Effect of pilling properties on different knit fabrics and recommendation for deciding Pilling Requirement

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Abstract

Pilling resistance is an important property of the knitted fabric. The main purpose of this research work is to provide precise and appropriate test result requirements for different types of knit fabrics with different fiber compositions. The Pilling test result requirement cannot be the same for different types of knit fabrics. But unfortunately, almost the same requirements are mentioned in the quality manual of buyers for knit fabrics with different fiber compositions. In real life, the requirement should be different and this research work was conducted keeping this issue in mind. In this work, the test standard ISO 12945-2 was used in this research work in where NU Martindale Pilling tester used with different pilling cycle/rubs e.g. 1000, 2000, 5000, and 7000 rubs. It was noted that the higher the pilling cycle/rub, the lower the pilling test result and this is the most important outcome from this study. The textile industry, buyers, suppliers, fabric manufacturers, students would be benefited if follow the suggested pilling requirement. Due to the limitations of availability of fabric samples; the researcher used five different types of knit fabrics such as 100% cotton single jersey, 100% cotton double jersey (1X1 Rib), Lycra single jersey(95% cotton 5% Lycra), 100% polyester Fleece, Blended Fleece fabric (60% cotton 40% poly). The future scope is there to conduct this type of research for woven fabrics also. Many researchers worked on pilling properties using this NU Martindale equipment but no study was conducted on the pilling cycles/rubs to see the effect on pilling results and this research work is a new one.

Keywords: *Pilling cycle, pilling Rub, fabric, test, the buyer.*

1. Introduction

Bangladesh is one of the leading exporters of knit garments in the world and this Ready Made Garment (RMG) sector is very much growth potential considering its 2nd (Second) position of RMG export worldwide. Statistically, Bangladesh achieved the ability to export RMG up to 80% compared to the country's total export. This sector is the main driver of Bangladesh's national economy. Bangladesh is well known in the world now for its stunning success in the field of the RMG sector. The shipment of garment products depends on the quality of garments and ultimately on fabric. There are various test properties are associated with fabric quality. There are various types of physical test properties and testing is mandatory to conduct. The Pilling test is one of the most important test properties that are related to the fabric or garment appearance. Aesthetic look or appearance in the finished garment product is the ultimate requirement of buyers.

The researcher realizes the importance of the effect of pilling behavior on various types of knit fabric fabrics. The acceptance of the fabric or garment product depends on the Pass/Fail of the Test report. If the test report is Fail, then buyers will not accept the goods/products. The researcher's observation is that the fabric manufacturer is helpless to meet the requirement of pilling test standard/requirement because fabric manufacturers are following the pilling test standard/requirement mentioned in the quality manual of buyers. The buyers are responsible for developing a quality manual after consultation with the technical expertise. It is to be noted that the pilling test results vary to a large extent depending on two main things; one is the increase or decrease of the number of pilling rubs/cycles and the second one is the types of fiber composition used in the fabric. Unfortunately, most of the buyers mentioned the pilling test standard or requirement in their respective quality manual is not appropriate. Because they mentioned a fixed number of pilling rubs/cycles for any type of knit fabric. In real life, if the fabric composition is fixed as example 100% cotton and the number of pilling rubs/cycles decided as 2000 and if the pilling test result is found as 4 (pilling test result assessed against a standard replica is where the worse pilling grade mentioned as 1 and the best is as 5), it is pretty sure that if the number of pilling rubs/cycles increased from 2000 to 5000, the pilling test results would deteriorate and it could be "3" or lower than this.

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Even if the same number of pilling rubs/cycles were used (for example 2000) for 100% cotton and 100% viscose, definitely the pilling test result of 100% viscose would be lower than 100% cotton fabric. Because the nature of 100% viscose tends to generate more pills due to its inherent fiber properties as well as for its morphological properties. If the number of pilling rubs/cycles increased from 2000 to 5000, the same 100% viscose would generate more pills. So, it is clear that the two parameters are affecting or influencing the overall pilling performance; the increase or decrease of pilling rubs/cycles, and the other one is the types of fiber used in the fabric. Keeping this phenomenon in mind, the researchers decided to conduct this study to remove the technical discrepancy related to the selection of pilling test standards or requirements to make benefited both the buyers and the fabric manufacturers. The present investigation has been conducted with five different types of fabric constructions e.g. 100% cotton single jersey, lycra single jersey (95% cotton 5% lycra), 100% cotton 1X1 rib, 100% Polyester fleece, 60% cotton 40% polyester fleece, etc. A Pilling test has been done for Martindale methods.

