World Applied Sciences Journal 24 (4): 503-506, 2013
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2013.24.04.186

The Effects of Weave Structure and Yarn Fiber Specification on Pilling of Woven Fabrics

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Submitted: Mar 13, 2013; **Accepted:** Apr 21, 2013; **Published:** Aug 18, 2013

Abstract: Pilling is a serious problems in clothes, not only impairs its appearance but also reduces its service life. Several factors involved have been identified by some researchers. In this paper the combined effect of weave type and weave density on pilling has been studied. Worsted fabrics with plain, twill 2/1 and twill 2/2 weave patterns and different warp/weft density are subjected to abrasion test and pilling intensity is evaluated by counting the pills. It is shown that these two factors influence the total floating yarn length [L]. It is also shown that L has a considerable effect on pilling. An empirical equation is introduced relating the combined effect of weave type and fabric density to L. Also the effect of reduced ultimate bending stiffness on pilling has been tested by three kinds of low pilling polyester. ASTM D4970 is used in this research. In this method for better displaying the results, instead of comparing the tested specimens with visual standards and evaluated degree of fabric pilling by scale ranging 5 to 1, the number of pills was counted. The results shows that the pilling decreased with increasing the yarn and fabric density however in order to preserve the products feature and properties, the use of modified polyester yarn are preferred which is also reducing the pilling.

Key words: Pilling · Weave Type · Fabric Density · Yarn Floating Length · Low Pilling Polyester · Ultimate Bending Stiffness

INTRODUCTION

Pilling on fabrics is a well-known phenomenon, which is defined as the entangling of fibers during washing, dry cleaning, testing, or wears to form balls or pills that stand proud of the surface of a fabric. During pilling, fibers become entangled and the different fibers around them join this structure, causing a more significant default on the fabric surface [1, 2]. As one of the results of fabric abrasion, the unsightly appearance of pilling can seriously compromise the fabric's acceptability for apparel. Pills are formed in four stages: fuzz formation, entanglement, growth and wear-off [3].The yarn kind and fabric type are two of the most important parameters that affect pilling. The loose structure of yarn and fabric are effective on fuzz formation and more pill production [4]. Pilling became an even more serious problem after the development and wide use of man-made fibers in textiles because fibers with higher tensile strength delay the wear-off stage. Many researches [5, 6], investigated the pilling performance of synthetic blend fabrics, they reported that as the polyester fiber content in a PES/wool fabric increases the pilling gets worse. Earlier, Gintis and Mead [7] ranked the fibers according to their fuzz tendency from minimum to maximum as acetate, wool, PAC (Orlon), PES (Dacron), viscose and PA (nylon). However, man-made fibers, especially blends of polyester and wool fibers are widely used nowadays because of their cost efficiency and suitable end-use possibilities. Therefore, suitable yarn and fabric parameters and finishing processes should be chosen to reduce the pilling tendency of these synthetic fibers [5, 8, 9]. The Wool Science Review also reported that the number of warp and weft threads per unit length should be increased by 30% to be able to reduce fabric pilling significantly, although this seems quite impractical [10]. Among the woven fabric parameters that effect pilling, weave pattern and weave density seems to be the most important. Twill fabrics are well known because of their loose structure, since this causes easier fiber migration compared to plain fabrics. In this study, the effect of weave pattern and weave density on pilling was shown with a parameter which is called total yarn

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floating length [L]. Another way to reduced fabric pilling is the option adopted for low-pill polyester yarns, of weakening (reduced ultimate bending stiffness) the fibers, leading to rapid break-off of pills due to fiber fatigue [11]. The effect of reduced ultimate bending stiffness on pilling by three kind of low pilling polyester has been tested.

MATERIALS AND METHODS

Yarns: In this study three kinds of wool / polyester (45% / 55%) R48/2 Nm yarn spun on the worsted spinning system. The specifications of wool tops and three kinds of polyester were used in the experiments are shown in Table 1.

Fabrics: Fabrics were woven with three weave types and several warp and weft picks/cm which the terms of trade are widely used. Then the fabrics were finished by standard worsted route. The technical data of the fabrics are given in Table 2.

Conditioning and Pill Testing: The fabrics were conditioned for 24h at a temperature of 20 ± 2 °C and relative humidity of 65 ± 2%, as specified in the standard. Pilling test of the fabric samples was carried out on Martindale Abrasion Tester according to modified ASTM D4970. The samples were chosen from commercial products of an industrial factory and hence there was few differences between their warp and weft pick/cm resulted in a little difference between their pilling. Therefore for better displaying of the result, instead of comparing the tested specimens with visual standards and evaluated degree of fabric pilling by scale ranging 5 to 1, the number of pills was counted. The results are shown in the Table 3. Outlines of the experimental design are shown in Figure 1.

