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EFFECT OF POLYESTER FIBRE SHRINKAGE ON CONSTRUCTION CHARACTERISTICS OF POLYESTER/WOOL WOVEN FABRICS

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ABSTRACT

This work aimed to study the effect of polyester fibres with different shrinkage on the structural characteristics (warp densities, weft densities and weight per square meter) of the various blend wool and polyester fabrics, after a normal clean finish. The main conclusions to be highlighted are: polyester fibres with 11% shrinkage give rise to higher weft densities and consequently fabrics with a higher weight per square meter compared to fabrics produced with polyester fibres with 4% shrinkage. In this context, and if for technical and/or commercial reasons, there is a need to change the type of polyester fibre, it is not enough to consider only the length, diameter, crimp and tenacity of the fibre, but also its shrinkage.

KEYWORDS

Polyester fibre shrinkage; Conventional yarn; Polyester/wool fabrics; Weight per unit area; Product design engineering

INTRODUCTION

The high diversity of polyester fibres available in the global market, which can differ significantly from each other, with regard to their shrinkage characteristics, requires the need to carry out a research work that allows, at the end of the study, to know their implications in the final construction characteristics of blend wool and polyester fabrics. This knowledge is essential for anyone involved in the fabric development area, so that the final construction characteristics of a given finished fabric are those defined in the technical specifications.

There is no perfect fibre. There are many different performances that are required from the fibres depending on the different final applications, whose satisfaction implies the existence of a variety of fibres with different characteristics [1].

Heat-based processes on thermoplastic fibre materials to shrink. Knitted may change their dimensions due to thermal shrinkage of the constituent yarns and the change in loop shape [2].

This work aimed to study the effect of different shrinkage of polyester fibres in different wool/polyester woven fabrics. The main conclusions to be highlighted are: polyester fibres with higher percentages of shrinkage give rise to higher weft densities and consequently fabrics with a higher weight per square meter compared to fabrics produced with polyester fibres with lower shrinkages. In view of these results, and if for technical, commercial or other reasons there is a need to work with another polyester fibre of different origin it is not enough to consider only the length, tenacity, crimp and the diameter of the fibre, but also its shrinkage under hot air at 200ºC [3].

MATERIALS AND METHODS

The fibrous compositions with greater applicability and industrial interest are 60% wool/40% polyester and 55% polyester/45% wool, eight samples of conventional yarn were produced in each of the mentioned compositions, with the title Nm 2/46, consisting of white wool and black polyester dyed in the mass. The hot air shrinkage (200ºC) of the 2,4 dtex and 4,4 dtex polyester fibres present values of 4% and 11%, respectively.

The different yarn samples differ from each other, in the diameter of the fibres that constitute them, as well as in the twist and re-twist, as can be seen in Table 1.

Table 1. Characterization of the yarn samples produced [3].

	Yarn samples (Ref.)	Component fibres	Twist and re-twist (v/m)	Twist coefficient of yarn to one cable
55% PES/45% WO	A	PES 2,4 dtex/WO 21,4 µm	Z_1=620 e S_2= 700	K=90
	B	PES 2,4 dtex/WO 21,4 µm	Z_1=720 e S_2= 800	K=106
	C	PES 2,4 dtex/WO 24,9 µm	Z_1=620 e S_2= 700	K=90
	D	PES 2,4 dtex/WO 24,9 µm	Z_1=720 e S_2= 800	K=106
	E	PES 4,4 dtex/WO 21,4 µm	Z_1=620 e S_2= 700	K=90
	F	PES 4,4 dtex/WO 21,4 µm	Z_1=720 e S_2= 800	K=106
	G	PES 4,4 dtex/WO 24,9 µm	Z_1=620 e S_2= 700	K=90
	H	PES 4,4 dtex/WO 24,9 µm	Z_1=720 e S_2= 800	K=106
60% WO/40% PES	I	PES 2,4 dtex/WO 21,4 µm	Z_1=620 e S_2= 700	K=90
	J	PES 2,4 dtex/WO 21,4 µm	Z_1=720 e S_2= 800	K=106
	K	PES 2,4 dtex/WO 24,9 µm	Z_1=620 e S_2= 700	K=90
	L	PES 2,4 dtex/WO 24,9 µm	Z_1=720 e S_2= 800	K=106
	M	PES 4,4 dtex/WO 21,4 µm	Z_1=620 e S_2= 700	K=90
	N	PES 4,4 dtex/WO 21,4 µm	Z_1=720 e S_2= 800	K=106
	O	PES 4,4 dtex/WO 24,9 µm	Z_1=620 e S_2= 700	K=90
	P	PES 4,4 dtex/WO 24,9 µm	Z_1=720 e S_2= 800	K=106

With the various yarn samples, 48 fabrics were manufactured in the three basic structures, most used in the woolen industry, twill 2/2, twill 2/1 and plain weave, using individually the 16 samples of the yarn Nm 2/46, in each of the structures. All samples were woven on a rigid rapier loom and finished simultaneously, according to a sequence of operations, characteristic of a normal clean finish, from the woolen industry. Table 2 presents the technical characteristics of fabric construction.

