Fabric Tensile Strength as Affected by Different Anti pilling Agents at Various Concentration and pH Levels

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Summary: Pilling is a phenomenon that has a long cause trouble in textile industry. It is the formation of pills or knops on the surface of woven or knitted fabrics caused by friction and abrasion. If fabric has a pronounced tendency to pilling, their appearances suffer severely after a short period of use. The pilling of fabrics is a serious problem for the apparel industry. The use of anti pilling finishes is one of the best techniques to control the pilling of the fabric. In this method fabric is treated with special anti pilling agents to prevent pilling that promote adhesion of the fibres in the yarn or the fabric. This paper endeavors to optimize the application of different anti pilling agents at different concentration and pH levels on the Tensile Strength of P/C fabric for best results. The results exposed that different anti pilling finishes have significant effects on the Tensile Strength of fabric at different concentration level however different pH levels have no considerable effects.

Introduction

Pilling may be defined as a surface fabric fault comprising of circular accumulations of entangled fibers that cling to the fabric surface thereby affecting the appearance and handle of the fabric. The pilling of fabrics is a serious problem for the apparel industry. It is realized that the problem of pilling is one of the biggest quality issues for the wool industry. The formation of pills occurs as a consequence of mechanical action during washing or wear. Under the influence of mechanical action, loose fibers that protrude from the fabric surface entangle. Subjected to further mechanical action the entanglements develop into roughly spherical accumulation of fibers (pills) that are distinct from the fabric surface. Wear-off of pills occurs under continued abrasion from laundering, drying, etc., and during wear [1]. The pilling propensity of the fabric depends on the surface fuzz formation, the rate of fuzz entanglement, and finally the rate of pills breaking off. The rate of the pills breaking off is directly related to the tenacity of the anchor fibers. Pilling of fabric changes the aesthetic properties. The smoothness, color and general handle of the fabric can be compromised. Pilling prevention is an ongoing challenge for manufacturers of cotton, polyester and blended fabrics. Polyester is often added to cotton fabric to improve product economics while increasing tenacity and resiliency. This increase in tenacity can be troublesome with respect to pilling. Cotton fibres have a lower tenacity, and as the pilling are further mechanical actions. Once the tenacity of the fabric is increased with added polyester, the pill break-off rate is much lower [2]. For the textile finisher, there are three common methods like Heat setting, Shearing and Singeing and Anti pilling finishes for reducing the pilling tendency of polyester staple fibre [3]. The finish has to cement the fibers within the yarn so that their dragging becomes more difficult, without affecting the handle adversely. The enzyme most widely used in finishing processes involving cellulosic fibre is cellulose. This enzyme is used extensively in the bio polishing of cellulosic fabrics. Bio polishing can be applied to the fabric to remove the pills and fuzz from fabric surface, to reduce the tendency of pilling, to improve the fastness, drape, flexibility and luster. Bio polishing consists of cellulose enzyme treatment to give a partial hydrolysis of cotton, so the short fibre ends are hydrolyzed, leaving the surface of fibres free and providing more even look [4]. The influence of different anti pilling finishes at various concentration and pH levels on the quality parameters of fabric has been reported. However the manipulation of these factors on the tensile strength (warp wise and fill wise) of P/C fabric has not been studied in Pakistan. This paper weighs up the performance of the application of different anti pilling agents at various doze and pH levels to optimize the quality of P/C fabric in respect of its Tensile Strength (warp wise and fill wise) for best manufacturing results.

Results and Discussion:

Fabric Tensile Strength (lbs)

Warp Wise

The analysis of data regarding the tensile strength in warp direction of polyester/cotton fabric as observed under the effect of six types of anti

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pilling agents (F) which are F_1 (Metastab ZC), F_2 (Texicil GC), F4 (Knittex RCT), F5 (Dicrylan PSF) and F6 (Wuxizyme RCL) under varying concentration(C) and pH level is presented in Table-1. All variables and interaction of F and C had highly significant effect on the warp wise tensile strength of the fabric except pH that showed non significant effect along with the other possible interactions.

Table-1: Analysis of variance for fabric warps wise tensile strength.

