Survey of the Anti-pilling Treatment of Polyester/Cotton Fabric

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Abstract: *Pilling is caused by a natural fibre migration from the yarns to the fabric surface as the fabric rubs against itself, another fabric, or even the skin. The main aim of this research is to investigate the effect of anti-pilling treatment on polyester/cotton fabric by using the anti-pilling agent. The objectives of this research are to apply the anti-pilling agent on polyester/cotton fabric with various concentrations and to analyse the effects of anti-pilling treatment on polyester/cotton fabric. Physical properties of the anti-pilling treated fabric such as air permeability, fabric stiffness, breaking strength and crease recovery are tested and analysed. According to the test results, polyester/cotton fabrics treated with polyacrylate, salicylic acid and amino silicone softener give the pilling resistant effect. The treated fabric* PC_{32} *gives not only the best result of pilling grade but also strength and crease recovery compared with other treated fabrics.*

Keywords: *Pilling, Anti-pilling agent, Air permeability, Fabric stiffness, Crease recovery.*

1. INTRODUCTION:

Pilling is a surface defect of textiles caused by wear, and is considered unsightly [1]. Pilling is a phenomenon exhibited by fabrics formed from spun yarns (yarns made from staple fibres). Pills are masses of tangled fibres that appear on fabric surfaces during wear or laundering. Fabrics with pills have an unsightly appearance and an unpleasant handle. Loose fibres are pulled from yarns and are formed into spherical balls by the frictional forces of abrasion. These balls of tangled fibres are held to the fabric surface by longer fibres called anchor fibres. Fabrics made from cotton, wool or rayon do not usually display pilling problems since the anchor fibres are easily broken and pills fall from the fabric soon after they are formed [2].

Pills observed in worn garments vary appreciably in size and appearance contrast, factors which are not evaluated when pilling is rated solely on the number of pills. The development of pills may be accompanied by other surface phenomena such as loss of cover, colour change, or the development of fuzz. Since the over-all acceptability of a specific fabric is dependent on both the characteristics of the pills tested in the laboratory be evaluated subjectively with regard to their acceptability and not rated solely on the number of pills developed. A series of standard based on graduate degrees of wear of the fabric type being tested may be set up to establish and aid subjective rating. The visual standards are most advantageous when the laboratory test specimens correlate closely in appearance with surfaces during wear or laundering [3].

The simplest method for reducing the tendency of a fabric to pill is to dry into it a solution of an adhesive or resin so as to make the fibres cling more strongly to each other in the yarns and fabric [4]. Anti-pilling agent can be applied to the fabric to remove pills and fuzz from fabric surface and to reduce the tendency of pilling. This research is intended to apply the anti-pilling agent on polyester/cotton fabric by using pad-dry-cure method. In this study, polyacrylate is used as anti-pilling agent in order to get the anti-pilling effect, salicylic acid is used as carrier and amino silicone is used as fabric softener.

2. EXPERIMENTAL PROCEDURE:

2.1 Collection and Preparation of Raw Materials

Polyester/cotton fabric is collected from local market. Polyacrylate, salicylic acid and amino silicone softener are collected from local market also. And then, various concentrations of anti-pilling solutions are prepared.

For sample fabric PC_{11}, 60 g of polyacrylate, 5 g of salicylic acid and 10 g of silicone softener are weighed by using the Electronic Analytical Balance. Salicylic acid is dissolved into the hot water. The total volume of anti-pilling solution is 1000 ml and it is ready to apply on the polyester/cotton fabric in order to get the anti-pilling effect. And then, other concentrations of anti-pilling solutions are prepared as above the procedure.

3. EXPERIMENTAL PROCEDURE:

The sample fabric of 13 in × 15 in (33.02 cm × 38.10 cm) is cut and conditioned in standard atmosphere about 12 hours. Before treating with anti-pilling solution, sample fabric is wetted with cool water. And then, the pre-wetted sample fabric is padded with anti-pilling solution by using padding mangle. The various concentrations of anti-pilling solutions and designation of sample fabrics are shown in Table 3.1. During padding, the speed of the machine and the pressure must be maintained at a constant level, otherwise, can cause the unevenness on the surface of the fabric. The machine speed is 5 rpm and the pressure is 2.5 psi. After padding, the padded fabric is dried in a chamber drier at the temperature of 100° C for 3 minutes. And then, the dried fabric is cured at the temperature of 140°C for 3 minutes. After treating, the degree of pilling formation of treated fabrics is tested and assessed by arbitrary rating scales. Physical properties of untreated and treated fabrics are compared and analysed.

