“A comparative study on conventional carded and compact combed yarn on

spirality and bursting strength of various knitted fabrics.”

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Approval Sheet

This project entitled "**A comparative study on conventional carded and compact combed yarn on spirality and bursting strength of various knitted fabrics at Daffodil International University, August 2014** prepared and submitted by in partial fulfillment of the requirement for the degree of BACHELOR OF SCIENCE IN TEXTILE ENGINEERING has been examined and hereby recommended for approval and acceptance.

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Acknowledgement

At first my gratefulness goes almighty Allah to give me strength and ability to complete the thesis report.

Now I wish to take this opportunity to thank a lot of people who have assisted and inspired me in completion of my training period.

My supervisor, Md**.Azharul Islam**, Sr.lecturer,Daffodil International University, to whom I am extremely indebted for his tremendous support and guidance throughout my training period. Being working him I have not only earned valuable knowledge but also inspired by his innovativeness which helped enrich my experience to greater extent. His idea and way of working was truly remarkable.

We are also express our gratitude to **prof.Dr.Mahbubul Haque** Head, Department of Textile Engineering, for his support and continuous guidance throughout our long journey in Daffodil International University and to complete this thesis report.

Weshould like thank the management of Impress Newtex Composite Ltd,for giving me opportunity to do theindustrial training successfully and also their valuable suggestions.

My heartiest thank to, who supervised me &all production officers in all section for their information and cooperation. We are graceful to all other Sr.Executive of different department for assisting me together information about various process and term.

Declaration

We hereby, declare that the work presented in this project is the outcome of the investigation performed by us under the supervision of, **Md.Azharul IslamSr. lecturer,** Department of Textile Engineering, Daffodil International University Bangladesh. We also declare that this project is not being submitted elsewhere.

Signature	**Signature**	**Signature**
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Dedicated

To our beloving parents

Abstract

This thesis presents an analysis and comparative study between conventional card and compact combed yarn on the properties of knitted fabrics. 30 Ne Card and 30 Ne compact Combed yarn have been used in this thesis which were produced from same lot. 6 types of fabrics (single jersey, single jersey elastane, single lacoste, double lacoste, rib and interlock) are knitted from both card and compact Combed yarn. Then the spirality and bursting strength are tested on all grey fabrics. 12 (6 Carded fabrics and 6 Combed fabrics) types of fabric are dyed together in a dyeing machine and finished in same times with same finishing parameters. After finish, the spirality, bursting strength are tested. From the test results it is revealed that the compact Combed yarn offers the most effective advantages over the conventional Card yarns. The overall results showed that the knitted fabrics produced from compact Combed yarn have lower grey spirality (single jersey=9, Lycra signle jersey= 4.2, single lacoste= 4, double lacoste 3.8, 1X1 rib= 3.5 and interlock 3.9) and finish spirality (single jersey=3.8, Lycra signle jersey= 2.7, single lacoste= 3.6, double lacoste= 3.5, 1X1 rib= 3 and interlock 3.1) with higher grey bursting strength (single jersey=95, Lycra single jersey= 69, single lacoste= 97, double lacoste= 89, 1X1 rib= 106 and interlock= 152) and finish bursting (single jersey= 76, Lycra signle jersey= 63, single lacoste= 78, double lacoste 74, 1X1 rib= 92 and interlock= 141) compare with knitted fabric produced from Card yarns and these are the key achievement of this research work. It was also accomplished that presence of lycra shows lower bursting strength values for both carded and compact combed yar

Contents

1. Introduction

1. Introduction:

1.1 General discussion

Although man‟s first articles of clothing and furnishing were probably animal skin wraps, sometimes stitched together using bone needles and animal sinews, he soon attempted to manipulate fibrous materials into textile fabrics, encouraged by experience gained from interlacing branches, leaves and grasses in the production of primitive shelters. The word „textile‟ originates from the Latin verb texere – to weave – but, as the Textile Institute‟s Terms and Definitions Glossary explains, it is now „a general term applied to any manufacture from fibres, filaments or yarns characterized by flexibility, fineness and high ratio of length to thickness.‟

Textile fabrics can be produced directly from webs of fibres by bonding, fusing or interlocking to make non-woven fabrics and felts, but their physical properties tend to restrict their potential end-usage. The mechanical manipulation of yarn into fabric is the most versatile method of manufacturing textile fabrics for a wide range of end-uses.

There are three principal methods of mechanically manipulating yarn into textile fabrics: interweaving, intertwining and interloping. All three methods have evolved from hand-manipulated techniques through their application on primitive frames into sophisticated manufacturing operations on automated machinery.

1.2 Review of recent research work

Different types of yarn are produced by same raw cotton (CIS) in same factory by two different ways. Six different fabrics are knitted by individually and compared in same design fabrics which are knitted by two types of different yarn. Specially Shrinkage, Spirality, GSM, Color Fastness, Bursting strength, Pilling are tested as the quality parameters.

The spirality problem has been investigated by several researchers [1-5]. Araujo and Smith [1, 2] studied the effect of machine, yarn and fabric properties on the fabric spirality. They determined that spirality depends on machine cut, feed density, machine rotation direction, loop shape, yarn twist value (twist liveliness) and yarn twist direction. They suggested using S-twist yarns in machines rotating counterclockwise and Z-twist yarn in machines rotating clockwise. Plied yarns, plating techniques and yarns with different twist directions can be used to solve or reduce this problem. They also presented an empirical model to predict fabric spirality on the fabric.

K. Hasan et al. [7] predicted the yarn count, stitch length and appropriate machine gauge in order to produce fabric of certain GSM is of great importance in this regard. They aimed at emphasizing the importance of the linear relationship among those quality parameters and implementing statistical methods and techniques in order to develop a linear relationship among different quality parameters in making different weft knitted fabrics.

Tao et.al. [3, 4], developed a yarn modification process on rotor-spun and friction-Sp

Spun yarn greatly reduces spirality and improves the fabric handle. However, they also stated that modifying rotor-spun degraded yarn tensile strength, burst strength and fabric pilling. On the other hand, modified friction-spun DREF III yarn reduces yarn snarling and fabric spirality. This modification process has resulted in higher yarn hairiness, fabric weight reduction, an increase in air resistance and reductions in thermal conductivity, yarn tenacity and elongation percentage at break.

Kang et.al. [6] Analyzed several fabric qualities such as count, cloth cover, fabric thickness, fabric weight, yarn crimp and the orthogonality of the yarn intersecting angle on woven fabric by image processing. They have used the grey values of the minimum points of an average profile in the x and y direction to determine the orthogonality of the yarn intersecting angle.

2.Literature review

2. Literature review:

2.1: Theoretical Backgrounds of Spinning:

Spinning is an ancient textile art in which plant, animal or syntheticfibers are drawn out and twisted together to form yarn. For thousands of years, fiber was spun by hand using simple tools, the spindleand distaff. Only in the High Middle Ages did the spinning wheelincrease the output of individual spinners, and mass-production only arose in the 18th century with the beginnings of the Industrial Revolution. Hand-spinning remains a popular handicraft.Characteristics of spun yarn vary according to the material used, fiber length and alignment, quantity of fiber used, and degree of twist.Main articles: Textile manufacture during the Industrial Revolutionand Spinning (textiles)Modern powered spinning, originally done by water or steam power but now done by electricity, is vastly faster than hand-spinning.

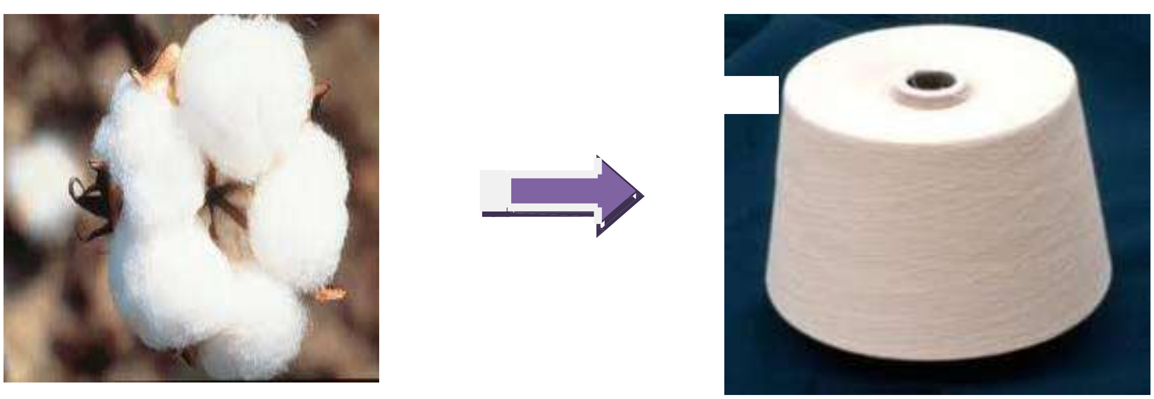
The spinning jenny, a multi-spool spinning wheel invented at 1764 by James Hargreaves, dramatically reduced the amount of work needed to produce yarn of high consistency, with a single worker able to work eight or more spools at once. At roughly the same time, Richard Arkwrightand a team of craftsmen developed the spinning frame, which produced a stronger thread than the spinning jenny. Too large to be operated by hand, a spinning frame powered by a waterwheelbecame the water frame.

In 1779, Samuel Cromptoncombined elements of the spinning jenny and water frame to create the spinning mule. This produced a stronger thread, and was suitable for mechanization on a grand scale. A later development, from 1828/29, was Ring spinning.

In the 20th century, new techniques including Open End spinning or rotor spinning were invented to produce yarns at rates in excess of 40 meters per second.

2.2 Yarn:

A continuous strand of twisted threads of natural or synthetic material, such as cotton, wool, nylon, etc. which is used in weaving or knitting.



2.2.1 Card Yarn:

A cotton yarn that has been carded but not combed. Carded yarns contain a wider range of fiber lengths and, as a result, are not as uniform or as strong as combed yarns. They are considerably cheaper and are used in medium and coarse

Flow chart of Card Yarn:

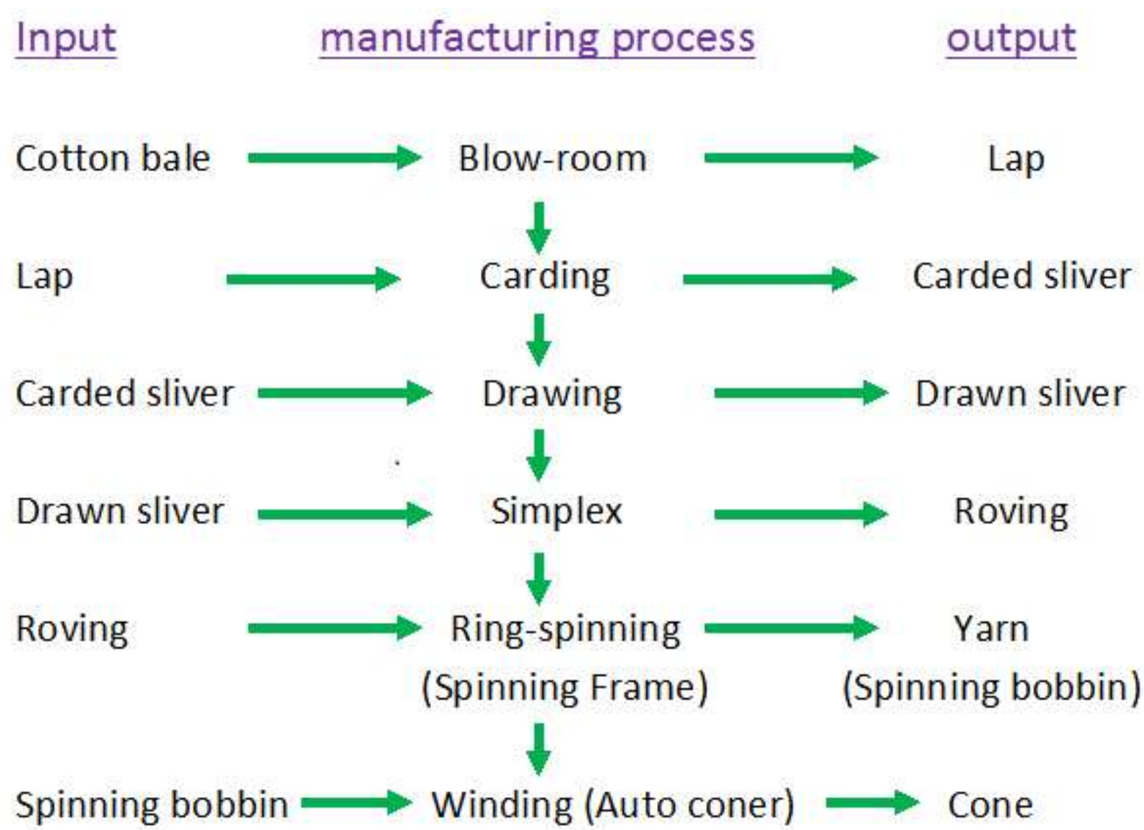


Figure: 3.5 Blow Room

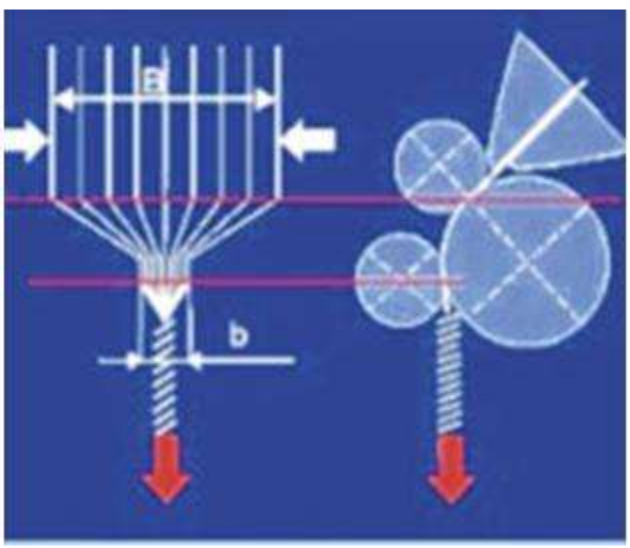
2.2.2Compact Spinning:

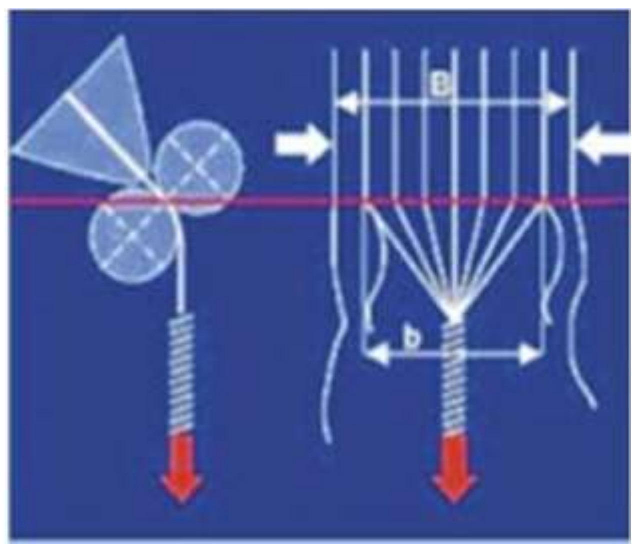
Compact spinning is recognized as a revolution in ring spinning. This technology is claimed to offer superior quality and better raw material utilization. In ring spinning the main source of the fiber migration is acknowledged to be the tension differences between fibers during the yarn formation. When a thin ribbon like fiber bundle is transformed into roughly circular shape by twist insertion fibers at the edges of bundle are faced with tension whereas fibers in the middle are subjected to compression unless there is excessive yarn tension. To release the stress, fibers subjected to tension try to shorten their path length in the yarn while fibers under compression try to lengthen it. As a result of this, fibers leave their perfect helical path and migrate between layers of the yarn. In compact spinning, tension differences between fibers during the twist insertion is smaller than those in ring spinning due to the elimination of the spinning triangle. Therefore fiber migration in compact yarns could be expected to be less than that in conventional ring spun yarns. The elimination of the spinning triangle by incorporating a condensing zone after the drafting system has opened up new interesting prospects to ring spinning. While the first attempts of the new compacting methods were restricted in practice to fine knitting yarns of combed cotton, there is now hardly any important yarn sector which has not been infiltrated by compact yarns. The Elite process with its unsurpassed flexibility has played an essential role in this development.