S. O. V	D. F	S. S	M. S	F. Value	Prob.
F	5	94.19	18.838	1883.80	0.0000**
C	5	1520.86	304.173	30417.30	0.0000**
P	3	0.04	0.013	1.30	0.2177Ns
F×C	25	32.48	1.299	129.90	0.0000**
F×P	15	0.14	0.009	0.90	0.4984Ns
C×P	15	0.09	0.006	0.60	0.8670Ns
Error	75	0.74	0.010		
Total	143	1648.54			

C. V. = 0.32% ** = Highly significant Ns = Non-significant

The statistical comparison of individual treatment mean values regarding the tensile strength in warp direction of polyester/cotton fabric treated with different anti pilling agents is presented in Table-1a. The best value regarding the fabric tensile strength was recorded for F5(Dicrylan PSF) i.e 123.33lbs while the other values are 121.42 lbs, 121.37 lbs, 122.50 lbs, 123.18 lbs and 121.65 lbs for F_1 (Metastab ZC), F_2 (Texicil GC) , F3 (Appretan N 9211), F4 (Knittex RCT) and F6 (Wuxizyme RCL) respectively. Whereas the warp wise tensile strength of untreated (control) P/C fabric was recorded as 130 lbs. It can therefore be concluded that different anti pilling agents show different levels of activity, hence caused different level of strength and weight loss as compared to untreated fabric. This is because the enzyme treated fabrics exhibited about 12-18% strength loss caused by the enzyme treatment, which degraded the fabric strength. The loss in breaking strength is consistent with fabric weight loss, a predictable out come of an effective enzyme treatment [5]. In the same line another study disclosed that the enzyme treatment significantly reduced both tear strength and dye uptake of the fabrics. Enzyme treated and successively dyed fabric showed different colour fading profiles as compared to untreated fabrics after laundering [6].

The comparison of individual treatment mean values concerning to fabric warp wise tensile strength due to different concentrations (C1, C2, C3, C4, C5, C6) presented in Table-1a. It shows that all of the values differ significantly from one another. The best value is obtained for C1 as 126.90 lbs, while other mean values are recorded 125.63 lbs, 123.02 lbs, 120.57 lbs 119.38 lbs and 117.94 lbs for C2, C3, C4, C5 and C6 respectively. These results disclosed that with the increase of concentration the tensile strength of fabric decreased. These findings are in line with the observations that a significant strength loss in both warp and fill direction occurred by increasing the enzyme concentration and evaluated that 0.82 GCU/g decreased 50% strength and increasing the enzyme concentration to 4.1GCU/g produced an additional 13%decrease in both warp and filling directions [7]. Similarly in a previous study it was observed that there was no difference in the hydrolysis efficiency between the purified Cellulose and Cellulose mixture however with the highest enzyme dosages significantly higher amount of cotton were hydrolyzed by the cellulose mixture then by the purified celluloses thus reduced the strength [8].

Table-(1a):Individual comparisons of treatment mean values for fabric warp wise tensile strength (lbs).

Finish Type	Concentration	pH
F1= 121.42 e	C1= 126.90 a	P1= 122.23
F2= 121.37 e	C2= 125.63 b	P2= 122.27
F3= 122.50 c	C3= 123.02 c	P3= 122.24
F4= 123.18 b	C4= 120.57 d	P4= 122.23
F5= 123.33 a	C5= 119.38 e	
F6= 121.65 d	C6= 117.94 f	

Mean values having different letters, differ significantly at 0.05 level of probability

Weft Wise

The analysis of data regarding the tensile strength in weft direction of polyester/cotton fabric under varying concentration(C) and pH level is presented in Table-2. All variables and interaction of F and C had highly significant effect on the weft wise tensile strength of the fabric except pH that showed non significant effect along with the other possible interactions.