Table 2. Technical characteristics of fabric construction [3].

Characteristics	Twill 2/2	Twill 2/1	Plain
Reed	75/4	95/3	90/2
Reed width (cm)	165	168	174
Warp density (yarns/cm)	30,0	28,5	18
Weft density (yarns/cm)	21,5	20,5	18

All quality control laboratory tests were carried out under controlled temperature (20±2ºC) and relative humidity (65±4%) conditions, in accordance with the ISO 139:2005 Standard.

The number of yarns per unit length, as well as the weight per unit surface area of the fabrics, were determined according to NP EN 1049-2: 1995 and NP EN 12127:1999, respectively [4-5].

RESULTS AND DISCUSSION

Given that, the results found in the fabrics produced revealed variations in relation to what was expected for each of the structure, with regard, essentially to the weft densities and the weight per square meter of the fabrics, produced with 4,4 dtex polyester fibre, therefore, in table 3 the densities found in the warp and weft and the weight per square meter for the fabrics in twill 2/2, twill 2/1 and plain weave, in both compositions, are presented.

Table 3. Structural characteristics of the fabrics [3].

		Twill 2/2			Twill 2/1			Plain weave		
	Yarn samples	Densities (yarns/cm)		Weight (g/m^2)	Densities (yarns/cm)		Weight (g/m^2)	Densities (yarns/cm)		Weight (g/m^2)
		Warp	Weft		Warp	Weft		Warp	Weft	
55% PES/ 45% WO	A	33,0	22,1	259	30,9	21,1	254	20,2	18,4	189
	B	33,0	22,0	262	30,8	21,4	257	20,6	18,5	187
	C	33,0	22,0	254	30,7	21,4	247	20,2	18,4	185
	D	32,7	22,0	255	31,0	21,1	249	20,4	18,7	187
	E	32,7	23,0	268	31,0	22,0	263	20,3	19,4	196
	F	32,6	23,0	269	31,1	22,2	267	20,4	19,6	198
	G	32,6	23,0	268	30,8	22,0	260	20,2	19,3	193
	H	32,6	23,1	269	31,2	22,0	261	20,4	19,4	193
60% WO/ 40% PES	I	32,4	22,5	257	30,7	21,1	255	20,4	18,5	181
	J	32,4	22,3	256	31,0	21,6	248	20,3	18,9	183
	K	32,8	22,2	252	30,8	21,2	246	20,4	18,6	182
	L	32,5	22,6	251	30,9	21,4	245	20,3	18,8	178
	M	32,2	23,3	263	30,6	22,4	260	20,2	19,6	191
	N	32,3	23,5	268	31,0	22,5	260	20,3	19,6	191
	O	32,4	23,1	265	31,0	22,2	261	20,4	19,4	190
	P	32,2	23,2	266	30,8	22,2	261	20,2	19,3	191

From the analysis of the results presented in table 3, it can be seen that, regardless of the weave and composition, fabrics produced with 4,4 dtex polyester fibre present a weft density slightly higher than that of fabrics produced with 2,4 dtex polyester fibre. As far as the warp densities are concerned, there are no significant differences. On the other hand, and as a result of the higher weft densities, fabrics produced with 4,4 dtex polyester fibre have a higher weight per square meter than fabrics produced with 2,4 dtex polyester fibre. These weight differences are apparently related to the significant difference in shrinkage between the two polyester fibres used, as the 2,4 dtex fibre has 4% while the 4,4 dtex fibre has 11%. This significant difference in shrinkage between the two polyester fibres directly conditions the shrinkage of the fabrics when they are subjected to finishing operations, such as termofixation.

The fact of density differences in the warp is explained by the fact that the fabrics are stretched in the direction of the weft during the termofixation process, thus not allowing them to shrink, regardless of the shrinkage of the polyester fibre that constitutes them. On the other hand, the existence of differences in weft densities is explained by the fact that there is a need to slightly overfeed the fabrics, for reasons related to the process, thus allowing them to shrink in the direction of the warp, which is higher or lower, depending on the shrinkage of the polyester fibre.

CONCLUSION

The results found in this study trigger a possible need to introduce a new variable in the calculations of the technical construction of the fabrics, since two fabrics with the same construction on the loom present, after the finishing process, differences in the number of yarns to the weft and consequently differences in weight per square meter. This new approach shows that the commonly used construction characteristics (reed, reed width, number of yarns/cm in the warp, number of yarns/cm in the weft and linear mass of the yarns) are not, by themselves, sufficient to guarantee that the desired structural features in the finished fabrics are complied with, since any significant change in the shrinkage characteristics of the polyester fibre used requires an adjustment/correction in the construction parameters in order to compensate for the differences in the shrinkage of the polyester fibre.

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[5] NP EN 12127:1999. Determinação da massa por unidade de superfície em amostras de pequenas dimensões.