2.2.3 Compact Combed Yarn Process:

In conventional ring spinning, the zone between the nip line of the delivery rollers and the twisted end of the yarn is called the “spinning triangle”. This is the most critical part of the ring spinning system. In this zone, the fiber assembly doesn‟t have any twist. The edge fibers play out from this zone, and make little or no contribution to the yarn tenacity. Furthermore, they lead to yarn hairiness. In compact spinning, the “spinning triangle" is eliminated and almost all fibers are incorporated into the yarn structure under the same tension. This leads to significant advantages such as increasing yarn tenacity, yarn abrasion resistance and reducing yarn hairiness. There are different compact spinning systems on the market from different manufacturers. The main difference of these systems is the condensing unit. Most of the pneumatic compacting systems are composed of perforated drums or lattice aprons over the openings of the suction slots. With the air flow, the fibers move sideways and they are consequently condensed. Today, pneumatic compact spinning system is widely used in compact yarn production. However the adaptation of this system to conventional ring spinning machine is very complex and expensive; also this method cause high additional energy consumption during spinning process. Mechanical compact spinning is an important alternative for compact yarn production. The system is cheaper and less complicated than pneumatic compact yarn spinning systems. Furthermore, there is not any additional energy consumption during the spinning process. In this study Rotorcraft mechanical compact spinning system (RoCoS) was used in the production of compact yarns. In RoCoS compact spinning system, the compact yarn is produced by adding positive nip at the end of the drafting unit. The condenser is held against the bottom front drafting roller by means of a magnet. By the help of the "groove" in the ceramic compactor, fibers are brought closer and spinning triangle is eliminated [5 and 6]. The view of the RoCoS mechanical compact spinning and the back

View of magnetic compactor are given in *Figure*





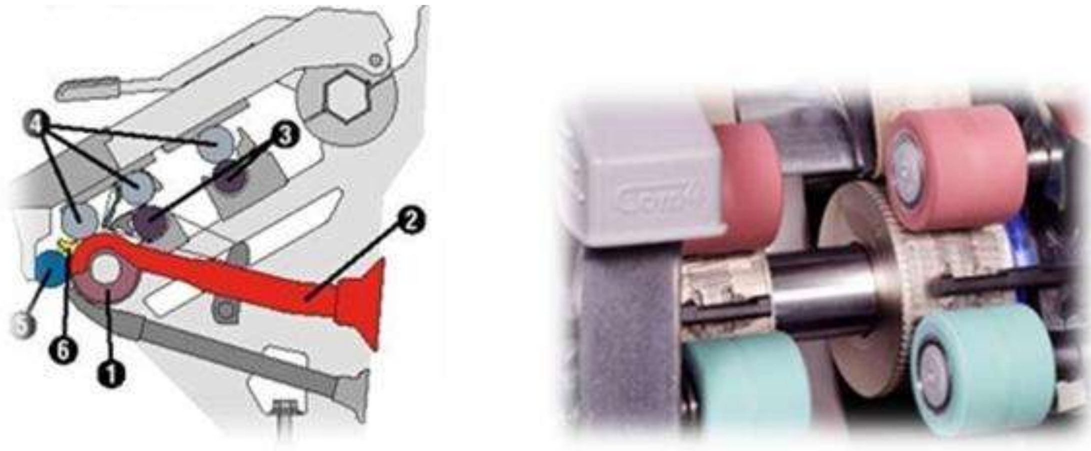


Fig: Magnetic compactor

Figure. The view of RoCoS mechanical compact spinning and the back view of the magnetic compactor.
The compacting zone of the compactor is the distance between the two nipping points (A and B). The front top roller and delivery rollers have the same are peripheral speed; therefore fibers are not drafted in this area. A roving guide is attached to the top roller mill shaft.
By the help of it, roving is fed into the center of the ceramic compactor. Roving guide movement is critical, during compacting process for the best compact yarn production roving guide should be stopped. However in bulk production to increase the life time of the roller, traversing distance must be reduced. According to previous research, mechanical compact spinning significantly improves yarn tensile properties and reduces its hairiness. Until now there are many studies about the comparison of the conventional ring and compact yarns properties. In the first part of the study, in order to understand how the effect of spinning system varies on yarn linear density and twist coefficient, we produced various compact and conventional spun yarns. In the second part of the study, we compared conventional ring, mechanical compact and pneumatic compact yarn spinning systems.

2.2.4Advantages of Compact Spinning:

Advantages in Spinning:

1. As maximum number of fibers are integrated into yarn body during spinning, so better utilization of fibers at the same time less fly generation and clean atmosphere is spinning department.
2. Yarn twist can be reduced by 10% while maintaining the same strength as the conventional ring yarn. Therefore, it is possible to increase the machine speed which ultimately results into increased production.
3. The weak point in the spinning zone (spinning triangle) is eliminated, the end breakage rate is considerably reduced which again leading to higher machine efficiency.
4. Increased strength and breaking elongation of yarn due to less protruding fibers and improved orientation of fibers, which leads to full realization of fiber strength.
5. Appreciable reduction in hairiness due to virtually elimination of spinning triangle.
6. Less expensive raw material can be used to produce good quality yarn.
7. Significant reduction in IPI, results better yarn quality.
8. Singeing can be completely eliminated.
9. Noil % at comber can be reduced as short fibers are better integrated into yarn body during spinning.
10. The improved characteristics of compact yarns gives higher yarn sales price.

2.2.5 Advantages in Winding:

1. Due to end breaks in spinning, improved winding efficiency as few clearer cuts.
2. Waxing of yarn can be eliminated.

2.2.6. Advantages in Twisting:

1. Lower twist can be employed in doubling, to improve the strength of yarn.
2. The systems like COM4twin, Elitist saves the cost of doubling.

2.2.7Advantages in Weaving Preparation & Weaving:

1. Better packing density of compact yarn gives better abrasion resistance and which leads to fewer end breaks in weaving. Also loom shed droppings and linting in knitting are reduced.
2. Degree of sizing can be reduced which reduces the sizing cost and the subsequent desizing cost.
3. Reduced end breaks in warping improves efficiency of warping.
4. Low end breaks in weaving improves weaving machine efficiency.
5. The compact spun yarn gives clearer cut contours in design.

2.2.8 Disadvantages of Compact Spinning:

1. Higher capital cost of the machine due additional condensing zone in drafting system.
2. Increased maintenance of condensing zone which adds to cost.

2.3 Theoretical background of Knitting:

According to knitting fundamentals (2000), the art of knitting has been rapidly Progressing in the developed countries of the world. Unlike woven fabrics, knitted fabrics are popular for their shape fitting properties, softer handle, bulkier nature and high extension at low tension. The hand knitting was a much older technology. The application of knitting was popular by the term hose to produce a complete covering of the legs and since then the word hosiery is conveniently used for a series of articles on stockings, socks and knitted leg coverings, and even to the general circular knitted goods. Though the invention of the first knitting machine is attributed to the reverend William Lee of England in the yarn 1589, the growth of knitting machine is Britain was not spectacular. The Lee hand stocking machine established the principle of breaded needle with sinkers, knock over bits etc. In nineteenth century, many inventors struggled to convert the hand operated into steam power by which the knitting speed attained 100 percent greater. The invention of latch needle and its introduction to circular knitting (first machine 1808) simplified the knitting action and enabled circular knitting machines, to be built for plain, rib and purl fabrics.

Knitting began with wool knitting and expanded fast to cotton and lately onto the synthetics including all types of blends. Knitting is comparatively faster and more economical process to convert yarn into fabric even straight into apparels, socks etc. Piece knitting is possible whereas piece weaving is not yet known. Besides being economical, knitted fabric being stretchable offers more comfort and better fitting in the most type of apparels. Designing possibilities are also larger though at times difficulty. The mass production of knits has overriding advantages. The apparel of knitted fabrics lies in part in the very nature of the knitted as compared to the woven structure its superior draping powers, its ready pack ability and its ease and excellent comfort.

2.3.1 Knitting:

Knitting is a method of converting yarn into fabric by intermeshing loops, which are formed with the help of needles.

In other word, the process in which fabrics are produces by set of connected loops from a series of yarns in weft or warp direction is called knitting. Knitting may be done by hand or by machine. There exist numerous styles and methods of knitting. Different yarns and knitting needles may be used to achieve different end products by giving the final piece a different color, texture, weight, and/or integrity. Using needles of varying shape and thickness as well as different varieties of yarn can also change the effect.

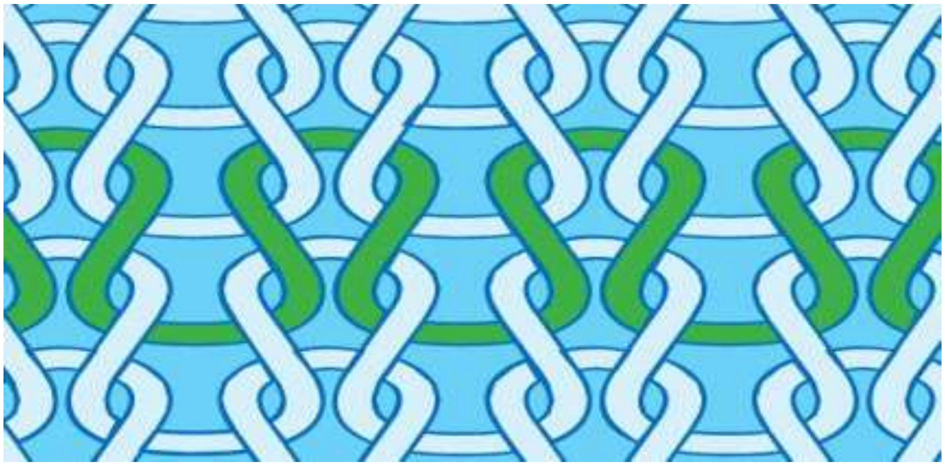
2.3.2 Types of Knitting:

Knitting is done by set of connected loops from a series of yarn in warp or weft direction. Knitted fabrics are divided into two main types; they are

i. Warp knitting
ii. Weft knitting

2.3.2.1 Weft Knitting:

In a weft knitted structure a horizontal row of loops can be made using one thread and the thread runs in the horizontal direction. Most of the knitted fabrics are produced by weft knitting.



2.3.2.2 Terms of weft knit:

2.3.2.3 Loop:

The needle loop (H +L in Fig. 3.11) is the basic unit of knitted structure. When tension in the fabric is balanced and there is sufficient take-away tension during knitting, it is an upright noose formed in the needle hook. It consists of a head (H) and two side limbs or legs (L).

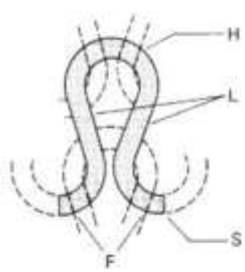


Fig: Loop

At the base of each leg is a foot (F), which meshes through the head of the loop formed at the previous knitting cycle, usually by that needle. The yarn passes from the foot of one loop into the foot and leg of the next loop formed by it. (NB: If the loop is the first loop knitted on that needle, its feet and legs will not be restricted and it will open out to give the appearance of a tuck loop. If the loops are knitted on a flat machine with a pressing down device and no take-down tension, the loops will be more rounded and will tend to incline due to the traversing movement of the presser.) In warp knitting the feet may be open or closed at the base of the loop. In the latter case, the yarn guide has passed across the back of the needle across whose hook it has previously formed a loop.

2.3.2.4 Course and wales:

In weft knits the interloop links two consecutive loops placed horizontally; when one loop breaks, the entire fabric can be undone simply by pulling the free end of the yarn. From a physical point of view, a fabric can be described as a flexible structure, made up by the vertical and horizontal repetition of two elements: the course and the wale. The word “course” defines a row of horizontal loops, belonging or not to the same yarn; “wale” means a row of loops laid vertically one upon the other.

(Saville, 1998) In other word, course is discussed as A course is a predominantly horizontal row of loops (in an upright fabric) produced by adjacent needles during the same knitting cycle. In weft knitted fabrics a course is composed of yarn from a single supply termed a course length. A pattern raw is horizontal row of cleared loops produced by one bed of adjacent needles.

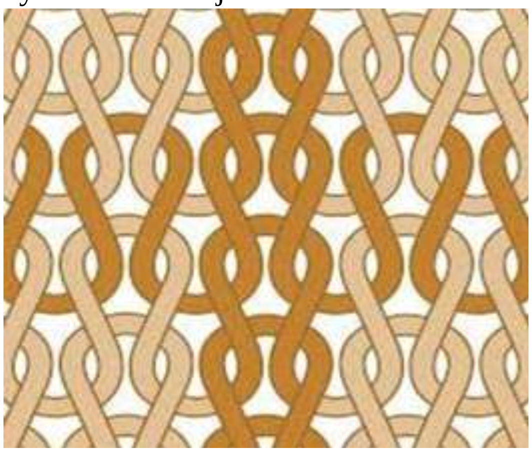


Fig: A course and a wale

In a plain weft knitted fabric this is identical to a course but in more complex fabrics a pattern row may be composed of two or more course lengths. In warp knitting each loop in a course is normally composed of a separate yarn.