The statistical comparison of individual treatment mean values regarding the tensile strength in weft direction of polyester/cotton fabric treated with different anti pilling agents is presented in Table-2a. The best value was recorded for F3 (Appretan N 9211), i.e 101.81 lbs while the other values are 100.95 lbs, 101.10 lbs, 101.81 lbs, 101.45 lbs, 101.6o lbs and 100.60 lbs for F_1 (Metastab ZC), F_2 (Texicil GC), F4 (Knittex RCT), F5 (Dicrylan PSF) and F6 (Wuxizyme RCL). Whereas weft wise tensile strength of untreated (control) polyester/cotton fabric was recorded as110 lbs. It can therefore be concluded that different anti pilling agents show different levels of activity, hence caused different level of reduction in strength as compared to that of untreated fabric. The present results are in agreement with the findings that when some finishes are applied

on the surface of the fabric in order to improve its wrinkle recovery, smoothness and general appearance, the cross linking of these finishes with the cellulosic structure of the fabric had its disadvantages in the form of the loss in tear and tensile strength of the fabric [9].

Table-2: Analysis of variance for fabric weft-wise tensile strength.

S. O. V	D. F	S. S.	M. S.	F. Value	Prob.
F	5	22.00	4.400	36.67	0.0000**
C	5	2879.06	575.812	4798.43	0.0000**
P	3	0.16	0.053	0.44	0.7215Ns
F×C	25	31.20	1.248	10.40	0.0000**
F×P	15	1.67	0.111	0.93	0.5422Ns
C×P	15	2.01	0.134	1.12	0.3579Ns
Error	75	9.03	0.120		
Total	143	2945.13			

C. V. = 0.34% ** = Highly significant Ns = Non-significant

The comparison of individual treatment mean values concerning to fabric weft wise tensile strength due to different concentrations (C1, C2, C3, C4, C5, C6) presented in Table-2a. It shows that all of the values differ significantly from one another. The best value is obtained for C1 as 106.87 lbs, while other mean values are recorded 105.64 lbs, 103.15 lbs, 100.38 lbs 97.29 lbs and 94.25 lbs for C2, C3, C4, C5 and C6 respectively. These results indicate that the increase in the concentration of anti pilling finishes put negative effect on the strength of the fabric. These findings are in line with the observation that as with the increase in concentration of finishing agents, the strength of treated fabric was decreased correspondingly [10].

Table-(2a): Individual comparison of treatment mean values for fabric weft-wise tensile strength (lbs).

Finish Type	Concentration	pH
F1= 100.95 c	C1= 106.87 a	P1= 101.26
F2= 101.10 c	C2= 105.64 b	P2= 101.28
F3= 101.81 a	C3= 103.15 c	P3= 101.30
F4= 101.45 b	C4= 100.38 d	P4= 101.21
F5= 101.60 b	C5= 97.29 e	
F6= 100.60 d	C6= 94.25 f	

Mean values having different letters, differ significantly at 0.05 level of probability

Experimental

The present research work was initiated in the Department of Fibre and Textile Technology, University of Agriculture Faisalabad, and mainly conducted at Arzoo Textile Mills Ltd. Faisalabad, Pakistan.

The reactive dyed samples of polyester/cotton (70:30) Plain weave fabric having weaving construction 90×76 were collected from the running stock of the mill and treated with different anti pilling agents from different companies i.e F1, F2 and F6 from "ICI"; F4 and F5 from "Swisstex" while F3 from "Clariant", with various concentration and pH levels as given in the table below.

Finish Type (F)	Concentration (g/l)(C)	pH (P)
F1= Metastab ZC	C1= 30	
F2= Texicil GC	C2= 40	P1=3.5
F3= Appretan N 9211	C3= 50	P2= 4.5
F4= Knittex RCT	C4= 60	P3= 5.5
F5= Dicrylan PSF	C5= 70	P4= 6.5
F6= Wuxizyme RCL	C6= 80	

The names of different anti pilling agents given in the table above are their trade names. Basically F1 and F2 are Formaldehyde (Dimethylol dihydroxyethylene urea); F3 is a binder (acrylates copolymer dispersions); F4 and F5 are cross linking agents (modified dihydroxyethylene urea) while F6 is of enzymatic basis.

Application of Anti Pilling Agents

Procedure

Anti pilling agents were applied on the polyester/cotton blended fabric by using different concentrations and pH level as mentioned above at same time and temperature that is different for different anti pilling agents. The process is accomplished by padding fabric through a water solution of the three components to a wet pickup of about 60%, drying and curing at an elevated temperature [11].