TABLE 3.1 VARIOUS CONCENTRATIONS OF ANTI-PILLING SOLUTIONS AND DESIGNATION OF SAMPLE FABRICS

Sr. No.	Polyacrylate (g/l)	Salicylic Acid (g/L)	Silicone Softener (g/L)	Sample Code
1	Untreated	-	-	PC_{00}
2	60	5	10	PC_{11}
3	60	10	10	PC_{12}
4	60	15	10	PC_{13}
5	60	20	10	PC_{14}
6	70	5	10	PC_{21}
7	70	10	10	PC_{22}
8	70	15	10	PC_{23}
9	70	20	10	PC_{24}
10	80	5	10	PC_{31}
11	80	10	10	PC_{32}
12	80	15	10	PC_{33}
13	80	20	10	PC_{34}

4. RESULTS AND DISCUSSIONS:

4.1 Determination the Degree of Pilling Formation

To evaluate the degree of pilling formation, pilling test is done by using the Martindale Abrasion Tester. The machine is run 1000 cycles for all fabrics. The weight of the specimen holder is set at 3kPa and the same fabric is used as abradant. The pilling test is carried out at Department of Textile Engineering in Yangon Technological University. And then, the degree of pilling formation is assessed by comparing with arbitrary rating scales. In this scale, five rating are denoted. Grade 5 represents as no pilling, grade 4 represents as slight pilling, grade 3 represents as moderate pilling, grade 2 represents as severe pilling and grade 1 represents as very severe pilling. Figure 4.1 shows the pilling test results of untreated and treated fabrics. According to the test results, the pilling ratings of all treated fabrics are increased to 2, 2.5, 3, 3.5, 4, and 4.5 after treatment. Among the treated fabrics, PC_{32} gives the best anti-pilling result. It is due to the fact that polyacrylate is surface coating material and it can be linked to cellulose fibre via N-methylol group. Moreover, carrier causes swelling of fibre and allowing larger polymer molecules to diffuse rapidly into the fibres. In addition, amino functional silicone influences on fabric pilling by reducing static and preventing lint from clinging to the fabric surface.

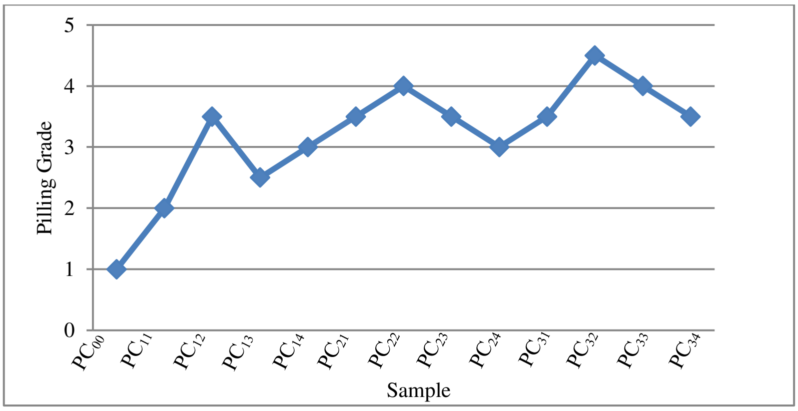

Fig. 4.1. Effect of Anti-pilling Treatment on Pilling Resistant Properties of Untreated and Treated Fabrics

4.2 Comparison the Physical Properties of Untreated and Treated Fabrics

The fabric analysis and determination the physical properties of fabric are done according to the respective ASTM and AATCC Test Methods. These tests are carried out at standard atmospheric condition at (20 ± 2°C) and (65 ± 2% R.H) before the assessment of their properties.

4.3 Air Permeability Air permeability of a fabric is the volume of air measured in cubic centimetres passed per second through 1 cm^2 of the fabric at a pressure of 1 cm of water. Figure 4.2 shows the air permeability of untreated and treated fabrics. According to the results, the air permeability of treated fabrics gradually decreases at higher percentage of polyacrylate. Sample fabric, PC_{34} is the least air permeability which is treated with 80g/l polyacrylate, and 20 g/l salicylic acid and 10 g/l silicone softener among other treated fabrics. It is due to the fact that the crosslinks are formed within the fibre during treatment with anti-pilling solutions and that make the fabric firmer and more compact structure and also less air permeability.