A wale is a predominantly vertical column of needle loops produced by the same needle knitting at successive knitting cycles and this intermeshing each new loop through the previous loop. In warp knitting a wale can be produced from the same yarn if a warp guide laps around the same needle at successive knitting cycles this are making a pillar or chain stitch lapping movement. Wales are joined to each other by the sinker loops or under laps.

2.3.2.5 Process flow chart of weft knitting:

Yarn
↓
Place
↓
Feeding
↓
Set
↓
Knitting
↓

Withdraw
↓
Weighting
↓
Inspection
↓
Grading

Fig: Flow chart of knitting fabric production:

2.3.2.6 Features of Modern Circular knitting Machine:

Fig: Circular Weft Knitting Machine

Some of the features of a modern circular fabric producing machine that ensure that high quality fabric is knitted at speed with the minimum of supervision are given below:-

Stop motion: The top and bottom stop motions are spring loaded yarn supports that pivot downwards when the yarn end breaks or its tension is increased. This action releases the surplus yarn to the feeder. Thus preventing a press-off, and simultaneously completes a circuit which stops the machine and illuminates an indicator warning light.

Various detectors: various spring loaded detectors points are carefully positioned around the cylinder to their particular function. A pointer is tripped to stop the machine by a fault or malfunctioning element such as a yarn slub, fabric lump, needle head, latch spoon etc.

Positive feeder: The tape positive feed provides three different speeds (course lengths) and is driven and can be adjusted from the drive arrangement.

Cam system: The cylinder needle cam system for each feed is contained in a single replaceable section and having an exterior adjustment for the stitch cam side.

Lubrication: These circular machines have automatic lubrication system which provides smooth function of all parts of this machine.

Operation: it has easy operation system like start, stop, inching button, touch screen operation, automatic calculation, etc.

Winding: The cam driven fabric winding down mechanism, which revolves with the fabric tube.

Counters: The revolution counters for each of the three shifts and a pre-set counter for stopping the machine on completion of a specific fabric length (in courses).

Creel: There have top and side creel facilities. So it is easier to adjust to a place for producing knitted fabrics by a suitable creel.

Lint blower: Lint blower reduces the incidence of knitted-in lint slubs, to improve quality when using open-end spun yarns. It is also cross-contamination by fibres from other machines.

2.3.2.7. Types of Weft Knitting:

i) Single Jersey

ii) Double Jersey

2.3.2.8 Single jersey:

The simplest and the most widely used weft-knit fabric is „jersey" or „plain" knit fabric. It consist of face loop stitches only on one side and back loop on another side. Single jersey produces by one set of needles. Single jersey is such as plain jersey. Polo pique, single Lacoste etc.

2.3.2.9 Double jersey:

These fabrics are most widely used as weft-knit fabric. It consist of face loop and back loop on same side. Double jersey produces by two or four sets of needles. Double jersey is such as rib fabric, interlock fabric etc.

2.3.2.10 Derivatives of Single Jersey:

Single jersey plain

Single Pique

Double Pique

Single Lacoste

Double Lacoste

2.3.2.10.1 Single jersey (Plain):

This is the basic construction of weft knit fabrics having one set of needles with all knit loops. It means that every course contains knit loops on every wale. As there have no variations of loops and only cylinder needles are available, this is the reason of calling it as single jersey plain fabrics.

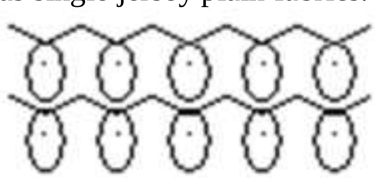


Fig: 3.8: Notation diagram of Single Jersey (plain)

2.3.2.10.2 Single Pique:

Single pique is a derivative of single jersey knit fabric having two courses in a repeat. It is a combination of knit and tuck loops. First, third, fifth and all the odd number needles of first course contain knit loop and second, fourth, sixed and all the even needles of the same contain tuck loop. The second course is the alternate of first course. All the odd needles of second course have knit loops and even needles of same course have tuck loops.

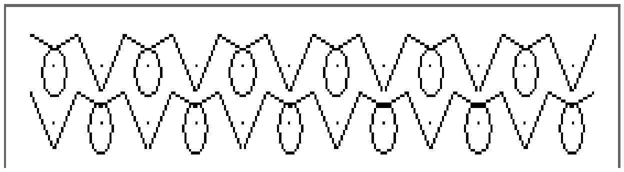


Fig: Notation diagram of Single Pique

2.3.2.10.3 Double Pique:

It is another type of derivative of single jersey having four courses in a repeat. This derivative has produced by the combination of knit loops and tucks loops. The first and second course has the same construction whereas the third and fourth course has the inverse loops compared to first and second course. In first and second course, all the odd needles contain tuck loops and all the even needles knit loops. In third and fourth course, all the odd needles contain knit loops and all the even needles tuck loops.

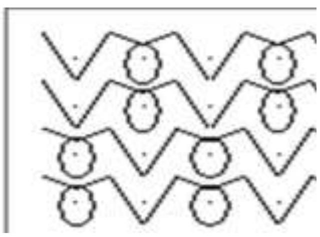


Fig: Notation diagram of Double Pique

2.3.2.10.4 Single Lacoste:

It is also a four course repeat single jersey derivative.It is a combination of single jersey plain and single pique design.Odd courses are on plain construction and even courses are on singel pique construction. The sequence of loops of each courses are given below:

First course: All the even needles tuck loop and odd needles areknit loop.
Second course: All needles are knit loops.
Third course: Alternate of first course. All the even needles are knit loops and odd needles are tuck loops.
Fourth course: Same as second course, all the needles are knit loops.

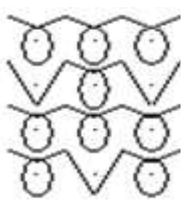


Fig: Notation diagram of Single Lacoste

2.3.2.10.5 Double Lacoste:

Double Lacoste is a six course repeat single jersey derivative. It is combination of single jersey and double pique construction. First, fourth, seventh and so on are on single jersey construction and others are on double pique construction. The sequences of courses are given below:

First course: All the even needles tuck loop and odd needles are knit loop.
Second fourse: Same as first course, all the even needles tuck loop and odd needles are knit loop.
Third course: All needles are knit loops.

Fourth course: Alternate of first course. All the even needles are knit loops and odd needles are tuck loops.

Fifth course: Same as fourth course, all the even needles are knit loops and odd needles are tuck loops.

Sixth course: Same as Third course, all the needles are knit loops.

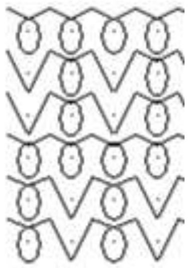


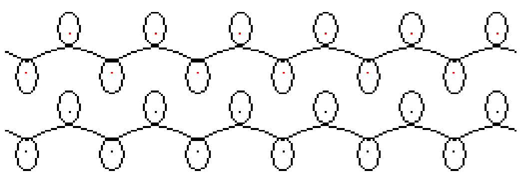
Fig: : Notation diagram of Double Lacoste

2.3.2.11 Derivatives of Double Jersey:

2.3.2.11.1 Rib:

A double-knit fabric in which the rib wales or vertical rows of stitches intermesh alternatively on the face and the back of the fabric. Rib knit fabrics have good elasticity and shape retention, especially in the width.

A fabric with vertical rows of loops on both sides of the fabric and produces more stretching the fabric.



Needle arrangement: Dial: 1,2,1,2 Cylinder: 1,2,1,2

A basic stitch used in weft knitting in which the knitting machines require two sets of needles operating at right angles to each other. Rib knits have a very high degree of elasticity in the crosswise direction. This knitted fabric is used for complete garments and for such specialized uses as sleeve banks, neck bands, sweater waistbands, and special types of trims for use with other knit or woven fabrics. Light weight sweaters in rib knit provide a close body hugging fit.

2.3.2.11.2 Interlock:

Interlock has the technical face of plain fabric on both sides, but its smooth surface cannot be stretched out to reveal the reverse meshed loop wales because the wales on each side are exactly opposite to each other and are locked together. Each interlock pattern row (often termed an "interlock course") requires two feeder courses, each with a separate yarn that knits on separate alternate needles producing two half-gauge 1*1 rib courses whose sinkers loops cross over each other. Thus, odd feeders will produce alternate wales of loops on each side and even feeders will produce the other wales.

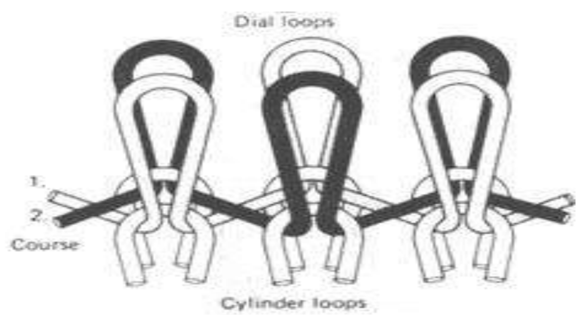


Fig::Interlock Fabric Structure

Interlock relaxes by about 30-40% or more, compared with its knitted width, so that a 30 inch diameter machine will produce a tube of 94 inch open width with finished at 60-66 inch wide. It is a balanced, smooth, stable structure that lies flat without curl. Like 1*1rib, it will not unrove from the end knitted first, but it is thicker, heavier and narrower than rib of equivalent gauge, and requires a finer, better , more expensive yarn.

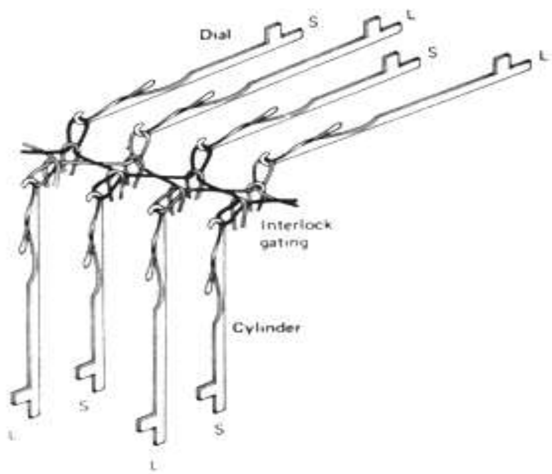


Fig::Knitting Interlock

As only alternate needles knit at a feeder,interlock machines can be produced in finer gauges than rib, with less danger of press-offs. Interlock knitting is, however, more of a problem than rib knitting, because productivity is half, less feeders can be accommodated, and there are finer tolerances. When two different-colored yarns are used, horizontal stripes are produced if the same color is knitted at two consecutive feeders, and vertical stripes if odd feeders knit one color and even feeders knit the other color. The number of interlock pattern rows per inch is offered double the machine gauge in needles per inch.

The interlock structure is the only weft knitted base not normally used for individual needles selection designs, because of the problems of cylinder and dial needle collision. However, selection has, in the past, been achieved by using four feeder courses for each pattern row of interlock, long and short cylinder needles not selected at the first two feeder courses for color A being selected at the second two feeders for color B. This knitting sequence is not cost effective.

Eightlock is a 2*2 version of interlock that may be produced using an arrangement of two long and two short needles, provided all the tricks are fully cut through to accommodate them and knot-over bits are fitted to the verges to assist with loop formation on adjacent needles in the same bed.

It was first produced on double-system V-bed flat machines having needles with two butt positions, each having its own cam system. This involved a total of eight locks, four for each needle bed, making one complete row per traverse. Set-outs for 4*4 and 3*3 can also be produced.

It is a well-balanced, uniform structure with a softer, fuller handle, greater width-wise relaxation, and more elasticity than interlock. Simple geometric designs with a four wale wide repeat composed of every two loops of identical colour, can be achieved with careful arrangement of yarns.

2.4 YARN COUNT:

Count is a numerical expression which defines its fineness or coarseness.

Definition (given by Textile Institute):
"Count: A number indicating mass per unit length or length per unit mass of yarn."

2.4.1Yarn numbering/counting systems:

There are two basic systems of yarn numbering:
3.4.1.1 Direct system (mass per unit length)
3.4.1.2 Indirect system (length per unit mass)

2.4.1.1Direct system:

In a direct yarn counting system count is the *weight of a unit length* of yarn.

Let,

N= Yarn number or count
W= Weight of sample
L= Length of the sample
l= unit of length of the system

Then, $N=\frac{Wxl}{L}$

Example of direct systems: Tex, millitex, kilotex, Denier, Jute etc

2.4.1.2Indirect system:

In an indirect yarn counting system count is the *unit of length per unit of weight* of yarn.

Let,
N= Yarn number or count
W= Weight of sample
L= Length of the sample
l= unit of length of the system
w= unit of weight of the system

$$\text{Then,}\quad N=\frac{wxL}{Wxl}$$

Example of indirect systems: Cotton (Ne), Metric (Nm), Worsted etc

Table -: Unit of Length &Weight (mass) in Direct Counting System

Name of the System	Unit of mass	Unit of length
Tex	Gm	Km
Denier	Gm	9km
Jute	Pound(lb)	14,400 yards (spindle)

Table -: Unit of Length &Weight (mass) in indirect counting system:

Name of the System	Unit of length	Unit of mass
Cotton (British or English)	840 yards(hank)	Pound(lb)
Metric	Km	Kg
Worsted	560 yards (hank)	Pound (lb)

Definitions:
Cotton count (Ne): It is defined as the length in hank of 840 yds per pound of yarn.
30 Ne: It is defined as the 30 hank (840x30 yds) of length per pound ofyarn.

2.4.2 Yarn Count Variation:

The term count variation is generally used to express variation in the weight of a lea and this is expressed as C.V. %. The number of samples and the length being considered for count checking affects this. While assessing count variation, it is very important to test adequate number of leas. After reeling the appropriate length of yarn, the yarn is conditioned in the standard atmosphere for testing before its weight is determined.

Table -: Count Conversion Chart:

	Ne	Nm	Tex	Grex	Denier
Ne=	1 xNe	0.5905 xNm	590.5 /Tex	5905 /Grex	5315 /Den
Nm=	1.693xNe	1 xNm	1000 /Tex	10,000/Grex	9000 /Den
Tex=	590.5 /Ne	1000 /Nm	1 xTex	0.1 xGrex	0.111 xDen
Grex=	5905 /Ne	10,000 /Nm	10 xTex	1 xGrex	1.111 xDen
Denier=	5315 /Ne	9000 /Nm	9 xTex	0.9 xGrex	1 xDen

2.5 Parameters of Single Jersey Fabric:

2.5.1 CPI:

The horizontal row of loops produced by adjacent needle to the same knitting cycle is known as a course. The course can be measured by the number of courses per linear unit. Expressed as inch per centimeter. In the figure a pattern of loop range in raw in color that is course. If drawing represent one inch by one inch area we identify these three courses per inch.

