



DEVELOPMENT OF DOUBLE LAYER KNITTED FABRIC FOR SPORTSWEAR USING TENCEL/ POLYPROPYLENEFIBRES

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ABSTRACT

In day to day life the requirement for the athletics and leisure wear are increasing to better their performance. The performance requirements of many sports goods often demand widely on different properties. Also the textile must fulfill the requirements such as fit, comfort, drape and easy movements of the consumers. The active sportswear fabrics has been developed in recent years and progressing towards high functions and to achieve comfort. The focus is to diversify the sportswear textiles in fibrous material and technology in manufacturing. The factors contributing for developing active sportswear fabrics are: polymer/fiber science, production and finishing techniques to obtain a sophisticated fiber, modified structure of yarns and fabrics. In this study, the sportswear are developed from *polypropylene* and *tencel* fibers by using a knitting technique, *Ponte de roma* structure (double layer knitted fabric by interlock structure) and analyzed for their various properties such as structural, mechanical and comfort properties of the knitted fabric samples.

Key Words: Fiber, Yarn, Fabric, Sportswear, Textile, Knit, Polypropylene and tencel

INTRODUCTION

The people are paying more attention to sports activity and that the market for sportswear continues to expand. Developing sportswear solutions in this field are invaluable in order to produce an adequate response to these increasingly demanding expectations. Recently developed functional fibers, innovations in new structures and garments contribute substantially to the wearing comfort of these types of clothes. Nowadays, from very simple manmade fibers to much more complex fabric structures are effectively used in sportswear garments¹.

Sportswear requires some important functional and comfort properties such as optimum heat and moisture regulation, rapid moisture absorption and conveyance capacity, good air and water permeability, prevention of a long term feeling of dampness, low water absorption of the layer of clothing facing the skin, quick drying fabric to prevent catching cold, pleasant to skin, soft, non-abrasive and non-chafing, dimensionally stable even when wet, durable, lightweight, soft and pleasant touch, easy care, smart and functional design. All

required properties are not possible to achieve for sportswear in a simple structure of any single fiber. The behavior of the fabric is mainly depending on its base fibers properties, fabric construction, weight or thickness of the material and presence of chemical treatments⁵.

The performance of layered fabrics in thermo-physiological regulation is better than single layer textile structure. The most common strategy used to give high performance in synthetic fiber based active sportswear is to use a two layer fabric with a hydrophobic skin contact layer and a hydrophilic outer layer. In doing so, it takes away some of the body heat and keeps the body cool. On the inside, a synthetic material with good moisture transfer properties and good capillary action e.g. *Polyester*, *Nylon*, *Acrylic* or *Polypropylene* is used, whereas on the outside, a material with a good absorber of moisture, e.g. *Cotton*, *Tencel*, *Wool*, *Viscose Rayon* or their blends can be placed².

In this study, the sportswear fabrics are developed from *polypropylene*; being used in sportswear have very low moisture absorbency, excellent moisture vapor permeability,

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wicking capabilities and has the advantage of providing insulation when wet, and *tencel* fibers, deliver the hydrophilicity needed for transport of moisture through the fabric and for spreading across the outer surface³. The double layer knitted fabric is developed with above said fibers by interlock structure using a knitting technique called *Ponte de roma* structure, a dense structure with stretching property is higher in lengthwise than in breadth wise, has advanced dimensional stability⁴. Then the fabric is analyzed for their various properties such as structural, mechanical and comfort properties of the knitted fabric samples.

MATERIALS AND METHODS

Selection and Purchase of yarns

a. *Tencel*: 100% Tencel yarn was selected for this study. The combed tencel yarn count with 40's was purchased at the cost of Rs.325/- per kg from Cheran Spinners Pvt Ltd., Erode.

b. *Polypropylene*: 100%polypropylene yarn of 120 Denier was selected and purchased at the cost of Rs.380/- per kg from Filatex India. Ltd, Dadra &Nagar Haveli.

The yarn package is shown in figure 1.

