THE WEAR RESISTANCE OF SOCKS MADE OF DIFFERENTLY SPUN MODAL YARNS

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Introduction

The casual men's socks are knitted next-to-skin-type garments, usually made of cotton yarns for softness and comfort, and blended with polyamide and/or Lycra for improved fit, durability and shrink resistance. Modal fibers (man-made artificial fibers from cellulose) provide exceptional contact comfort and have better hydrophilicity than cotton, but are insufficiently researched in the knitting of socks.

Male socks in calf length

Socks have to fulfil high demands of wear resistance, particularly lower propensity to surface pilling and higher abrasion resistance. As the wear resistance of socks depends on their construction and fiber content, it is very important to select adequate yarns for their production.

Materials

Three groups (A, B and C) of calf length man's socks of the same size (EU 42), made in the highest percentage of modal fibers spun with three different spinning techniques (Ri, Ro, Ai) in form of single spun yarns and in full plating by textured polyamide 6.6 yarns of different linear density were knitted.

Structure of ring (Ri), rotor (Ro) and air-jet (Ai) spun yarns

Table 1: Yarn tensile properties

Yarn type	Breaking strength (cN)	Breaking elongation (%)
PA 6.6 (1)	652 ± 8	26.7 ± 0.6
PA 6.6 (2)	991 ± 4	28.5 ± 0.2
Lycra	551 ± 14	321.0 ± 18
MD-Ri	487 ± 10	10.2 ± 0.2
MD-Ro	325 ± 9	7.2 ± 0.2
MD-Ai	406 ± 10	9.0 ± 0.2
Cotton-Ri	326 ± 8	3.8 ± 0.1

The A and B groups of socks were knitted with three soft single spun modal yarns of the same linear density of 20 tex (spun by ring, rotor or air-jet spinning system), while in the group C one of the single spun modal yarns were replaced with coarser cotton yarn of linear density of 25 tex. The groups also differ in the linear density of textured polyamide 6.6 yarn used for plating. Wherein group A a finer PA 6.6 yarn of 156 dtex f 42 (1) and in groups B and C a coarser 220 dtex f 68 (2) were used.

Methods

The socks wear resistance was tested by standardized test methods for determination of the abrasion resistance (EN 13770, method 1) and fabric propensity to surface pilling (EN ISO 12945-2), before and after five repeated washing and drying cycles, performed according to the procedure 3M (EN ISO 6330), with line drying in open-air (procedure A) after every washing cycle.

Sampling of socks: a) for testing of propensity to surface pilling; b, c) for testing of abrasion resistance

Before and after five washing and drying cycles, mass per unit area (EN 12127), thickness (EN ISO 5084), the number of wales and courses (EN 14971) of socks plain knits and overall mass of socks was determined on the conditioned samples at the temperature of 20 ± 2 °C and air relative humidity of 65 ± 4 % .

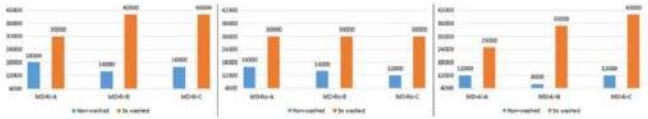
Results and discussion

From the properties of socks plan knits (Table 2) it can be seen that the B and C groups of socks are thicker and heavier than those of group A. After the laundering process, the properties of sock plain knit change, regardless of the yarn spinning technique used, due to the influence of shrinkage, resulting in tighter construction of all tested socks knits.