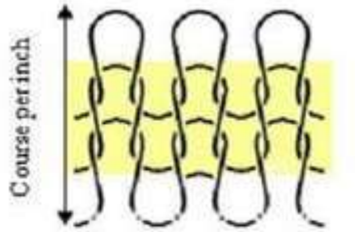


Fig: Course per inch

2.5.2 WPI:

The vertical column of loops produced by same needle knitting at successive knitting cycles is referred to as wale. The wale can measure by the number of Wales per linear length. In the same drawing three Wales per inch.

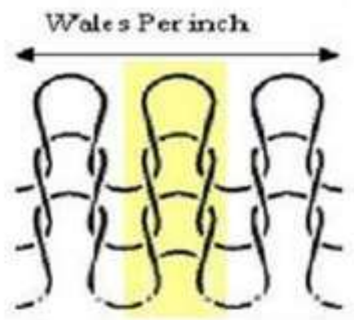


Fig: Wales per inch

2.5.3 Stitch density:

The term stitch density is frequently used in knitting instead of a linear measurement of courses or wales; it is the total number of needle loops in a square area measurement such as a square inch or square centimeter. It is obtained by multiplying, for example, the number of courses and wales, per inch together. Stitch density tends to be a more accurate measurement because tension acting in one direction in the fabric may, for example, produce a low reading for the courses and a high reading for the wales, which when multiplied together cancels the effect out. Usually pattern row and courses are, for convenience, considered to be synonymous when counting courses per unit of linear measurement. [Alimuzzamanbelal, pp: 328]

Stitch density = Wales per inch (wpi) x Courses per inch (cpi).

2.5.4 Stitch length:

Stitch length is the length of yarn in knitted loop. It is the dominating factor for all knitted structures. In wet knitted, it is usually determined as the average length of yarn per needle, while in warp knitted, it is normally determined as the average length of yarn per course.

2.5.5 GSM:

GSM means the weight in gram per square meter of fabric. GSM is a very important parameter for specified a certain quality of knitted fabric. The production of knitted fabric is calculated in weight. The GSM cutter is very popular and easy usable GSM testing instrument used in most knitted factory. But the construction of the cutter is very simple. It is circular disk of 100 square cm area with sharp blade attached to its edge. So 100 square cm fabrics can easily cut by it and weighted at the electric balance to get GSM reading.

2.5.6 Loop Formation:

There are only three types of loop or stitches possible in weft knitting.
They are –

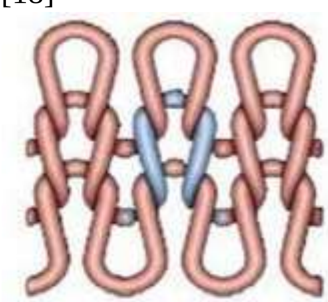
i. Knit,

ii. Tuck &

iii. Float.

2.5.7 Knit loop stitch:

Weft knitted stitches described so far has been composed entirely of knitted loops. A knitted loop stitch is produced when a needle receives a new loop and knocks-over the old loop that it held from the previous knitting cycle. The old loop then becomes a needle loop of normal configuration. Other types of stitch may be produced on each of the four-needle arrangement base structures by varying the timing of the intermeshing sequence of the old and new loops. These stitches may be deliberately selected as part of the design of the weft knitted structure or they may be produced accidentally by a malfunction of the knitting action so that they occur as fabric faults. When these stitches are deliberately selected, a preponderance of knitted loop stitches is necessary within the structure in order to maintain its requisite physical properties. The needles generally produce knitted loop stitches prior to the commencement, and at the termination, of these selected stitches, and there are usually certain needles that are knitting normally during the same cycles as those in which these stitches are produced. Apart from the knitted loop stitch, the two most commonly-produced stitches are the float stitch and the tuck stitch. Each is produced with a held loop and shows its own particular loop most clearly on the reverse side of the stitch because the limbs of the held loop cover it from view on the face side. [18]



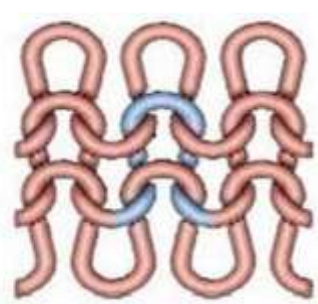


Fig: Technical face **Fig: 3.18: Technical back**

2.5.8Stitch Length:

Stitch length is the length of yarn in knitted loop. It is the dominating factor for all knitted structures. In weft knitted, it is usually determined as the average length of yarn per needle, while in warp knitted, it is normally determined as the average length of yarn per course.

2.5.9 Spirality:

Spirality is a dimensional distortion in circular plain knitted fabrics. The wales or needle lines should occupy a truly vertical line in the fabrics and should always be right angles to the cross wise courses of stitches.

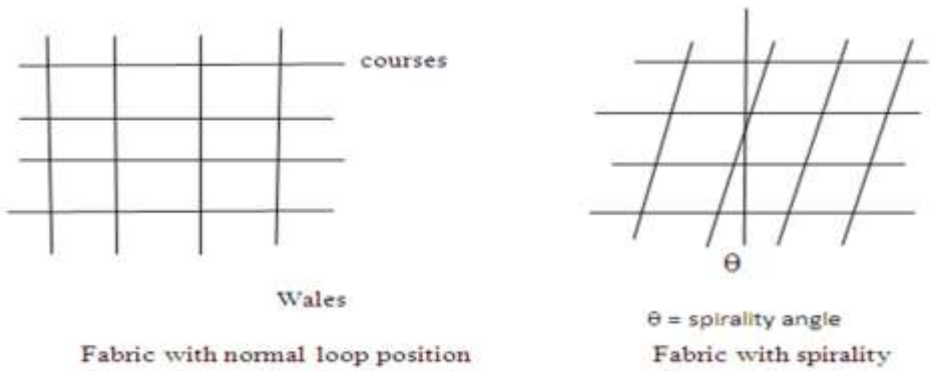


Fig:: Spirality of fabric

This perpendicularity of wales to the courses is frequently, not the case and many times the wales many skew to the right or left forming an angle, which appears in the form of a twilled surface. The geometrical defect has been termed spirality of knitting in circular fabrics (Das, 1998).

In other words, spirality occurs in knitted fabric because of asymmetric loops which turns in the wales and course of a fabric into an angular relationship other than 90 degree. This is a very common problem in single jersey knits and it may exist in grey, washed or finished state and has an obvious influence on both the aesthetic and functional performance of knitwear. However, it does not appear in interlock and rib knits because the wale on the face is counter balanced by a wale on the back.

Course spirality is a very common inherent problem in plain knitted fabrics. Some of the practical problems arising out of the loop spirality in knitted garments are: displacement or shifting of seams, mismatched patterns and sewing difficulties. These problems are often corrected by finishing steps such as setting / treatment with resins, heat and steam, so that wale lines are perpendicular to the course lines. Such setting is often not stable, and after repeated washing cycles, skewing of the wales normally re-occurs.

2.5.10Causes of generation:

The residual torque in the component yarn caused due to bending and twisting is the most important phenomenon contributing to spirality. The residual torque is shown by its twist liveliness. Hence the greater the twist liveliness, the greater is the spirality. Twist liveliness of yarn is affected by the twist factor or twist multiple. Besides the torque, spirality is also governed by fibre parameters, cross-section, yarn formation system, yarn geometry, knit structure and fabric finishing. Machine parameters do contribute to spirality. For instance, with multi-feeder circular knitting machines, course inclination will be more, thus exhibit spirality.

2.5.11Influencing factors:

2.5.11.1 Influence of yarn properties:

Count: Degree of freedom of yarn movement in the fabric structure contributes significantly to the increase in spirality. Dimensional parameters of fully relaxed single jersey fabrics depend on the yarn linear density and tightness of construction. If diameter is reduced, its resistance to deformation is lowered. It indicates that, deformation of loop structure is influenced by yarn count. In other words, the finer the yarn, the more will be the spirality due to more twisting.

Twist:Usually in knitting, low twisted yarns are used. High twisted yarn has a great impact on spirality due to its unrelieved torque. With the increase in twist, the twist liveliness increases, this in turn, causes the angle of spirality to increase. The direction of spirality in the fabrics knitted from short staple ring spun single yarns is determined by the yarn twist direction. Thus, the technical face of single jersey fabric exhibits spirality in the Z direction if a Z twisted yarn is knitted.

a) Yarn Twist Multiplier (TM):

This index is represented by the following formula:

TM = T.P.I. / $\sqrt{N}$, where T.P.I. indicates twist per inch and N represents yarn number in an indirect system, the cotton system unless otherwise specified. With the increase in twist multiplier, the angle of spirality increases.

(b) Yarn Twist Factor (TF):TF is related with the following formula:

TF = TPCm x $\sqrt{T}$, where T signifies yarn number in Tex.

Raising the twist factor of two ply yarn increases the left hand or S-direction spirality, whereas increasing the twist factor of single yarn increases the right hand or Z-direction spirality.

Conditioning: The minimum spirality level that can be achieved by several ways such as storing yarn at appropriate temperature and relative humidity or by thermal conditioning with low temperature saturated steam in vacuum that results in a speedy relaxation. This process balances the twist so that it does not regain its original state. However, there is no systematic study carried out to understand the effect of yarn conditioning on spirality ofsingle jersey fabrics.

Spinning method: Yarn produced by different spinning technique has a direct bearing on spirality of knitted fabric. Friction spun yarn made of 100% cotton produce fabrics with highest degree of spirality, followed by ring spun yarns. Both rotor spun and air jet yarns produce fabrics with a low degree of spirality.

Blend: In general, 50/50 cotton/polyester blends have a lower tendency to produce spirality in fabrics than the 100% cotton yarns. Spirality can be virtually eliminated by using 50/50 cotton/polyesters blend of air jet and rotor yarns.

2.5.11.2 Influence of fabric properties:

Fabric stitch length: This is the length of one loop in knitted fabric. Spirality increases withthe length of loop.

Fabric structure: More spirality in single jersey due to non-arrest of loops. By adding moisture to such a structure, the twist will try to revert as it swells, that distorts the shape of the loop. In double jersey, the effect of spirality is nullified. Pique and honey comb also show spirality even if sometimes two beds are used. Spirality can be noticed in certain jacquard structures. In stripe pattern, it increases with the size. Noappreciable problem of spirality is there in ribs and interlocks.

Fabric tightness: Slack fabric presents higher spirality angle compared to tightly knitted fabrics. At each level of yarn twist factor, the degree of spirality decreases linearly with fabric tightness factor.

Fabric relaxation: Fabric relaxation (dry and wet) treatment removes the residual knitting tension in the yarn introduced during the knitting process. The relaxation treatment relieves the residual yarn torque as a resultof changes in the molecular structure and increasing yarn mobility.

2.5.11.3 Influence of machine parameters:

Number of feeders: The number of feeders in a circular knitting machine also influences the angle of spirality. Due to more course inclination, spirality will be more.

Direction of machine rotation: The direction of machine rotation has influence on spirality. For Z twist yarns, the wales go to the right and thus, giving Z skew and S twist yarns makes the wales go to the left, giving skew to the fabric. With multifeed machines, the fabric is created in helix, which gives rise to course inclination and consequently wale spirality. Direction of spirality depends on the rotational direction of the knitting machine. Earlier research work revealed that, for a clockwise rotating machine, the wale would beinclined towards the left, thus producing the S spirality.

Gauge: In knitting terminology, number of needles per inch is called the gauge. Smaller the gauge, lesser will be the spirality keeping other parameters constant. A proper combination of linear density and gauge is required to reduce spirality e.g. torque can be controlled in 20 gauge and 40scount.

2.5.11.4 Knitting tension:

The effects of various knitting tensions including the whole process of loop formation on fabric spirality had been investigated by the researchers. Experimental investigation could not establishconsistent trends with respect to variations in fabric quality with knitting tensions.

The twist factors of ply and single yarn, loop length, and fiber diameter have significant effects on the angle of spirality, while yarn linear density and fabric tightness factor have comparatively lesser effect.

2.5.11.5Remedial measures:

Compacting: Compaction reduces the length of the fabric based on its elongation during processing which, in turn, reduces the width. It helps in controlling the shrinkage of the fabric. There are two types‟ ofcompactors - open and tubular. In tubular compactor, the squeezing line gets on the sides in this process and is done on natural movement thus controlling spirality. If the wales are straightened manually then it results in spirality.

Resin treatment: Cross-linking the fabric by means of interfibre bonding also reduces spirality. Resin in the form of aqueous solution is applied and set by passing the fabric through a high temperature stenter. This method is not recommended for cotton fabrics, since it weakens the cotton yarn.

Heat setting: Steam or hot water setting reduces twist liveliness and hence spirality. Mercerization is recommended for cotton yarns, so that fibres are made to relax permanently. Balancing yarn twist factor: In an earlier investigation on plain knitted wool fabrics, it was been revealed that raising the twist factor of a ply yarn increases the left-hand of S-direction spirality of fabrics. But whileincreasing the twist factor of a single yarn, there is decrease in left-hand of S-direction spirality with an increase in right-hand or Z-direction spirality. Thus, there is possibility to balance twist factors for both ply and single yarns with a view to achieve zero spirality.

2.5.16Bursting strength:

Tensile strength tests are generally used for woven fabrics where there are definite warp and weft directions in which the strength can be measured. However, certain fabrics such as knitted materials, lace or nonwovens do not have such distinct directions where the strength is at a maximum .Bursting strength is an alternative method of measuring strength in which the material is stressed in all directions at the same time and is therefore more suitable for such materials. There are also fabrics which are simultaneously stressed in all directions during service, such as parachute fabrics, filters, socks and nets, where it may be important to stress them in a realistic manner. A fabric is more likely to fail by bursting in service than it is to break by a straight tensile fracture as this is the type of stress that is present at the elbows and knees of clothing. When a fabric fails during a bursting strength test it does so across the direction which has the lowest breaking extension. This is because when stressed in this way all the directions in the fabric undergo the same extension so that the fabric direction with the lowest extension at break is the one that will fail first. This is not necessarily the direction with the lowest strength [11]

The standard type of bursting strength test uses an elastic diaphragm to load the fabric, the pressure of the fluid behind the diaphragm being used as the measure of stress in the fabric. The bursting strength is then measured in units of pressure. As there is a sizeable force needed just to inflate the diaphragm this has to be allowed for in the test. The usual way is to measure the increase in height of the diaphragm during the test and then to inflate the diaphragm to the same height without a specimen present. The pressure required to inflate the diaphragm alone is then deducted from the pressure measured at the point of failure of the sample. The relationship between the diaphragm height and the fabric extension is quite complex so that the method is not used to obtain an estimation of fabric extension.

