of degree of torsion and distance (d)

3. INTERPRETATIONS AND CONCLUSIONS

- The device has an effect of changing the section of the spun yarn during torsion
- Additional threads of fibers create a thread compaction effect
- Thread stiffness is modified / reduced
- Positioning the device with the spinning triangle has an influence on the control of hairiness
- Index of pilosity varies in function of degree of torsion and of distance (d) and the minimum point is outside of plan of experimentation for the variable X2 (α_m)

In order to understand the thread formation phenomenon and to optimize the hairiness it is necessary to collect a larger amount of information

Proposed method: statistical control of the process, by statistical evaluation of the values obtained from the experimental data.

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