Due to the mechanical action involved in washing and wear, the pill formation is responsible. Loose fibers tend to protrude from the surface of the fabric and repeated mechanical action finally forms entanglement with a hairy appearance. Laundering, drying, etc. are also influencing factors for pill formation. For a particular type of fabric, the degree of pill formation depends on some physical properties fiber, yarn structure and fabric contents, fabric construction.

Pilling Mechanism

Cooke (Cooke, 1982) investigated the formation of pill and advised the stages of pill formation:

1. The establishment of a localized area of high fuzz density.
2. The development of a loose entanglement within that area.
3. The tightening of the entanglement into a roughly spherical mass of fiber.
4. The pulling out of the anchor fiber to form a discrete mobile pill;
5. The fracture of certain anchors, with the relocation of the pill.
6. The Fracture of the remnants of pill anchors as well as loss of the pills.

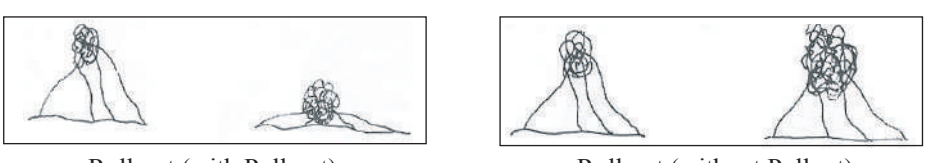
Fuzz Pill-Loose Entanglement Pill-Tight Entanglement Pill-Spiral Entanglement

Fig 1: Pill forming mechanism

According to Gintis and Mead (Gints and Mead, 1959), there are three stages of pilling:

(a) Fibers are drawn to the fabric surface as a result of some mechanical action, and these form fuzz.
(b) The fuzz become entangled and form pills.
(c) Pills tend to wear off under repeated mechanical action, such as laundering, drying, rubbing, cleaning, and during wear.

In cases where the fiber tensile forces are insufficient to overcome frictional forces within the yarn, pill growth is restricted, and the roll-up process leads to pill immobilization and an increased pill life due to the reduced scale of cyclic bending and torsional strain in the fibers (Savile, 1999).



Roll out (with Pull out) Roll out (without Pullout)

Fig 2 : Pilling Stages

The test standard ISO 12945-2 was applied which is used for the testing of Pilling resistance for Martindale Pilling Tester (ISO 12945-2, 2020).

Pilling is one of the key properties of knit fabrics and the aesthetic look and comfort depend on this property. Pilling is a complex issue in the textile and garment industry because many factors influence the pilling behavior even if the garment is made from the fabric with higher quality if proper process control is not followed in each step from the raw cotton stage to readymade garments. The importance of pilling needs to understand by the fabric. If this test property fails, there is a possibility of canceling shipment or order.

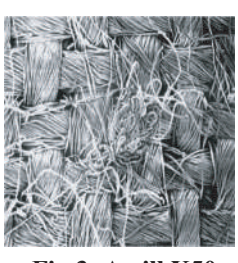


Fig 3: A pill X50

Fig 4: Pilling (Synthetic)

Fig 5: Pilling (Cotton)

Factors affecting pilling:

Numerous researches were conducted to see how the pilling is affected by various factors. It was found that pilling is affected by fiber, yarn, and fabric parameters Apart from this pilling is also affected by the ambient atmosphere.

Effect of Fiber: Pilling is affected by the fiber type, e.g. Polyamide and polyester fibers are most severe for pill formation while acetate and wool are least affected by pill formation (Elshakenkery, 2008) Coarser fibers have fewer tendencies to pill because they are stiff &. Fiber length affects pilling resistance or pilling test results. The long filaments do not break easily and therefore have fewer tendencies to migrate to the surface of a fabric in wear or cleaning. Inter fiber friction affects pilling resistance or pilling. Inter fiber friction is affected by the surface characteristics of the fiber. Fiber crimp affects pilling resistance.

Effect of Yarn parameters: Ring-spun yarn is, in general, more resistant to pilling than open-end spun yarn (Rameshkumar, Kumar, Senthilnathan, Jeevitha and Anbumani ,2008) Regarding yarn count, it was observed that knitted fabrics having finer count suffered from less pilling. The higher the twist in the yarn the less is the pilling because of the compactness and because there is less protruding fiber in the yarn. The doubled yarn gives less pilling than single yarn for the same reason. Fabric made from a blend of fibers forms more pills than a similar fabric made from only one of the blend components. The projecting loops or fibers causing the hairiness are very important because less pilling tendency is observed with fewer projecting fibers (Beltran and Wang, 2013). Fabrics made from singles yarn tend to pill than those produced from plied yarns.