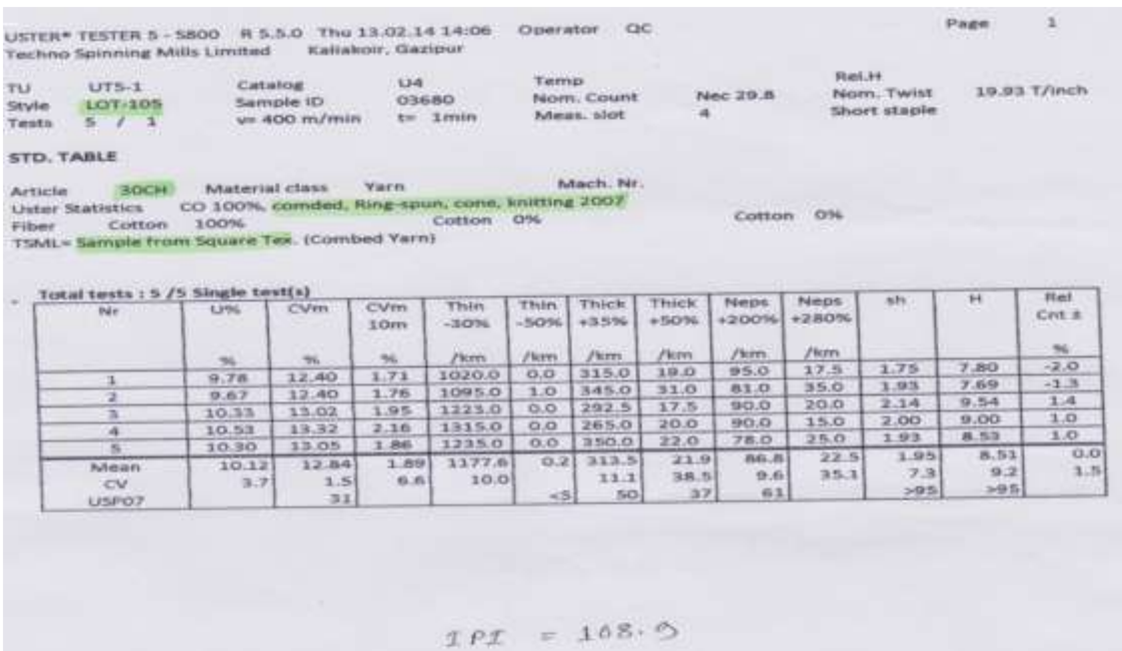
3.Material and method

3. Materials

The total thesis was conducted in Impress Newtex Composite Textiles Ltd. In this time several tasks had been conducted according to this thesis topic. At first the fabrics were knitted from yarn by a circular knitting machine. After that it was dyed by dyeing machine then finished by finishing machine. With these processes all data was collected with the individual interval of each process.

3.1 Yarn Characteristics**:**

For this thesis we select two yarns (30/1 Ne combed & combed compact, lot -105 with same fiber. It was collected yarn from Square Tex ltd. We tasted these yarn from Techno Spinning. Please have a look on the below test result:



USTER® TESTER 5 - S800 R 5.5.0 Thu 13.02.14 14:06 Operator QC Page 1
Techno Spinning Mills Limited Kaliakoir, Gazipur

TU UT5-1 Catalog U4 Temp Rel.H
Style LOT-105 Sample ID 03680 Nom. Count Nec 29.8 Nom. Twist 19.93 T/inch
Tests 5 / 1 v= 400 m/min t= 1min Meas. slot 4 Short staple

STD. TABLE

Article 30CH Material class Yarn Mach. Nr.
Uster Statistics CO 100%, comded, Ring-spun, cone, knitting 2007
Fiber Cotton 100% Cotton 0% Cotton 0%
TSML= Sample from Square Tex. (Combed Yarn)

Total tests : 5 /5 Single test(s)

Nr	U% %	CVm %	CVm 10m %	Thin -30% /km	Thin -50% /km	Thick +35% /km	Thick +50% /km	Neps +200% /km	Neps +280% /km	sh	H	Rel Cnt ± %
1	9.78	12.40	1.71	1020.0	0.0	315.0	19.0	95.0	17.5	1.75	7.80	-2.0
2	9.67	12.40	1.76	1095.0	1.0	345.0	31.0	81.0	35.0	1.93	7.69	-1.3
3	10.33	13.02	1.95	1223.0	0.0	292.5	17.5	90.0	20.0	2.14	9.54	1.4
4	10.53	13.32	2.16	1315.0	0.0	265.0	20.0	90.0	15.0	2.00	9.00	1.0
5	10.30	13.05	1.86	1235.0	0.0	350.0	22.0	78.0	25.0	1.93	8.53	1.0
Mean	10.12	12.84	1.89	1177.6	0.2	313.5	21.9	86.8	22.5	1.95	8.51	0.0
CV	3.7	1.5	6.6	10.0		11.1	38.5	9.6	35.1	7.3	9.2	1.5
USP07		31			<5	50	37	61		>95	>95	

IPI = 108.5

Fig: Comb lot 105 yarn test report

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Techno Spinning Mills Limited Kaliakoir, Gazipur

TU	UTS-1	Catalog	U4	Temp		Rel.H	
Style	LOT-105	Sample ID	03679	Nom. Count	Nec 29.85	Nom. Twist	19.93 T/inch
Tests	5 / 1	v= 400 m/min	t= 1min	Meas. slot	4	Short staple	

STD. TABLE

Article 30CH Material class Yarn Mach. Nr.

Uster Statistics CO 100%, comded, Compact-spun, cone 2007

Fiber Cotton 100% Cotton 0% Cotton 0%

TSML= Sample from Square Tex. (Compact Yarn)

Total tests : 5 /5 Single test(s)

Nr	U%	CVm	CVm 10m	Thin -30%	Thin -50%	Thick +35%	Thick +50%	Neps +200%	Neps +280%	sh	H	Rel Cnt ±
	%	%	%	/km	/km	/km	/km	/km	/km			%
1	9.78	12.40	1.71	1020.0	0.0	268.5	12.0	52.5	17.5	1.51	5.80	-2.0
2	9.67	12.40	1.76	1095.0	1.0	253.0	16.0	75.0	12.0	1.59	5.91	-1.3
3	10.01	12.61	1.95	989.0	0.0	292.5	10.0	50.0	20.0	1.60	5.98	1.4
4	10.11	12.69	1.91	1124.0	0.0	265.0	9.0	59.0	15.0	1.40	5.80	1.0
5	10.30	13.05	1.86	1235.0	0.0	279.0	11.5	61.0	13.0	1.49	5.68	1.0
Mean	9.97	12.63	1.84	1092.6	0.2	271.6	11.7	59.5	15.5	1.52	5.83	0.0
CV	3.5	1.5	6.6	10.0		11.1	18.5	9.6	35.1	2.8	2.9	1.5
USP07		31			<5	50	23	51		26	29	

SPT = 71.4

Fig Comb lot 105 yarn test report

Fabric production: At first we have made 6 types of knitted fabrics (Single Jersey, Lycra Single Jersey, Single Lacoste, Double Lacoste, 1x1 Rib & Interlock) of 12 sample. To manufacture these knitted fabric we need to use the following materials:

3.1.1Yarn package:

Yarn is the primary raw material for knit a fabric. For cotton yarns, cone form package is very suitable for knitting. So, to conduct this experiment suitable and available count was selected.

Fig: Cone

3.1.2 Circular Knitting Machine:

Most of the high speed single jersey knitting machines is circular type. It is very popular for its higher production rate and easy operating system and maintenance. Because of the structure of this machine it needs limited space and have more scopes to involve the auto motions like stop motions, sensors, detectors, cleaning and auto lubrication systems.

Fig: Circular Knitting machine (jersey)

The machine specification is given bellow which was used to knit the samples.

3.1.2.1 Machine Specification (Jersey):

Machine Name: Jiunnlong
Needle: 1884& 2260
Feeder: 75 & 90
Dia: 25"& 30"
Gauge: 24G
Origin: Made in Taiwan

Fig: Rib circular knitting machine

3.1.2.2 Machine Specification (Rib):

Machine Name: Fukuhara
Needle: 1696x2
Feeder: 60
Dia: 30”
Gauge: 18G
Origin: Made in Japan

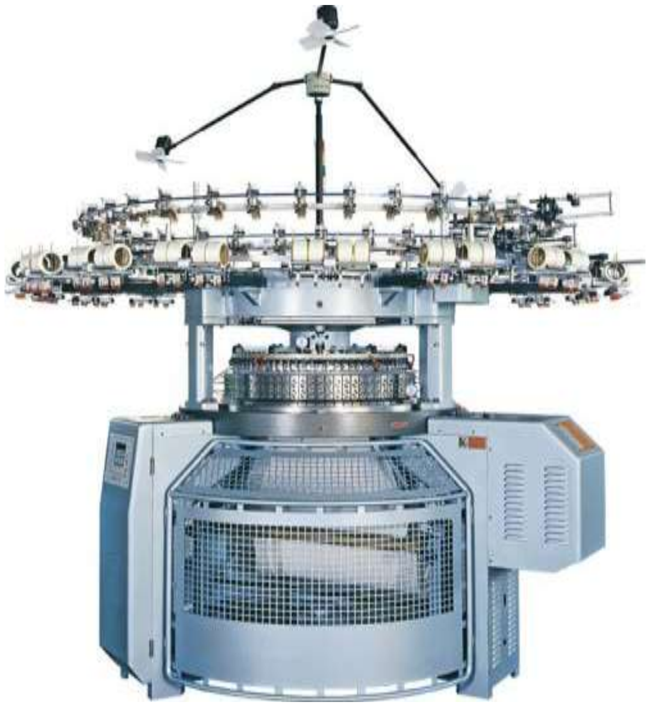


Fig: Interlock circular knitting machine

3.1.2.3 Machine Specification (Interlock):

Machine Name: Jiunnlong
Needle: 2712x2
Feeder: 72
Dia: 36"
Gauge: 24G
Origin: Made in Taiwan

3.1.2 4. Needle:

The fundamental element of construction of knitted fabrics is the knitting needle, during yarn feeding, the hook is opened to release the old loop and to receive the new loop which is then enclosed in the hook. The new loop is then drawn by the hook through the old loop which slides over the outside of the closed hook.

There are mainly three types of needle:

1. The bearded needle.
2. The latch needle.
3. The compound needle.

Latch needle is used in single jersey circular knitting machine for its self interlooping technology.

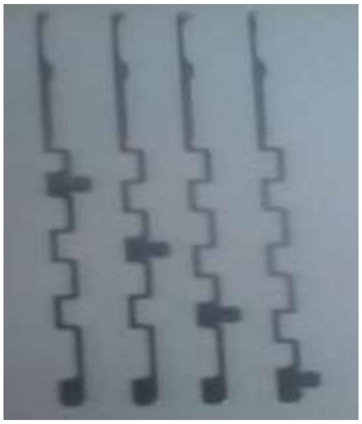


Fig: 4.7: Latch Needle.

3.1.2 5. Needle Track:

Where all Needles is placed together in a decent design.

Fig: Needle Track.

3.1.2 6. Needle Detector:

This part detects the any type of faults of needles.

Fig: Needle Detector.

3.1.2.7. Sinker:

The sinker is the second knitting elements. It is a thin metal plate with an individual or a collective action operation approximately at right from the hook side between adjacent needles.

Fig: Sinker.

3.1.2.8. Sinker Ring:

Where all sinkers are placed together to complete their horizontal actions.

.

3.1.2.9. Cylinder:

The cylinder is a steel circular bed having grooves/tricks/cuts on its outer periphery into which the needles are mounted. With reference to the tricks, the needles move vertically up and down by their butt being in contact with the cam track. The number of tricks per inch i.e.: Number of needles per inch decides the gauge of the machine. Machines are built as low as 4 NPI to as high as NPI 32. Based on the machine gauge, the fineness of the yarn to be knitted can be varied. The diameter of the cylinder also varied based on the type and width of the fabric and the maximum of 75 cm diameter machines are available.

3.1.2.10. Cylinder Balancer:

It helps the cylinder to set in a proper alignment. Perfect balance of cylinder prevents many fabric faults like horizontal stripe, needle breakage and increases the life time of the needles, sinkers and cylinders itself.

3.1.2.11. Cam:

Cams are the third primary knitting elements which cover the rotary machine drive into a suitable reciprocating action for the needles and other elements. The cams are carefully profiled to produce precisely timed movement and dwell periods. The drive transmitted and adapted via cam followers, leavers, pivots and rocking shafts. One complete 360° revolution of the driver shaft is equivalent to one knitting cycle. Two types of cam:

1. Engineering cams
2. Knitting cams
    a) Knit cam
    b) Tuck cam
    c) Miss cam

Fig: Cam.

3.1.2.12. Cam Box:

Where the cam are set vertically to produce a horizontal needle path.

Fig: Cam Box.

3.1.2.13. Creel:

Creel is a part of a knitting machine. Here yarn package are store and ready to feed in the machine.

Fig: Creel.

3.1.2.14. VDQ Pulley:

It is a very important part of the machine. It controls the quality of the fabric by increasing or decreasing the stitch length of the fabric. The abbreviation of VDQ is variable diameter for quality. By varying the diameter of the VDQ pulley stitch can be increased or decreased. As it is known that GSM of knit fabric is inversely proportional to stitch length, so by enlarging the diameter of VDQ pulley stitch length can be increased to decrease the GSM of the fabric and vice versa.

Fig: VDQ Pulley.

3.1.2.15. Pulley Belt:

It controls the rotation of the MPF wheel and supplies motion to positive feeders.

3.1.2.16. Brush:

Its clean the pulley belt.

Fig: Brush

3.1.2.17. Tension Disk:

It confronts the tension of the supply yarn. It may be two types, spring loaded tensioner and magnetic tensioner. Now a day, magnetic tensioner is used frequently on circular knitting machine for its better performance.

Fig: Tension Disk.

3.1.2.18. Inlet and Outlet Stop Motion:

It is an important part of the machine. It stops the machine instantly when a yarn is break.

Fig: Inlet and Outlet Stop Motion.