Selection of fabric construction

The technique of fabric construction selected for the study is knitting, as it is the most common fabric structure for base layer and possesses high stretch and recovery by providing greater freedom of movement, shape retention and tailored fit. Knitted fabrics also have relatively uneven surfaces (less direct contact with skin), which make the wearer feel more comfortable than smooth surfaced woven fabric of similar fiber compositions.

a. Double layer knitted fabric

The bi-layer weft knitted fabric with wicking fibers: *polypropylene* in their inner layer and *tencel* as outer layer, on circular double jersey knitting machine with interlock structure is prepared, which can able to transfer moisture from skin to the environment. Thus the bi-layer knitted fabric is prepared for the sportswear fabric as shown in the figure. This fabric provides a comfortable environment for the wearer and consequently able to handle moisture vapor and sweat produced by the body during strenuous activity in sports to feel good.

b. Selection of interlock structure- Ponte de roma

Interlock fabric is double knit fabric is produced by the action of two needle by the interlinking of loops. The needles used were cylinder needle and dial needle. The interlock fabric is manufactured in various diameter and gauges. It depends upon end use of the fabric.

The fabric is a double knit, which means it is a double layer of fabric knitted with a 2 sets of needles on 2 needle beds most probably on a machine. As far as knits go, Ponte is a good fabric to start experimenting with. It is nice and stable, does not have a huge amount of stretch and won't curl too much either when cut. The Knitting construction of Ponte de Roma was shown in Figure 2.

c. Knitting machine details

The weft circular knitting machine (type: rib machine) was chosen to knit the fabric. The main parameters of the machine are given below.

Table 1: Machine parameters

S. No.	Machine parameters	Details
1	Type	Rib machine
2	Make	Terrot
3	Cylinder Dia	30inches
4	Gauge	18needles/inch
5	Number of feeders	52
6	Number of functional feeders	52
7	Number of needles	3360
8	Number of needles in dial	1680
9	Number of needles in cylinder	1680
10	Number of track	2

d. Cam order

Table 2: Cam order

Machine Parameters	Feeders								
	F1	F2	F3F	F4	F5	F6	F7	F8	F9
Dial 1	√	—	—	√	√	—	—	√	√
Dial 2	—	√	—	√	—	√	—	√	—
Cylinder 2	∧	—	∧	—	∧	—	∧	—	∧
Cylinder1	—	∧	∧	—	—	∧	∧	—	—

Note: (√)(∧)- Knit cam; (—) -Miss cam

e. Needle order

Table 3: Needle order

	Needles							
	N1	N2	N3	N4	N5	N6	N7	N8
Dial 1	A	B	A	B	A	B	A	B
Dial 2	B	A	B	A	B	A	B	A
Cylinder 2	A	B	A	B	A	B	A	B
Cylinder1	B	A	B	A	B	A	B	A

Note: A – Long needle; B – Short needle.

Processing of fabrics

The above knitted fabric is bleached using *Hydrogen Peroxide* (H_2O_2) in a pressurized High Temperature (HT) apparatus at the temperatures of 110 - 130°C for 1 hour with *Sodium Hydroxide* (*NaOH*) as a Stabilizer, *Imerol blue* liquid and Acetic acid. After bleaching, the fabric is rinsed in water for 3 times.

Recipe: *Hydrogen Peroxide* (H_2O_2) : 3%
Sodium Hydroxide (*NaOH*) : 1%
 Imerol blue liquid : 1.5%
 Acetic acid : 2.5%
 Time : 1 hour
 Temperature : 110 - 130°C
 Material to liquor ratio : 1:3
 pH Value : 4.5

Fabric testing

The knitted fabric is tested for various properties such as, a. Structural Properties; b. Mechanical properties and c. Comfort properties.

a. Structural tests

The knitted fabric is tested for structural properties such as Course per inch, Wales Density, GSM, Loop length, Tightness Factor, Fabric Thickness and Dimensional Stability using the standard methods.

b. Mechanical properties

The knitted fabric is tested for mechanical properties such as Bursting strength, Abrasion resistance, Drapability and Pilling using the standard test methods and the results are obtained.

c. Comfort properties

The knitted fabric is tested for various comfort properties such as Wet ability – drop test, Wick ability, Water remind ratio, Water vapor permeability, Air permeability, Air resistance, Thermal conductivity, Thermal resistance and Stretch ability using the standard test methods and the results are obtained.

