The effect of selected mechanical properties acquired by the KES-F instruments on the level of puckering of cotton fabrics after washing

Lubos Hes, Fatima M. Pinheiro, Miranda M.C. Goncalves and Arthur Cavaco-Paulo

Universidade do Minho, Guimaraes, Portugal

Introduction

Within the wide range of woven fabrics made of synthetic yarns and their blends with cotton, the 100 per cent cotton products still offer the best handle and excellent physiological properties, but their nature leads to the creation of wrinkles and puckers, which have to be avoided in the final product (garment). Therefore, the finishing of these products commonly includes the permanent press treatment, based on the application of the crosslinked (polymerized) resins preferably not containing the free formaldehyde. Moreover, the finishing process also should reduce the shrinking (due to the mercerization), and the handle might be even improved though softeners. Such a long series of individual processes sometimes results in the occurrence of final effects which (owing to some cross-effects) differ from those expected. Since it happened in one Portuguese factory, the people responsible have decided to determine all the mechanical properties of the successful products and the fabrics exhibiting the puckering effects, with the objective of storing the mechanical properties of the quality products and avoiding the wrong finishing approaches. Thus, the quality of the goods is verified not only subjectively, but also by laboratory tests.

As well as the measured mechanical properties, the levels of formability and sewability were also calculated and related to the puckering level determined subjectively[1]. As regards the formability F, the concept of Lindberg was used, but based on the direct applications of the results determined by the KES-F instruments, according to the relation

$$F = B\,\varepsilon / 49{,}5. \tag{1}$$

The other parameter, the sewability S_K (according to Kawabata) was calculated by the equation

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$$S_K = 500 \cdot G \cdot LT/2HG5 \cdot W \cdot EMT. \quad (2)$$

Meanings and units of all the parameters mentioned are identical with those published in [2].

Simultaneously with the objective measurement of the mechanical properties of cotton fabrics, the level of puckering of the samples was determined subjectively by a group of factory experts. The results were treated statistically and represented graphically.

Besides the mechanical properties, the thermal-contact feeling of the fabrics was also determined, with special emphasis on the level of the coefficient of variation CV [per cent] of thermal absorptivity b of the tested fabrics. The principal idea of this study depends on the assumption that the puckering fabric should exhibit higher values of CV, since the thermal contact area is poorly defined in this case. The thermal absorptivity b [$Ws^{1/2}/m^2$] measured, e.g. by means of the alambeta instrument[3] expresses the level of warm-cool feeling – see [4].

Experimental

Samples preparation

All the samples of 100 per cent cotton twill were subjected to various kinds of finishing treatment, ranging from desizing and singeing (for all samples) to mercerization, sanforization and softening. For every treatment group, three samples were prepared. Some of these samples were not washed before being measured by means of the KES-F instruments, other samples (each having three pieces) were washed and pressed. Other groups of samples were subjected to the permanent press treatment, where the temperatures of polymerization were set to 150°C, 160°C and 170°C – see the points PI, P2 and P3 in Figure 1. After the measurement, these samples were washed and measured again.

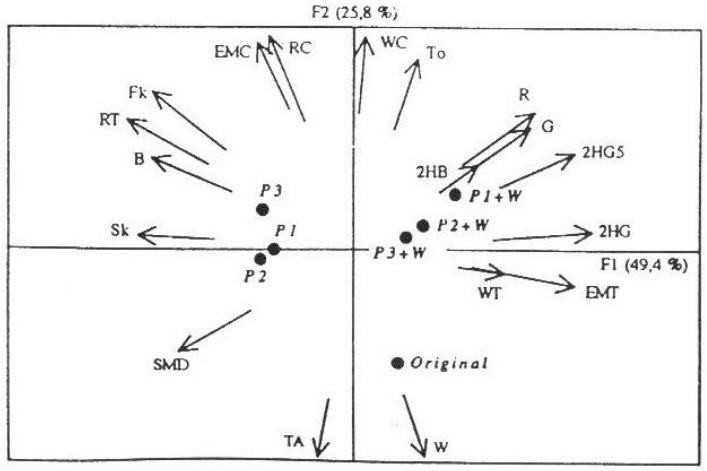

Figure 1.
Vector map of changes of mechanical and thermal properties of cotton fabrics due to resin crosslinking (polymerization) P and washing W

Statistical treatment of results

All the mentioned results were demonstrated either by simple diagrams, or by the vector diagrams, applying the multivariate analysis method according to Bishop and Cox[5]. Data for the vectors map were obtained by principal components analysis. The co-ordinates of the vectors are "the factor scores coefficients" for each parameter and "the factor scores" are given by the position of each fabric sample on the maps. A high correlation between data of two different parameters is evaluated by the projection of one vector on to the other. The values of the mechanical parameters of the fabrics are obtained from their projections on to the respective parameter vectors.