3.1.2.19. Yarn Guide:
Its help the yarn to feed in the feeder.

Fig: Yarn Guide.
3.1.2.20. Feeder Ring:
It is a ring. Where all feeders are pleased together.
3.1.2.21. Positive Feeder:
Feeder is help yarn to feed in to the machine.

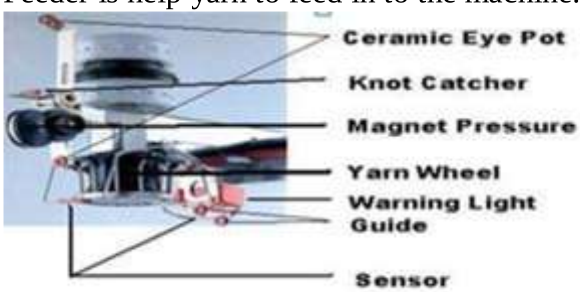


Fig: Feeder.
3.1.2.22. Lycra Attachment Device:
Lycra is placed here and feed to the machine. Lycra percentage of fabric can be calculated and measured from this lycra attachment device.

Fig: Lycra Attachment Device.

3.1.2.23. Lycra Stop Motion:
It is one kind of stop motion to stop the machine when the Lycra is break.

Fig: Lycra Stop Motion.

3.1.2.24. Uniwave Lubrication:
The Uniwave lubricator provides uniform lubrication to needles, cam tracks, lifters and other knitting machine components. The patented nozzle construction separates the air-oil mixture into air and droplets of oil.

3.1.2.25. Adjustable Fan:
This part removes lint, hairy fibre from yarn and others. To clean the dust by air flow.

Fig: Adjustable Fan.

3.1.2.26. Expander:
To control the width of the knitted fabric. No distortion of the knitting courses. Even take down tension in the knitting machine. As a result, an even fabric structure is achieved over the entire fabric width. The deformation of the knitted fabric goods can be reduced.

Fig: Expander.

3.1.2.27. Air and oil Nozzle:
For proper machine services and productions it is necessary to supply oil to the needle and sinker tricks as well as air to clean the sophisticated areas where blows from fan is not sufficient.

Fig: Oil nozzle

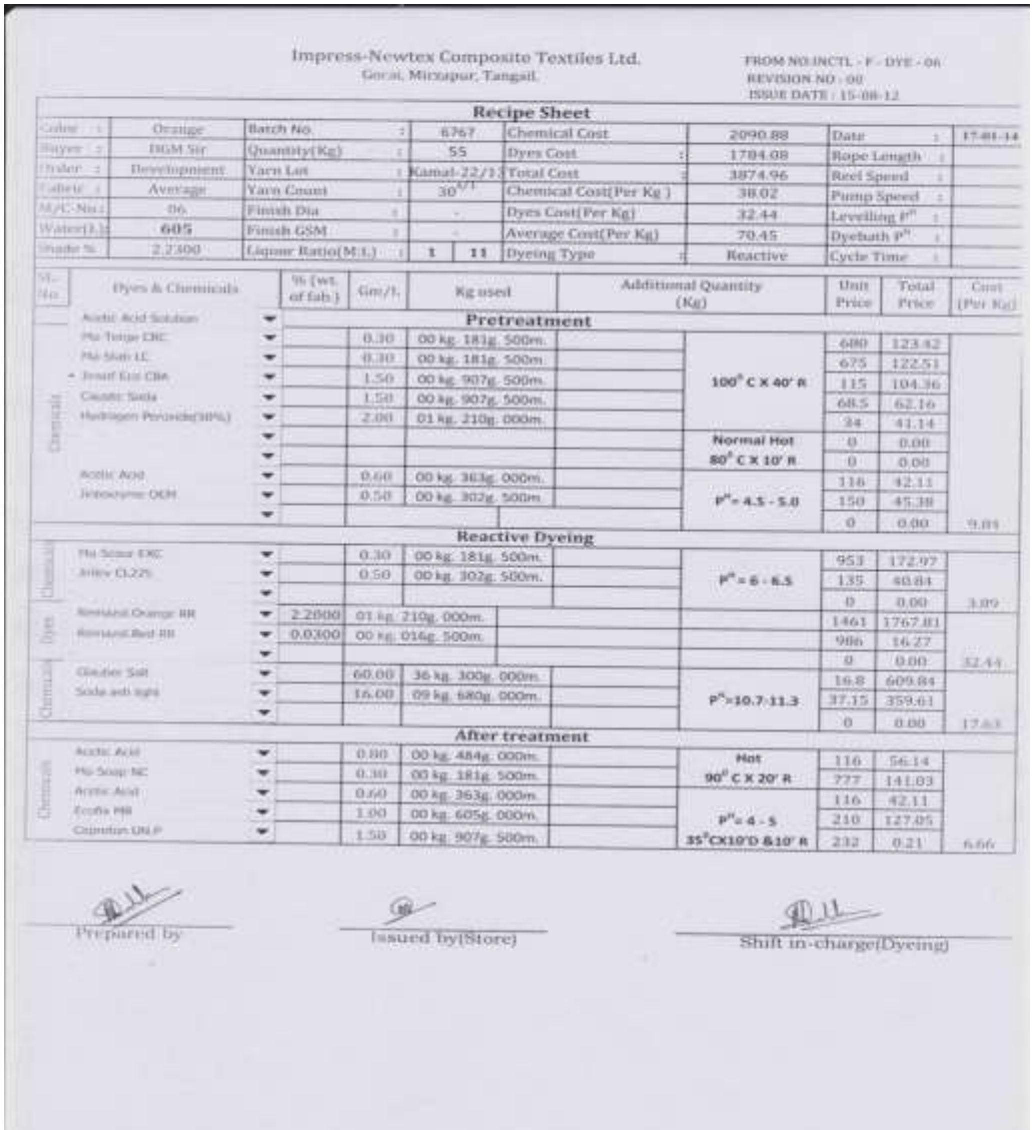
3.2. Dyeing:

Dyeing is the process of adding colour to textile products like fibres, yarns, and fabrics. Dyeing is normally done in a special solution containing dyes and particular chemical material. After dyeing, dye molecules have uncut chemical bond with fiber molecules. The temperature and time controlling are two key factors in dyeing.

3.2.1 Dyeing machine:

Fig: Dyeing machine

3.2.2 Dyeing Recipe:



Impress-Newtex Composite Textiles Ltd.
Gorai, Mirzapur, Tangail.

FROM NO:INCTL - F - DYE - 06
REVISION NO : 00
ISSUE DATE : 15-08-12

Recipe Sheet

Color :	Orange	Batch No. :	6767	Chemical Cost	2090.88	Date :	17-01-14
Buyer :	DGM Sir	Quantity(Kg) :	55	Dyes Cost :	1784.08	Rope Length :	
Order :	Development	Yarn Lot :	Kamal-22/13	Total Cost :	3874.96	Reel Speed :	
Fabric :	Average	Yarn Count :	$30^{s/1}$	Chemical Cost(Per Kg) :	38.02	Pump Speed :	
M/C-No.:	06	Finish Dia :	-	Dyes Cost(Per Kg)	32.44	Levelling P^H :	
Water(L):	605	Finish GSM :	-	Average Cost(Per Kg)	70.45	Dyebath P^H :	
Shade %	2.2300	Liquor Ratio(M:L) :	1 : 11	Dyeing Type :	Reactive	Cycle Time :	

Sl. No.	Dyes & Chemicals	% (wt. of fab.)	Gm/L	Kg used	Additional Quantity (Kg)		Unit Price	Total Price	Cost (Per Kg)
	Pretreatment								
Chemicals	Acetic Acid Solution								
	[illegible]		0.30	00 kg. 181g. 500m.		100° C X 40' R	680	123.42	
	[illegible]		0.30	00 kg. 181g. 500m.			675	122.51	
	[illegible]		1.50	00 kg. 907g. 500m.			115	104.36	
	Caustic Soda		1.50	00 kg. 907g. 500m.			68.5	62.16	
	Hydrogen Peroxide(50%)		2.00	01 kg. 210g. 000m.			34	41.14	
						Normal Hot 80° C X 10' R	0	0.00	
							0	0.00	
	Acetic Acid		0.60	00 kg. 363g. 000m.		P^H= 4.5 - 5.0	116	42.11	
	[illegible]		0.50	00 kg. 302g. 500m.			150	45.38	
							0	0.00	9.81
	Reactive Dyeing								
Chemicals	[illegible]		0.30	00 kg. 181g. 500m.		P^H = 6 - 6.5	953	172.97	
	[illegible]		0.50	00 kg. 302g. 500m.			135	40.84	
							0	0.00	3.09
Dyes	[illegible] Orange RR	2.2000		01 kg. 210g. 000m.			1461	1767.81	
	[illegible] Red RR	0.0300		00 kg. 016g. 500m.			986	16.27	
							0	0.00	32.44
Chemicals	Glauber Salt		60.00	36 kg. 300g. 000m.		P^H=10.7-11.3	16.8	609.84	
	Soda ash light		16.00	09 kg. 680g. 000m.			37.15	359.61	
							0	0.00	17.63
	After treatment								
Chemicals	Acetic Acid		0.80	00 kg. 484g. 000m.		Hot 90° C X 20' R	116	56.14	
	[illegible]		0.30	00 kg. 181g. 500m.			777	141.03	
	Acetic Acid		0.60	00 kg. 363g. 000m.		P^H= 4 - 5 35°CX10'D &10' R	116	42.11	
	[illegible]		1.00	00 kg. 605g. 000m.			210	127.05	
	[illegible]		1.50	00 kg. 907g. 500m.			232	0.21	6.66

Prepared by — Issued by(Store) — Shift in-charge(Dyeing)

Fig: Dyeing Recipe

3.3. Finishing:

After dyeing, knit fabric requires to finish. During dyeing some knit fabrics are dyed in tubular form. According to the fabric types it needs to be tubular or open form in dyeing time. Normally the Lycra fabrics which are required to heat setting, these types of fabrics are open form. **.** To conduct this thesis, tube finishing is performed.

Following m/c Used

- De-watering
- Dryer
- Open compactor

3.3.1 Dryer (Stenter)

Function:

- To dry the fabric

Fig::Stenter Machine

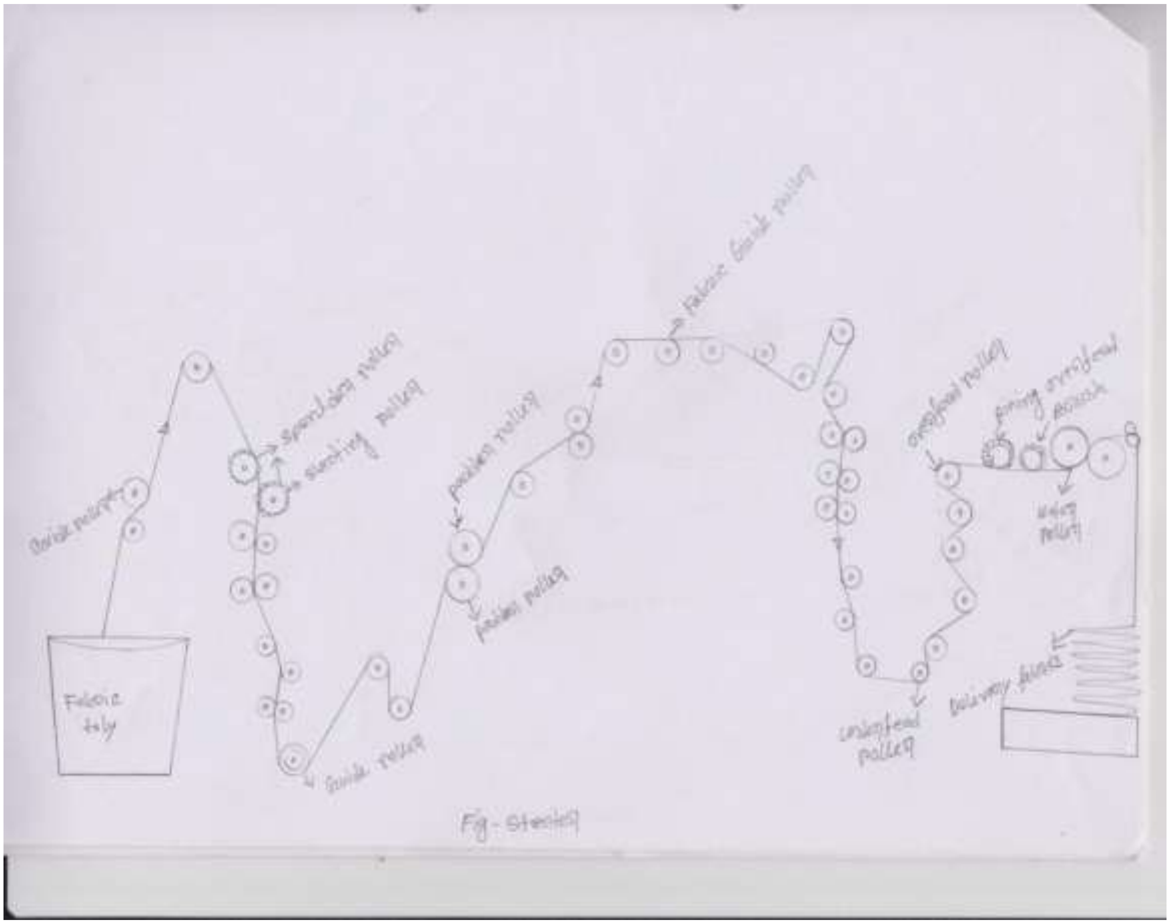


Fig::Flow diagram of Stenter machine

3.3.2.1 Machine specification:

TYPE	: Efficient shrinkage dryer
MANUFACTURER	: Santex
COUNTRY	: Switzerland
MAX. TEMP.	: 200°C
YEAR OF BUILT	: 2011
CAPACITY	: 15000 kg/day

3.3.2.2 Working Procedure of Stenter:

After de-watering then the fabric through the dryer. The main function of the dryer is given below,

- To dry the fabric.
- To control the overfeed system.
- To control the fabric width.

This machine contains eight chambers. Two mesh endless conveyors are placed lengthwise to the chamber named conveyor net and filter net, each chamber contain a burner, which supply hot air .This hot air is guided through the ducting line by suction fan .There are nozzles placed in between filter net and conveyor net .When the fabric

pass on the conveyor net, hot air is supplied to the wet fabric to dry it. There are exhaust fan which such the wet air and deliver to the atmosphere through the ducting line.
The speed of the dryer depends on the temperature of the m/c & the G.S.M of the fabric. If the m/c temp. Is high then m/c speed also high and the m/c temp. Is low then m/c speed also low. The vibration speed of the m/c for heavy fabric is 730 m/min and normal fabric is 480 m/min.