RESULT AND DISCUSSION

Structural properties

The structural properties for the samples is analyzed and given in the table.

Table 4: Properties of Tencel/Polypropylene Double Knitted Fabric

S.No	Properties	Tencel/Polypropylene Double Knitted Fabric
1	Course Per Inch	56
2	Wales Per Inch	28
3	GSM	270
4	Loop length	0.25cm
5	Tightness factor	15.36
6	Structural Fabric thickness	1.5mm
	Dimensional stability	Length-wise 3
7	Elongation (in %)	Width-wise 2
8	Bursting strength (lbs)	71
9	Mechanical Abrasion resistance (Weight loss %)	12.6
10	Drapability (%)	62.31
11	Pilling (Grade)	1 (Excellent)
12	Wet ability (in cm)	28.07
13	Water vapor permeability (g/m ² /day)	12.74
14	Air permeability (CC)	189.47
15	Air resistance (sec)	0.005
16	Thermal conductivity (w/m/k)	0.05675
17	Thermal resistance (mk/w)	17.636
18	Comfort Stretch ability (%)	Lengthwise 24 Widthwise 66
		(in min) 5 (in cm) 2
		10 3.5
		20 5.2
19	Wick ability	30 6.5
		40 8
		50 10.5
		60 11.8

CONCLUSION

Fiber qualities and fabric structure always influences the fabric quality. In this study, attempts were made to understand the characteristics required in fabrics used for sports and active apparel productions and other allied applications.

Here we studied about the various possibilities and methods of producing double layered knitted fabrics with different material combinations. And also we have developed the double layer knitted fabric by interlock structure called ponte de roma structure with *Polypropylene* yarn (inner layer) and *Tencel* yarn (outer layer) and analyzed to evaluate the structural, mechanical and comfort properties of the fabric samples.

The test results gives indication that double layered knitted fabrics made of different combinations influences the mechanical and comfort properties and hence suitable attentions have to be paid while choosing combinations for functional active and sportswear fabrics productions. The fabric sample have more GSM and thickness because the denier of the *Polypropylene* yarn is about 120 D. By the study we can conclude that the fabric tencel- polypropylene is most suitable for active sportswear.

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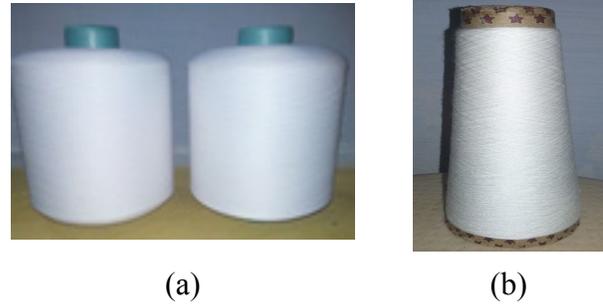


Figure 1: (a) Polypropylene yarn package; (b) Tencel yarn package

Feeder no.	Cylinder Cam		Dial Cam		Knitting Construction (Technical Structure)
	Track 2	Track 1	Track 1	Track 2	
1	—	—	△	△	
2	△	△	—	—	
3	—	△	△	—	
4	△	—	—	△	

Note: — - Misscam; △ - Knit cam

Figure 2: Knitting construction of Ponte de Roma



Figure 3: Circular double jersey knitting machine

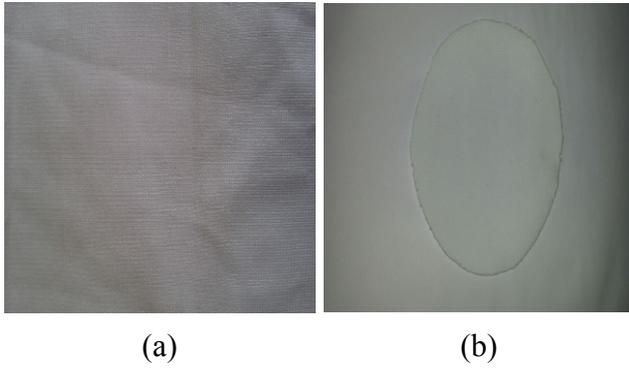


Figure 4: (a) Before Bleaching; (b) After Bleaching