Table 1: The specifications of fibers

Fiber	Mean fiber length mm	Fiber fineness	Tops liner density g/m
wool	68-70	22.5 µm	20
Polyester (Iran Polyacril Co.)	75-80	3.6 dtex	20
Trevira 220 (Hoechst)	75-80	3.3 dtex	20
Trevira 350 (Hoechst)	75-80	3.3 dtex	20

Table 2: The technical data of the fabrics.

Kind of Polyester	Weave Type	Sample Number	Warp Picks/cm	Weft Picks/cm
Polyester (Iran Polyacril co.)	plain	1	23	21
	plain	2	22	20
	2/1 Twill	3	30	26
	2/1 Twill	4	30	22
	2/2 Twill	5	30	25
	2/2 Twill	6	28	25
Trevira 220 (Hoechst)	plain	7	23	21
	2/1 Twill	8	31	21
	2/1 Twill	9	27	23
	2/2 Twill	10	30	23
Trevira 350 (Hoechst)	plain	11	23	21
	2/1 Twill	12	30	25
	2/2 Twill	13	30	23

Table 3: The total yarn floating length and Pill count results for sample fabrics

Sample Number	L mm	Number of pill	Sample Number	L mm	Number of pill
1	0.91	15	8	1.28	14
2	0.96	14	9	1.24	15
3	1.1	19	10	1.54	22
4	1.24	22	11	0.91	2
5	1.47	25	12	1.13	2
6	1.51	25	13	1.28	3
7	0.91	8	14	1.54	5

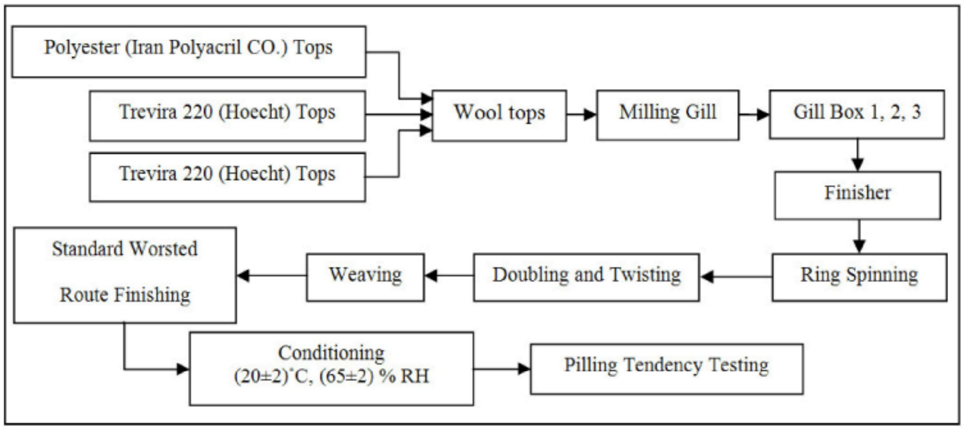

Fig. 1: Flowchart of the experimental design.

RESULTS AND DISCUSSION

Combination Effect of Weave Type and Fabric Density on Pilling: Greaves [12] and Göktepe [2] showed that both the number of warp and weft threads per unit length and weave type affect on pilling separately. In this paper, a new parameter called total yarn floating length L was identified which shows the effect of two above-mentioned parameters, simultaneously. L Value can be determined using Equation 1. Equations 2 to 4 present the L value formulation for different weave types used in this study.

Total Yarn Floating Length [L] = Warp Floating Length + Weft Floating Length (1)

$$L(Plain)(mm) = \frac{10}{(WarpPicks)/cm} + \frac{10}{(Weft\ Picks)/cm} \quad (2)$$

$$L(2/1Twill)(mm) = \frac{10}{(Warp\ Picks)/cm} + \frac{20}{(Weft\ Picks)/cm} \quad (3)$$

$$L(2/2Twill)(mm) = \frac{20}{(Warp\ Piks)/cm} + \frac{20}{(Weft\ Piks)/cm} \quad (4)$$

The total yarn floating length and the number of counted pills of the fabric samples are given in Table 3.

Figure 2 shows the effect of L on the pilling for different types of polyester. It can be seen that, with increasing the L value in the fabrics, pilling was increased. It indicates that, the pilling can be controlled by production of yarns and fabrics with higher density which controls the fuzz formation stage [13]. Although, this is a simple solution, but it reduces the comfort and good aesthetics of the fabrics [11].

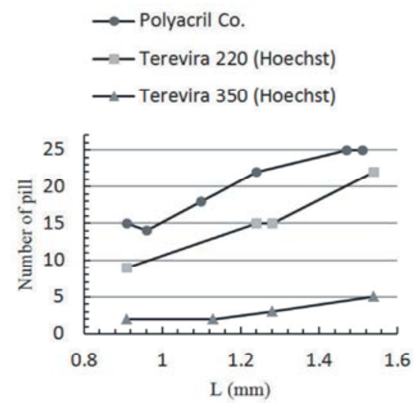

Fig. 2: The effect of L on pilling.