3.3.3. Compactor machine:

Function:

- To control shrinkage.
- To control width.
- To control GSM.
- To smooth fabric.
- To change from deep to light shade.

.
Fig:: Compactor machine.

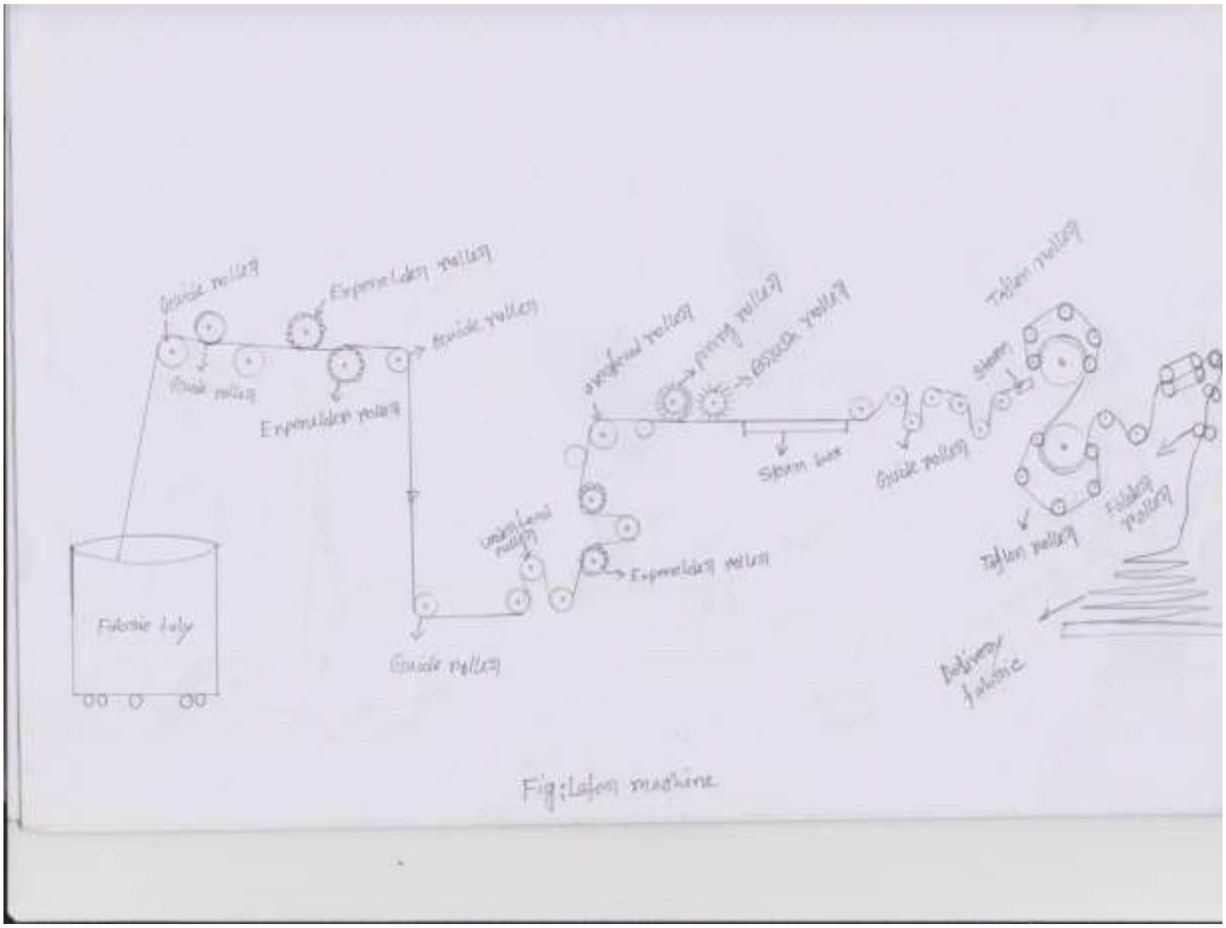


Fig:: Flow diagram of Compactor machine

Manufacturer : san-tex (tubular)
Country : Switzerland
Construction year : 2008
Capacity : 12000 kg/day
No. of shoes : 02
Checking Parameters:
a) Shade check: At delivery side operator check shade with approved swatch.
b) Width Check: Operators measure fabric width with measuring tape and compare with approved swatch.
c) Weight Check: Operators check GSM by GSM cutter & electronic balance

3.4 Testing materials:

3.4.1. CPI, WPI Measuring material:

Counting glass:

Fig: Counting glass

For close observations of knit fabrics in one inch square area, counting glass is used. With the help of counting needle CPI, WPI and stitch density can be measured physically. This equipment contains a magnifying glass for larger view of small stitches of fabrics.

3.4.2. Stitch length counting materials:

Scale and pen: Pen is used to count the wales (it may be 50 or 100) with the help of counting glass and scale is used to measure the length of the course length contains those wales.

3.4.3. GSM checking material:

GSM cutter and digital balance:

GSM is the short term of Gram per Square meter which expresses the weight of fabrics. To test the GSM of a fabric a round cutter is used known as GSM cutter.

GSM cutter and digital balance

It cuts a single part from 100 parts of one square meter. It means, after taking the weight of the cut sample specimen by digital balance it have to multiply by 100 to get the GSM of the sample.

3.4.4. Shrinkage and spirality test:

Shrinkage and spirality are very important properties of single jersey weft knit fabrics which is measured after washing. Because, this properties of knit fabrics are observed after wetting and drying consecutively.

Fig: Template

Fig: Line dry

Fig: Washing machine

A fixed dimensioned fabric is cut and stitched with the help of a template and washed on washing machine and dried on line dryer. After drying, the shrinkage and spirality is measured.

3.4.4.1 Washing machine specifications:

Brand name: LG
Capacity: 6 kg
Standard method: ISO 6330
Company and origin: LG, China.

3.4.6. Bursting strength:

Of diaphragm bursting test and ball bursting test, diaphragm bursting testing method is applied on this experiment. The British standard describes a test in which the fabric to be tested is clamped over a rubber diaphragm by means of an annular clamping ring and an increasing fluid pressure is applied to the underside of the diaphragm until the specimen bursts. The operating fluid may be a liquid or a gas.

Two sizes of specimen are in use, the area of the specimen under the stress being either 30 mm diameter or 113 mm in diameter. The specimens with the larger diameter fail at lower pressures. However, there is no direct comparison of the results obtained from the different sizes. The standard requires ten specimens to be tested.

In the test the fabric sample is clamped over the rubber diaphragm and the pressure in the fluid increased at such a rate that the specimen bursts with in 20±3 seconds. The extension of the diaphragm is recorded and another test is carried out without a specimen present. The pressure to do this noted and then deducted from the earlier reading.

Fig: Auto burst

3.4.6.1 Bursting machine specification:

The auto bursting machine specification is:

Brand name: Auto burst

Function: Bursting Strength test

Standard method: ISO 13038-1

Company: SDL Atlas

Origin: England

3.5. Methods

Both 30/1 Combed & Compact combed yarn have been used to knit total twelve different samples Single Jersey, Lycra Single Jersey, Single Lacoste , Double Lacoste, 1x1 Rib & Interlock fabrics. All machine parameters of knitting machine like stitch length, take down tension, sinker timing, yarn feeder position, spreader width- were fixed for same construction fabric in order to observe the variations. All these knitted samples were dyed on dyeing machine on a single batch with a fixed recipe. After that samples were dried on open dryer and compacted of compactor. The dryer and compactor machine setting was same for all the samples. The required tests were performed by collecting necessary samples from all these finished same.

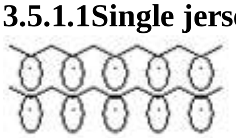
Knitting, dyeing, finishing and testing methods are discussed below:

3.5.1. Knitting method:

As all the machine parameters were same for same fabrication, only needle arrangement and cam arrangement was done and installed on the machine. The machine parameters were kept like follows according to fabric type:

SL No	Fabric Type	Yarn			Machine	
		Yarn Type	Brand	Lot	Dia(inch)	Gauge
1	Combed S/J	30/' CB	Square	105	26	24
2	Cmpt. Combed S/J	30/'Cmpt. CB	Square	105	26	24
3	CombedL.S/J	30/' CB	Square	105	30	24
4	Cmpt. Combed L.S/J	30/'Cmpt. CB	Square	105	30	24
5	Combed S/L	30/' CB	Square	105	26	24
6	Cmpt. Combed S/L	30/'Cmpt. CB	Square	105	26	24
7	Combed D/L	30/' CB	Square	105	26	24
8	Cmpt. Combed D/L	30/'Cmpt. CB	Square	105	26	24
9	Combed (1X1)RIB	30/' CB	Square	105	30	18
10	Cmpt. Combed (1X1)RIB	30/'Cmpt. CB	Square	105	30	18
11	Combed Inerlock	30/' CB	Square	105	34	24
12	Cmpt. Combed Interlock	30/'Cmpt. CB	Square	105	34	24

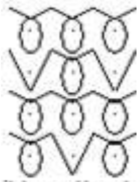
3.5.1.1Single jersey (Plain) & Lycra Single jersey:



Needle Arrangement : 11111

Fig: Cam arrangement of Single Jersey (plain)

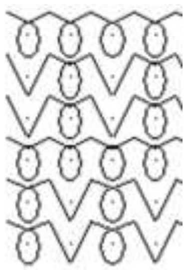
3.5.1.2Single Lacoste:



Needle Arrangement : 1212

Fig:: Cam arrangement of Single Lacoste

3.5.1.3Double Lacoste:



Needle Arrangement : 1212

Fig:: Cam arrangement of Double Lacoste

Five kilogram fabrics were knit for each design and individualized by writing the knitting parameters on each samples

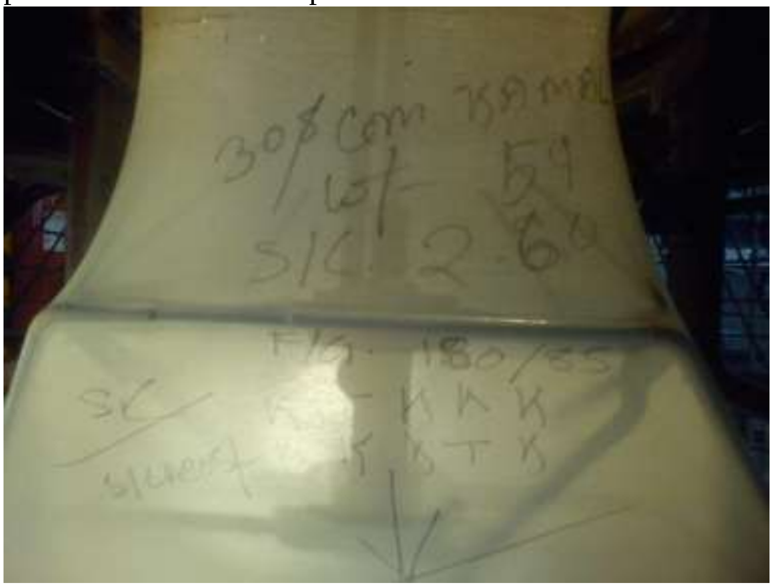


Fig: Knit fabrics

3.5.4. Parameters test & data collection:

3.5.4.1 CPI test:

By a counting glass and counting needle,the total number of courses were calculated on 1 inch at every stages (Grey,Dryed,Finished). The daviations of the values of grey to dry samples and dry to finish samples were calculated which are given below:

3.5.4.2 WPI test:

Like CPI, with the help of counting glass and counting needle total number of wales were measured in 1 inch at every stages (Grey,Dryed,Finished).The daviations of grey fabric to dried fabric and dried to finished fabrics were calculated and the resultsare given below:

3.5.4.3 Stitch length:

Total n (100) numbers of wales were counted by a counting glass then they were measured by a millimeter scale. After measuring the scale measurement is divided by number of wales (100). Then we get the stitch length in millimeter.

3.5.4.4 Stitch density:

Stitch density is the number of total loops per square inch. There have an equation to calculate the stitch density.

Stitch density= WPI X CPI

This stitch density has a direct impact on the fabric properties like air permeability, water permeability, dimensional properties, thickness, aesthetic properties of fabrics etc. WPI and CPI don‟t have any direct effect on weft knit fabrics except the stripe effects like horizontal and vertical effects. WPI and CPI together affects the stitch density, it means the total number of loops on specific area.

3.5.4.5 GSM:

GSM calculation is simply done by GSM cutter & digital balance machine. By GSM cutter the sample was cut from the fabric and it weighted on digital balance. Multiplying by 100 the final GSM was obtained. GSM was tested on all three stages (grey, after dry & after compacting).All the values are positioned below:

3.5.4.6 Width of fabric:

Width of fabric is measured with an accurate measuring tape after laying on table without any tension or elongation. It directly affects the marker efficiency of a garments production. Higher or lower in width increases the wastage% of fabrics. So, it is very important to maintain the accurate fabric width as the requirement of garments section.
After measuring all samples, the following width values were obtained:

3.5.4.7 Spirality Test of knitted fabrics:

Method: ISO 16322-2 Spirality or twisting in a garment is appeared after washing. As a result one of the side seams comes at front of the garment when wearer wears it. Spirality percentage depends on fabric torque and garment structure.

Procedure: By the following way we can test spirality.
Sample: Two piece of 50cm x 50cm fabric is taken for test.

i. Conditioning: put the sample in the table for 4 hours conditioning before starting test.
ii. Cut the sample 50cmx50cm and benchmark should be 35cmx35cm. stitch the sample (3 sides).by over lock sewing machine.
iii. Sample is washed in washing machine.
iv. All samples are driedon tumble dryer.