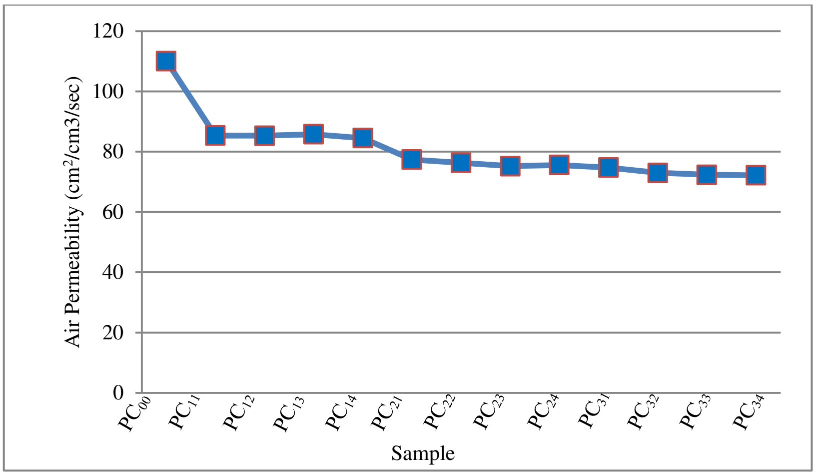

Fig. 4.2. Effect of Anti-pilling Treatment on Air Permeability of Untreated and Treated Fabrics

4.4 Breaking Strength

The breaking strength is a measure of the resistance of the fabric to tensile load or stress in either the warp or filling direction. When the fabrics are treated with anti-pilling solutions, the breaking strength is increased in both directions. The sample fabric, PC_{32} is the highest strength among other treated fabrics. According to theory, polyacrylate consists of copolymers that contain a small number of reactive components which make it possible to fix the chemically to the fibre and it can be linked to fibre without diminishing the strength. Moreover, amino silicone softener decreases fibre to fibre friction by internal lubrication and consequently decreases in fabric pilling. In addition, silicone softener improves physical properties such as strength, abrasion resistance, and so on. Figure 4.3 shows the breaking strength results of untreated and treated fabrics.

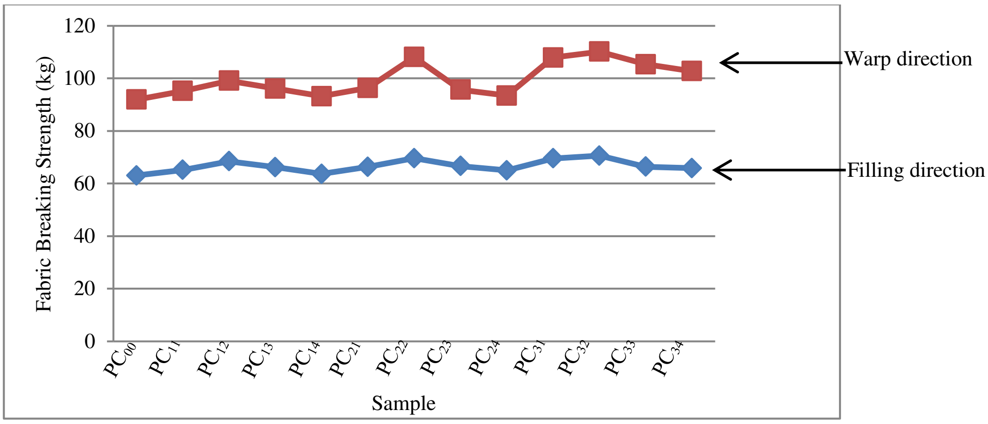

Fig. 4.3. Effect of Anti-pilling Treatment on Breaking Strength of Untreated and Treated Fabrics

4.5 Fabric Stiffness

Fabric stiffness and handling are important factors for textile products. The degree of fabric stiffness is related to its properties such as types of fibre and yarn, fabric structure and finishing treatment. Figure 4.4 shows the overall flexural rigidity of the untreated and treated fabrics. The bending length of the treated fabrics in both warp and filling directions decreases when the anti-pilling solution applies to the fabric. Sample fabric, PC_{34} is the highest overall flexural rigidity among the treated fabrics. It is due to the fact that flexural rigidity of all treated fabrics increases because some of polyacrylate molecule deposit on the surface and lead to stiffer. The propensity to pilling decreases as stiffer fibres are more resistance to entanglement. The thicker the fabric, the heavier the weight and the stiffer the fabric.

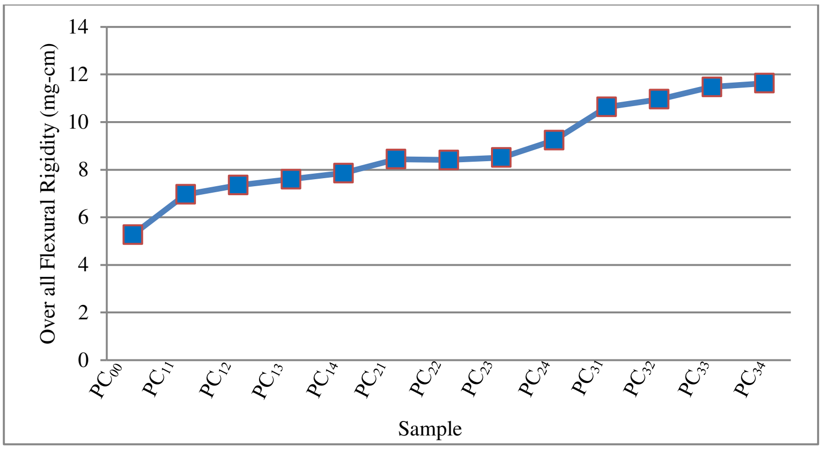

Fig. 4.4. Effect of Anti-pilling Treatment on Fabric Stiffness of Untreated and Treated Fabrics