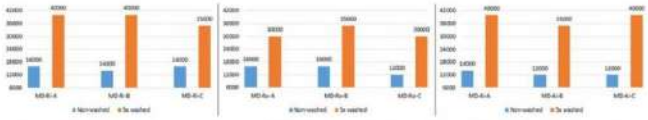
Table 2: Properties of socks and sock plain knits before and after five repeated washing and drying cycles

Sample	Mass of sock [g]		Mass per unit area [g/m²]		Thickness [mm]		No. of wales/cm		No. of courses/cm	
	Non-washed	5x washed	Non-washed	5x washed	Non-washed	5x washed	Non-washed	5x washed	Non-washed	5x washed
MD-Ri-A	19.87	19.93	267.97	295.05	0.88	1.02	6	7	7	8
MD-Ro-A	20.10	20.15	262.45	290.28	0.90	1.00	6	6	8	8
MD-Ai-A	20.21	20.33	261.48	316.56	0.93	1.08	6	6	7	9
MD-Ri-B	22.27	22.36	284.67	310.14	0.95	1.11	6	7	7	9
MD-Ro-B	22.31	22.36	279.88	327.18	0.99	1.09	6	6	8	9
MD-Ai-B	22.63	22.73	289.33	296.76	1.00	1.08	6	6	7	8
MD-Ri-C	23.74	23.79	292.87	326.66	1.01	1.15	6	6	7	8
MD-Ro-C	23.73	23.80	304.47	308.43	1.06	1.13	6	6	7	9
MD-Ai-C	23.81	23.91	310.77	329.62	1.04	1.12	6	6	7	8

It was found that coarser polyamide plating threads in B and C group of socks, as well as one cotton spun yarn in group C, didn't contribute to the improvement of abrasion resistance of non-washed socks samples. Socks made from ring spun yarns showed the least fiber wear off. That can be connected to the fact that ring spun yarns are more compactly structured and have higher values of breaking strength and elongation (Table 1). After the five washing and drying cycles a great increase in abrasion resistance was observed in all tested socks samples. Increase in abrasion resistance could be connected with the higher compactness of sock knit structure (Table 1), that contributed to higher elasticity of the knit structure. By observing individual groups of socks, the influence of coarser polyamide yarns can be observed in the most of the socks tested samples of B and C groups when compared with socks group A.



Abrasion resistance of non-washed and five times washed and dried plain knits taken from the heel of three groups of socks (A, B and C)



Abrasion resistance of non-washed and five times washed and dried plain knits taken from the sole of three groups of socks (A, B and C)

With the increase of tested socks abrasion resistance, increased their propensity to surface pilling. Best rated non-washed knits were found in socks of group A, especially those made in the highest percentage of air-jet spun modal yarns, because of their lower surface hairiness. After the laundered of socks, and 7000 pilling rubs, drop in final grades were found in all tested samples (Table 3). The best grades and the lowest propensity to surface piling, were shown by the knits of socks, made in the highest percentage of rotor spun yarns.

Table 3: Visually assessed propensity to surface pilling of non-washed and five-time washed and dried samples of sock knits by grades of pilling

Plain knit sample	Non-washed						5x washed					
	125	500	1000	2000	5000	7000	125	500	1000	2000	5000	7000
MD-Ri-A	4/5	4/5	4/5	4	4	3/4	4/5	4	3	2/3	2	2
MD-Ri-B	4	4	3/4	3/4	3	2/3	4/5	4/5	4	3/4	3	1
MD-Ri-C	3/4	3	2/3	2	1	/	4/5	4	3	2/3	2	1
MD-Ro-A	4/5	4/5	4/5	4	4	3	4/5	4/5	4	3/4	3	2/3
MD-Ro-B	4/5	4	4	3/4	2/3	2/3	4/5	4/5	4	4	3/4	3
MD-Ro-C	4	3/4	3	2/3	2	1	4/5	4/5	4	3/4	3/4	3
MD-Ai-A	5	5	5	5	4/5	4/5	4/5	3/4	3	2/3	2	1
MD-Ai-B	4/5	4/5	4/5	3/4	3	2/3	4/5	3	2/3	2	1	/
MD-Ai-C	4	3/4	3	3	1/2	1	4/5	4/5	3/4	3	2/3	2

Conclusion

On the basis of the results obtained, it was concluded that for selection of the modal spun and plating polyamide yarns for socks production is necessary to consider their structure and the characteristics, but also the fact that yarn spinning technique, as well as the process of domestic care significantly influence sock knits wear resistance.

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