3.5.8.1**Spirality test calculation:**

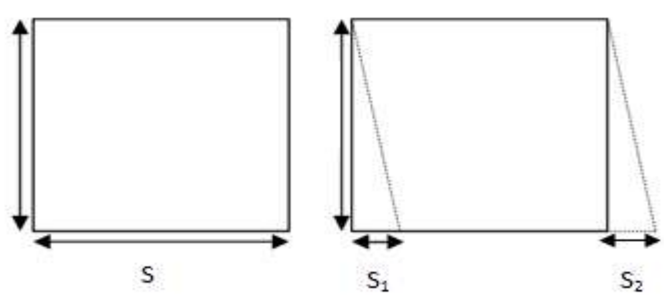


Fig:: Spirality

Total length S= 47 cm
Twist in one end S_1= 2.3 cm
Twist in another end S_2= 2.2 cm
Average Spirality = (2.3+2.2)/2= 2.25 cm

So, Spirality= $\frac{2.25}{47} * 100$ = 4.78%

All the measured values are showed on the following table:

3.5.4.8 Bursting strength test:
Method: ISO 13938-1
Machine: Auto Burst

3.5.4.8.1 Testing procedure:
Click on “manual”, enter any sample details and click “OK”
• Place a specimen under the bell ensuring that it is flat and free from creases and distortions. Press the two clamp buttons.
• If at this point the fabric needs to be unclamped (e.g. if the fabric is not flat), press the retract button. Then clamp the sample again.
• Use the mouse to select the flow rate; this determines the speed at which the bell will inflate. The flow rate is often defined in the test method or standard being tested to. NOTE: if the method does not specify flow rate but time, the automatic mode may be used.
• Click on “start”.
• The diaphragm will automatically inflate until the specimen bursts, at which point the diaphragm will automatically return to the zero position. If the fabric is too elastic and the distension reached exceeds the maximum, a message will be seen on the screen. The maximum distension on the larger bell is 70mm and on the smaller bell sizes is approx. 55 cm.
• If at any time the operator should need to abort the test, the abort button should be pressed. Pressing the emergency stop button will also abort a test.
• Once a burst has occurred the diaphragm will return to the zero position and the bell will unclamp. The operator is then given the opportunity to examine the burst before pressing accept or reject. The burst should be rejected if it has burst at the edge of the bell instead of on the main body of the specimen to be tested.
• If the burst is accepted, this procedure should be followed until the series of tests has been completed, either 5 or 10 depending on which has been selected as the number of tests in a series.
• After the required number of tests has been completed, the operator will be prompted to carry out the diaphragm correction. The fabric should be removed from the clamping area and the bell clamped over the diaphragm only.
• Press “start”, the diaphragm will automatically inflate to the mean distension reached on the series of tests. The diaphragm will deflate and the bell will unclamp. The results will then be shown on the screen, these can either be printed or if “END” is pressed the results will be stored to disc.

4.Results and discussions

4. Results and discussions:

4.1 Effect of carded and compact combed yarn on grey spirality of knitted fabrics:

Table 4.1: Effect of carded and compact combed yarn on grey spirality of knitted fabrics

Fabric Type	Grey spirality%		Deviation%
	carded	Compact	
Single Jersey	9.5	9	5.26
Lycra Single Jersey	4.5	4.2	6.67
Single Lacoste	4.3	4	6.98
Double Lacoste	4	3.8	5
1x1 Rib	3.8	3.5	7.89
Interlock	4.1	3.9	4.88

From figure 4.1 and table 4.1 is was observed that grey spirality was found higher for carded yarn fabrics than compact combed yarn. Higher grey spirality was found for single jersey fabrics (9.5 and 9) and lower value was observed for 1X1 rib fabrics (3.8 & 3.5). It is also seen that higher spirality deviation was found for 1X1 rib also (7.89%). So it can be discussed that 1X1 rib fabric contains lower grey spirality but higher deviation for card to compact. From single lacoste and double lacoste fabrics, it was seeen that higher presence of tuck loop decreases the spirality of both carded (4.3, 4) and compact combed yarn (4, 3.8).

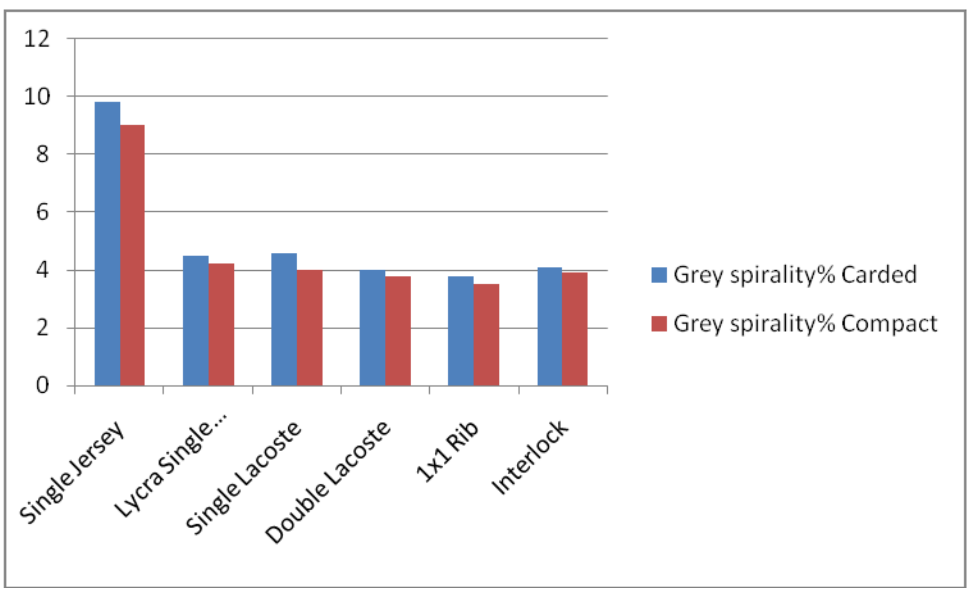


Figure: 4.1: Effect of carded and compact combed yarn on grey spirality of knitted fabrics

Fabric Type	Finish Spirality%		Deviation%
	Carded	Compact	
Single Jersey	4.8	3.8	20.83333
Lycra Single Jersey	4.1	2.7	34.14634
Single Lacoste	3.8	3.6	5.263158
Double Lacoste	4	3.5	12
1x1 Rib	4.8	3	37.5
Interlock	4.3	3.1	27.91

4.2 Effect of carded and compact combed yarn on finish spirality of knitted fabrics:

Table 4.2: Effect of carded and compact combed yarn on grey spirality of knitted fabrics.

From figure 4.2 and table 4.2 is was observed that finish spirality was found higher for carded yarn fabrics than compact combed yarn. Higher finish spirality was found for single jersey fabrics (4.8 and 3.8) and lower value was observed for Single Lacoste fabrics (3.8 & 3.6). It is also seen that higher spirality deviation was found 1 x1 rib also (37.5%). And lower deviation was found in single lacoste (5.26%) for card to compact. From single lacoste and double lacoste fabrics, it was seeen that higher presence of tuck loop decreases the spirality of both carded (3.8, 3.6) and compact combed yarn (4.8, 3).

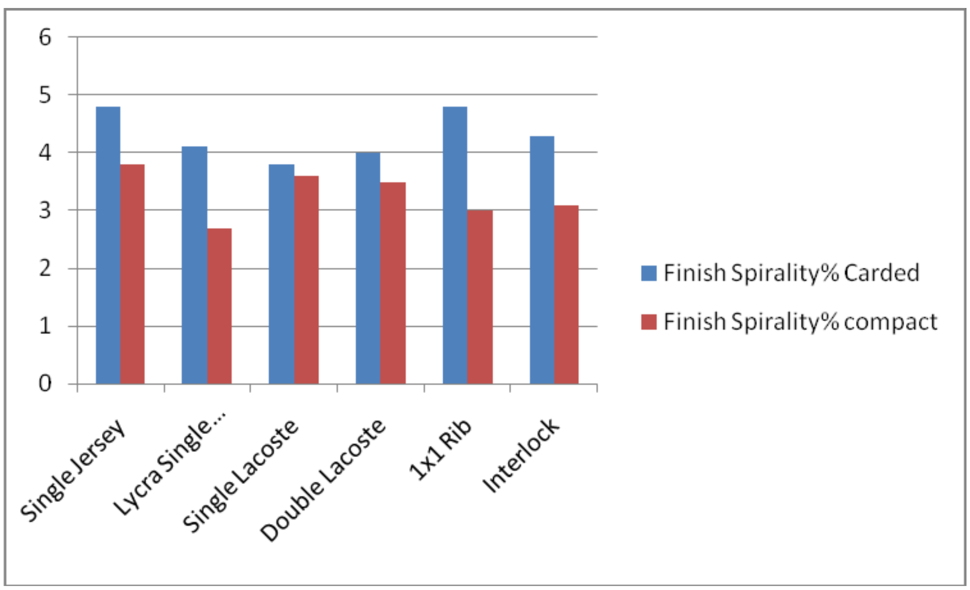


Figure: 4.2: Effect of carded and compact combed yarn on finish spirality of knitted fabrics

4.3 Effect of carded and compact combed yarn on grey bursting strength of knitted fabrics:

Table 4.3: Effect of carded and compact combed yarn on grey spirality of knitted fabric

Fabric type	**grey bursting strength test(PSI)**		**deviation%**
	Carded	**compact**	
Single Jersey	80	95	18.75
Lycra Single Jersey	53	69	30.1887
Single Lacoste	74	97	31.0811
Double Lacoste	68	89	30.8824
1x1 Rib	92	106	15.2174
Interlock	123	152	23.5772

From figure 4.3 and table 4.3 is was observed that grey bursting strength was found higher for carded yarn fabrics than compact combed yarn. Higher grey bursting strength was found for interlock fabrics (123 and 152) and lower value was observed for lycra single jersey fabrics (53 & 69). It is also seen that higher grey bursting strength deviation was found in single lacoste (31.08%). And lower deviation was found in 1x1 rib fabric (15.21%) for card to compact. From lycra single jersey fabrics, it was seeen that higher presence of lycra decrease the grey bursting strength of both carded and compact combed yarn.

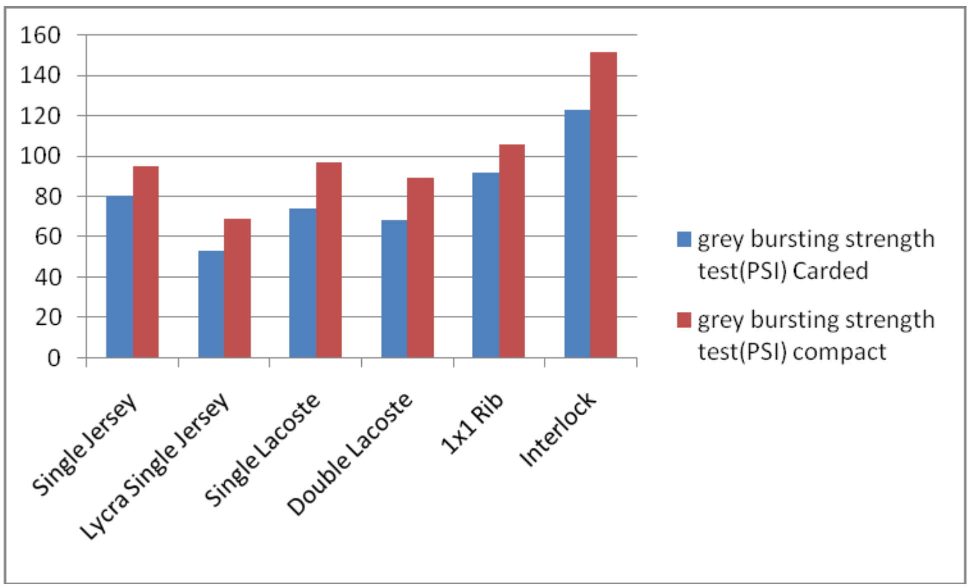


Figure: 4.3: Effect of carded and compact combed yarn on grey bursting strength of knitted fabrics

4.4 Effect of carded and compact combed yarn on finish bursting strength of knitted fabrics:

4.4: Effect of carded and compact combed yarn on finish bursting strength of knitted fabrics

Fabric Type	Finish Bursting Strength Test(PSI)		Deviation%
	Carded	compact	
Single Jersey	62	76	22.5806
Lycra Single Jersey	43	63	46.5116
Single Lacoste	61	78	27.8689
Double Lacoste	58	74	27.5862
1x1 Rib	75	92	22.6667
Interlock	121	141	16.5289

From figure 4.4 and table 4.4 is was observed that finish bursting strength was found higher for carded yarn fabrics than compact combed yarn. Higher finish bursting strength was found for interlock fabrics (121 and 141) and lower value was observed for lycra single jersey fabrics (43 & 63). It is also seen that higher finish bursting strength deviation was found in lycra single jersey (46.51%). And lower deviation was found in interlock fabric (16.52%) for card to compact. From lycra single jersey fabrics, it was seen that higher presence of lycra decrease the finish bursting strength of both carded and compact combed yarn.

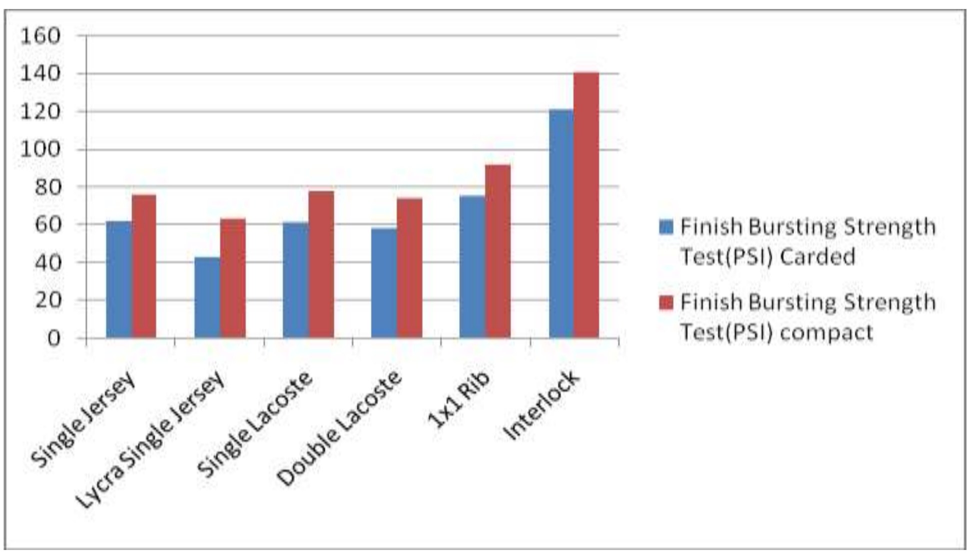


Figure: 4.4: Effect of carded and compact combed yarn on grey bursting strength of knitted fabrics

5.Conclusion

Conclusion

From the detail project the following findings are can be summarized:

1. Compact combed yarn fabric shows lower grey spirality than carded yarn fabrics.
2. Compact combed yarn fabric shows lower finish spirality than carded yarn fabrics.
3. Compact combed yarn fabric shows higher grey bursting strength than carded yarn fabrics.
4. Compact combed yarn fabric shows higher finish bursting strength than carded yarn fabrics.
5. Presence of lycra reduces the bursting strength for both carded yarn fabrics and compact combed yarn fabrics.

6.Reference

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