It has to be mentioned, that in this study the values of mechanical parameters for weft and warp direction were not treated separately, but medium values were used for simplicity.

Results evaluation

Figure 2, characterizing one of the samples, should serve as a proof that washing reduces sewability and formability of the tested fabrics and some of the selected parameters as well, which results in lower resistance against puckering. The final pressing recovers this lack just partially.

According to Figure 1, the unwashed samples containing the resin crosslinked at various temperatures P1, P2, P3 are always very resistant to puckering, but washing (W) partially reduces this advantage. It has to be noted, that there were also some other samples treated in different way, or samples with slightly increased yarn density (both in weft and warp direction), which had shown good resistance to puckering after washing.

From the comparison of the KES-F mechanical properties of tested fabrics with their resistance to puckering, it may be concluded that the best resistance

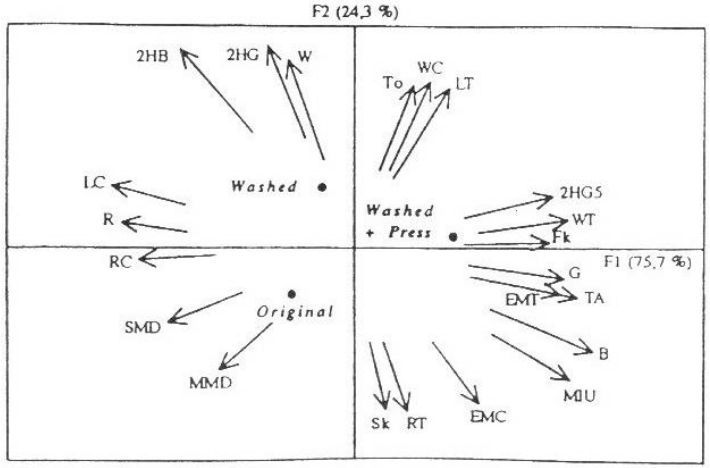

Figure 2.
Vector map of changes of mechanical and thermal properties of cotton fabrics due to washing and pressing

is shown by samples exhibiting high values of 2HB, 2HG and 2HG5 and sewability as well. To some extent also higher levels of B, G and formability help to keep the samples smooth – see Figures 3-7. Note that the values for weft and warp direction may be different.

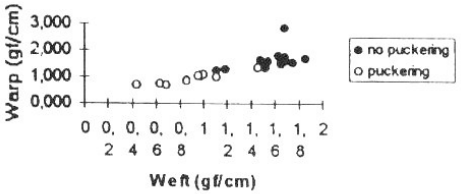

Figure 3.
Graphic correlation between warp and weft for values of (G)

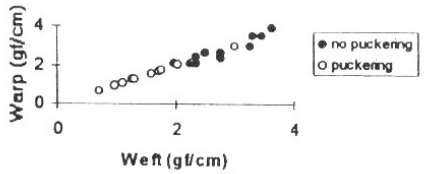

Figure 4.
Graphic correlation between warp and weft for values of (2HG)

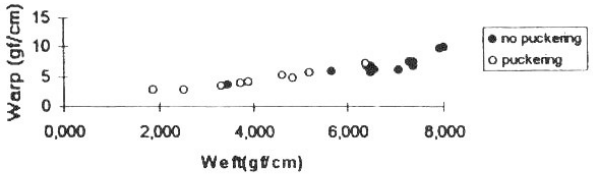

Figure 5.
Graphic correlation between warp and weft for values of (2HG5)

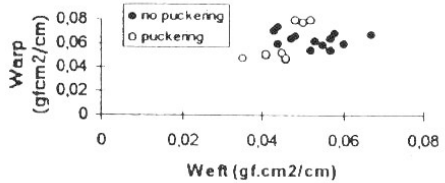

Figure 6.
Graphic correlation between warp and weft for values of (B)

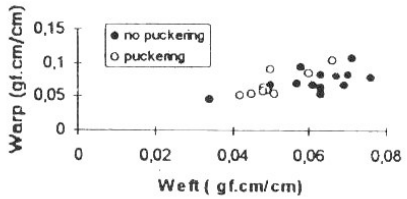

Figure 7.
Graphic correlation between warp and weft for values of (2HB)

In the study, the idea of correlating the occurrence of fabric puckering with the level of the variation coefficient of thermal absorptivity of the tested samples was also investigated, since the uneven surface of puckered fabric, when being measured by means of the the alambeta instrument, should theoretically exhibit higher dispersion of such a surface characteristic as the mentioned thermal absorptivity or q_{max} (when evaluating the warm-cool feeling of fabrics by means of the thermolabo instrument). Unfortunately, the results did not verify the validity of this assumption for all the fabrics tested within the mentioned project.

References

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