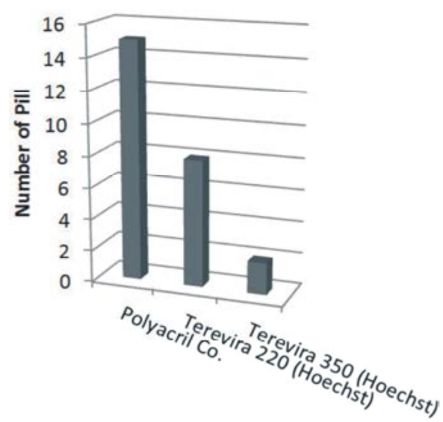

Fig. 3: The effect of polyester types on pilling.

The Effect of Polyester Type on the Pilling: In order to study the effect of polyester type on the pilling, the number of pills in samples 1, 7 and 11 produced from three different polyester types include, Iran Polyacril, Trevira 220, Trevira 350, respectively, with similar warp and weft density and weave type and hence equal L values were compared in Figure 3.

From Figure 3 it can be seen that sample 1 from Iran Polyacril co. has the pill number of 15 which was the highest among these three samples. For reducing the pilling tendency of the fibers in this company, the tenacity of the polyester fibers was reduces to 2.5 g/den. Therefore, it can be concluded that the method used by Iran Polyacril co. to produce polyester fibers with low pilling was not that effective.

On the other hand, the number of pills in sample 11 (Trevira 350) from Hoechst was as low as 2. For this sample, the modification of the chemical structure of the polyester caused the change in the fibers and fabrics properties during dying process resulted in reduced ultimate bending stiffness. Therefore the generated pills were separated from the fabrics as fast as their generation.

Ultimate bending stiffness of Trevira 220 and Trevira 350 are 4500 and 800, respectively which is in consistent with the number of generated pills in the fabrics. It can be concluded that the ultimate bending stiffness of polyester fibers has a direct effect on the pilling, as the ultimate bending stiffness is lower; the number of generated pills in the fabrics is lower as well.

CONCLUSIONS

The effect of weave type, weave density and yarn fiber specification on pilling was investigated in this paper. Although the weave structure affect on pilling, it also effect on the fabric properties and its end-use, therefore the weave structure cannot be considered as an effective factor for reducing pilling. Pilling of the worsted fabrics can be controlled by the modification of the polyester properties especially its ultimate bending stiffness. The use of modified polyester can make a balance between the reduction of the pilling and the bulky of the yarns. Existing errors may be due to the low difference in warp and weft density of the samples because of the choosing of the samples from commercial product or truncate of the results.

REFERENCES

1. Xin, B., J. Hu and H. Yan, 2002. Objective Evaluation of Fabric Pilling Using Image Analysis Techniques. Textile Research Journal, 72(12): 1057-1064.
2. Göktepe, Ö., 2002. Fabric Pilling Performance and Sensitivity of Several Pilling Testers. Textile Research Journal, 72(7): 625-630.
3. Zhang, J., X. Wang and S. Palmer, 2007. Objective Grading of Fabric Pilling with Wavelet Texture Analysis. Textile Research Journal, 77(11): 871-879.
4. Baird, M.E., P. Hatfield and G.J. Morris, 1965. Pilling of Fabrics, A Study of Nylon and Nylon Blended Fabrics. Journal of the Textile Institute, 47(3): 181-201.
5. Sivakumar, V.R. and K.P.R. Pillay, 1981. Study of Pilling on Polyester/Cotton Blended Fabrics. Indian Journal of Textile Research, 6(1981): 22-27.
6. Moghassem, A.R., A.A. Gharehaghaji, S. Shaikhzadeh Najar, M. Palhang and M. Shambeh, 2010. Application of Artificial Neural Nets in Carpet Thickness Loss Prediction. World Applied Sciences Journal, 9(2): 167-177.
7. Gintis, D. and E.J. Mead, 1959. The Mechanism of Pilling. Textile Research Journal, 29(7): 578-585.
8. Ukponmwan, J.O., A. Mukhopadhyay and K.N. Chatterjee, 1998. Pilling (Textile Progress). The Textile Institute.
9. Doustaneh, A.H., M. Gorji and M. Varsei, 2010. Using Self Organization Method to Establish Nonlinear Sizing System. World Applied Sciences Journal, 9(12): 1359-1364.
10. Anonymous, 1972. Wool Science Review. International Wool Secretariat, Development Centre, 43(1972): 26.
11. Hearle, J.W. and A.H. Wilkins, 2006. Mechanistic Modelling of Pilling. Part II: Individual-Fiber Computational Model. Journal of the Textile Institute, 97(4): 369-376.
12. Greaves, R.L., P.H. Roche and M.A. White, 1981. The Pilling Behavior of Wool-Blend Fabrics. Processed on the Short-Staple System. Textile Research Journal, 51(10): 681-682.
13. Miao, M., 2004. The Knitwear Paradox: Handle and Bulk Versus Pilling, where is the Balance? In the Proceedings of the 2004 World conference of The Textile Institute, Shanghai, People's Republic of China.