Recipes

Recipe # 1

Metastab ZC	30-80 g/l
Magnesium Chloride	15% (of resins weight)
PH	3.5-6.5
Pick up	60%
Drying temperature	120 °C
Curing temperature	170°C
Curing time	30 sec

Recipe # 2

Texicil GC	30-80 g/l
Softicone SME	10g/l
Magnesium Chloride	15% (of resins weight)
PH	3.5-6.5
Pick up	60%
Drying temperature	110 °C
Curing temperature	150°C
Curing time	30 sec

Recipe # 3

Apprretan N 9211	30-80 g/l
Cassurit MFB Liq	15g/l
Tylose C6000 gr1	6g/l
PH	3.5-6.5
Pick up	60%
Drying temperature	120 °C
Curing temperature	120°C
Curing time	30 sec

Recipe # 4

Knittex RCT	30-80 g/l
Knittex catalyst Mo	5g/l
Ultratex UM	5g/l
Turfex CAN	4g/l
PH	3.5-6.5
Pick up	60%
Drying temperature	130 °C
Curing temperature	140°C
Curing time	30 sec

Recipe # 5

Dicrylan PSF	30-80 g/l
Ultratex FSA	5g/l
PH	3.5-6.5
Pick up	60%
Drying temperature	130 °C
Curing temperature	150°C
Curing time	30 sec

Recipe # 6

Wuxizme RCL	30-80 g/l
Ultratex FSA	5g/l
PH	3.5-6.5
Pick up	60%
Drying temperature	110 °C
Curing temperature	120°C
Curing time	40 sec

Testing of Fabric Tensile Strength

Scope

To determine the elongation and effective strength of fabric in use that is the strength of the yarns in a specific width, together with the additional strength contributed by adjacent yarns. Fabric tensile strength is measured by using Zweigle tensile tester as described by ASTM standards [12].

Apparatus

Tensile tester (Zweigle F-425)

Procedure

Before specimen preparation the fabric was given three home laundered then specimens were prepared for warp and weft direction. Cut each specimen 100±1 mm (4±0.05") wide and 150 mm (6") long, the dimension paralleled to the direction for which the breaking load is required. Draw a line 37±1mm (1.5 ± 0.024") from the edge of the specimen parallel to the direction of the test used to centre specimen in the clamps, specimen cut parallel to the warp should contain the same set of warp ends, and specimens parallel to the filling should contain the same set of filling picks. Samples should be taken not nearer to the selvage than one tenth of the width of the fabric. Instead of cutting (five) single specimens in each direction, one continuous specimens of 300 mm by minimum of 150 mm in each direction may be cut.

Specimens were given four hours conditioning (20±1ºC and 65±2% RH). Prepared the apparatus, checked the zero point of the scale prior to each series of tests and checked the distance between clamps at start of the test i.e. 200 mm. Then the test specimen was inserted in the clamps so that the line drawn on the sample running parallel with the direction of the test specimen was adjusted to the side of the upper and lower jaws. After clamping the machine was started and breaking force was noted directly from the machine. All the laboratory samples were tested in the same way and mean value for fabric tensile strength was calculated.

Statistical Evaluation of Data

The data thus obtained was analyzed statistically using Completely Randomized Design and M-Stat Micro-Computer Statistical Program [13, 14].

Conclusion

The present research study was planned in order to optimize the application of different anti pilling agents at different concentration and pH levels on the Tensile Strength of P/C fabric for best results in respect of its strength .The results revealed that various anti pilling agents from different chemical companies with altered compositions showed different levels of activity on fabric tensile strength. However among all the used chemicals, the Dicrylan PSF(from Swisstex) and Appretan N 9211(from Clariant) showed the best results in respect of weight loss of fabric i.e to reduce fabric strength warp wise and weft wise respectively. Similarly various level of

chemical concentration exposed significant effects on the Tensile strength of the fabric. Among all the concentration levels of chemicals, 30g/l gave the best results regarding the tensile properties of the P/C fabric disclosing that the lower concentration level of finishes put positive results on the tensile properties of the fabric. While variou pH levels of anti pilling finishes used in this study had no significant effect on the Polyester/ Cotton fabric tensile strength.

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