Effect of fabric parameters: Knitted fabrics tend to pill more readily than woven fabrics. Since knitted constructions are composed of a series of loops, a greater amount of yarn surface area is exposed, making them more susceptible to abrasion in wear. Compactness affects the pilling resistance or pilling test results e.g. a very tight, compact construction, such as denim, usually exhibits little or no pilling during its life expectancy. (Gita, Kestutis and Verginijius, 2011) Fabric weight affects the pilling resistance or pilling test results.

Effect of Dyeing and Finishing: Singeing is one of the most important finishing treatments that reduce the pilling Shearing and cropping reduces pilling in polyester/wool fabric. Heat setting at a higher temperature for a suitable duration reduces pilling. The cellulosic material is super steam reduces pilling. Low heat setting temperature for a longer duration in polyester/cotton fabric reduces pilling.

2. Literature Survey

Before study this specific article, "Effect of pilling properties on different knit fabrics and recommendation for deciding Pilling Requirement" a survey and review are required. This is because to ascertain that the exact or very nearly similar study or research activity had been done or not earlier by any research fellow, scientist, students, educationists, etc. It is to be noted that the survey concentrated on the published article in national and international journals. The way of collecting information in this regard is the book, Journal, Internet, etc. In this regard, the internet search did is one of the most effective tools to acquire related information. I followed the same manner and did not find the exact or nearly similar article.

Most of the articles about pilling resistance or pilling properties published in the national and international journals are based on the effect of different chemical treatments, the effect of different dyes auxiliaries like anti-pilling agents, etc. But very few articles were published about the instrument parameters effect of pilling properties.

Muhammet Akaydin and Yahya Can in their article named *Pilling Performance and Abrasion Characteristics of Selected Basic Weft Knitted Fabric in their article published in Fibers and Textiles in Eastern Europe,* (Muhammet and Yahya, 2010), did the study that they tried to find out the pilling performance of two types of fabric; made from Ring Raw and Ring combed cotton. Here NU Martindale pilling tester was used. They used 2000 pilling rub/cycle for the pilling test and the abrasion test, they used 5000 and 7000 cycles. From their study, the effect of pilling properties not covered the major knit fabrics that have demand in the present market.

Mr. Ozer Goktepe in his article named *fabric pilling and sensitivity of several Pilling Tester conduced,* conducted a pilling test using polyester/viscose, polyester/viscose/Lycra, and %100 cotton fabrics in both normal and wet conditions. (Goktepe and Ozer, 2010). The author used the NU Martindale pilling tester and ICI Pilling Box Tester to see the pilling behavior of the mentioned fabric composition versus the effect of instrument types and mechanism of pilling tester. Pilling rub/cycle not considered here.

Bruce A. Mc. Gregor in their article named *A comparison of the ICI Pillbox and the Random Tumble Methods is assessing pilling and appearance change of worsted spun cashmere and cashmere-wool blend knitwear* published in the international journal of Sheep and Wool Science (Gregor and Bruce, 2006) The author studied to see the difference between two international test methods for the assessment of pilling and appearance change of worsted spun cashmere and superfine wool knitwear and their blends. Nu Martindale pilling tester is widely for the pilling assessment of knitwear but in this study, NU Martindale pilling tester was not used.

Muhammed Ali Karat and Osman Babaarslan in their article named *Viscose spun yarn and knitted fabrics properties produced by using different spinning technologies (2020);* published in the International Journal of Polymer and Textile Engineering (Muhammed and Osman, 2020). studied the topic by using ICI Pilling Box Tester and NU Martindale Tester. There is somewhat similarity with my article in terms of the NU Martindale pilling tester. They used the pilling rub/pilling as 500, 1000, 2000, 5000, and 7000. With the increase of the number of pilling rubs the results start to deteriorate. They compared the result by using two instruments; ICI pilling box tester and Nu Martindale pilling tester and they used the material as ring, compact, rotor, vortex spinning system and their material was 100% viscose yarn with a count of Ne 28/1 (21 tex).

3 Methodology

3.1 Sampling Plan

The knitted fabric samples were collected from **JINNAT KNITTING LTD.,** which is a knitting Industry of DBL GROUP, Sardagonj, Kashimpur, Gazipur. The samples were chosen and collected in such a way so that they represent most of the knit products exported from Bangladesh. (TABLE 1: Sampling Plan).