4.6 Crease Recovery Angle

The crease recovery angle in warp direction is greater than that of the filling direction of fabric because warp yarn is well in quality, strength, treated with sizing, kept in more tension during weaving. Figure 4.5 shows the overall flexural rigidity of the untreated and treated fabrics. The crease recovery angles of all the treated fabrics are greater than that of untreated fabric. Among them, PC_{32} has the highest crease recovery angle in both warp and filling directions. The reason is that polyacrylate, anti-pilling agent may link to the fibre structure and this linking can increase the crease recovery angle. Another reason is that silicone softener can penetrate the inner structure of the yarn providing crease recovery.

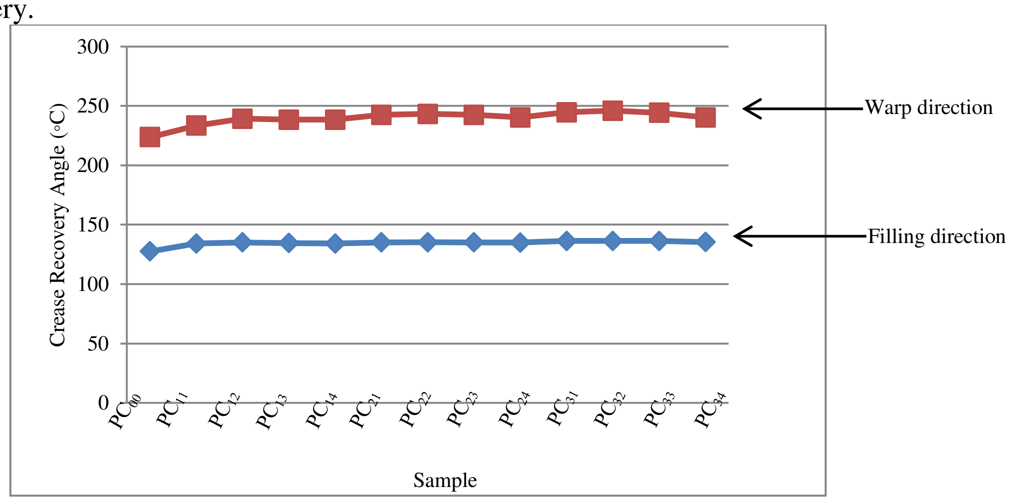

Fig. 4.5. Effect of Anti-pilling Treatment on Crease Recovery Angle of Untreated and Treated Fabrics in Warp and Filling Direction

5. CONCLUSIONS:

In this study, anti-pilling agent is applied to investigate the effect of anti-pilling treatment on polyester/cotton fabric. Pilling test results and related physical properties of untreated and treated fabrics are carefully studied and the following conclusions are reached.

According to these results, pilling propensity of all treated fabrics is less than that of untreated fabric. So, polyester/cotton fabric treated with polyacrylate, salicylic acid and amino functional silicone softener gives more satisfactory appearance than the untreated fabric. Although the pilling grade of all treated fabrics increases, the air permeability decreases and stiffness increases. Therefore, treated fabrics are less comfortable than the untreated fabric. This fact cannot affect the properties of end uses. Therefore, these anti-pilling treated fabrics can be used as clothing such as apparel, dress good, casual and bed sheet. The sample fabric PC_{32} is the best result of pilling grade, strength and crease recovery angle among treated fabrics.

6. RECOMMENDATIONS:

Different concentrations of polyacrylate such as 60 g/l, 70 g/l and 80 g/l are used in this research. Among them, 80 g/l polyacrylate concentration gives the best result of pilling grade. It is recommended that the polyacrylate concentration should be investigated more than 80 g/l concentration.

In the future work, other chemicals for instance enzyme can be used to improve the pilling resistance of fabric. And also, other carrier agents such as diphenyl, di-methyl ester, benzonic acid, ketones and alcohols can be used in anti-pilling treatment. Moreover, nanosilicone softener should be used to improve the pilling resistance of fabrics.

The degree of twist will influence the ability of fibre to migrate to the surface. So, amount of twists of untreated and treated fabrics should be tested. In addition, different types of fabric construction (for example, knitted fabric) should be examined because the construction of the fabric is also important in determining its susceptibility to pilling. Moreover, types of fibre (for example, natural, man-made) can influence the pilling effect. Therefore, various materials such as 100% cotton fabric, cotton/wool, polyester/wool blended fabrics and so on, can be used as sample fabric.

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