PRODUCTION OF BILAYER KNITTED FABRICS

A PROJECT REPORT

Submitted by

N.MOHAN RAJ 71206212016

R.RADHA KRISHNAN 71206212024

M.SATHISH KUMAR 71206212032

D.VIGNESH 71206212046

In partial fulfillment for the award of the degree

of

BACHELOR OF TECHNOLOGY

In

TEXTILE TECHNOLOGY

KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE-641 006

ANNA UNIVERSITY: CHENNAI 600 025

APRIL 2010

ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report **"PRODUCTION OF BILAYERED KNITTED FABRICS"** is the bonafide work of **N.MOHAN RAJ, R.RADHA KRISHNAN, M.SATHISH KUMAR and D.VIGNESH who** carried out the project work under my supervision.

SIGNATURE	**SIGNATURE**
DR.K.THANGAMANI	MR.N.JEGADEESAN
HEAD OF THE DEPARTMENT	**SUPERVISOR**
	Lecturer
Department of Textile Technology,	Department of Textile Technology,
Kumaraguru College of Technology,	Kumaraguru College of Technology,
Coimbatore-641006	Coimbatore-641006

Viva- voce examination is conducted on 16..04..10

(INTERNAL EXAMINER)	**(EXTERNAL EXAMINER)**

ACKNOWLEDGEMENT

We the students of this project humbly honor '**THE ALMIGHTY**' for the blessings and his doings.

First and foremost we thank our beloved Co-Chairman **Dr. B.K. Krishnaraj Vanavarayar,** respected Director **Dr.J.Shanmugam** and our respected Principal **Dr.S.Ramachandran** for providing us the wonderful opportunity to carry out this project. We take this opportunity in expressing our profound thanks to **Dr.K.Thangamani**, Professor&Head(i/c), Department of Textile Technology, whose constant encouragement was instrumental in completing this project work.

Our sincere thanks and profound gratitude to our Project Coordinator **Prof.M.Dhinakaran,** Assistant professor and Project Guide **Mr.N.Jegadeesan,** Lecturer for their Wonderful guidance, enthusiasm and invaluable help rendered throughout the project.

We must thank at this moment to all who ever helped us to succeed this project. We pay our sincere thanks to **M/s Tube Knit Fashions Ltd, Tirupur** for providing their facility and invaluable time to produce fabric.

We pay our sincere thanks and credit to **Mr.K.Jagannath,** GM, **Canndy Internationals** for their guidance and contribution to finish our project work successfully.

We are obliged to express our sincere thanks and gratitude to **KCT-TIFAC CORE and SITRA**, for completing the project work successfully. We thank all the **Teaching and Non-Teaching** staff of Kumaraguru College of Technology.

We also wish to thank our **parents** for their constant encouragement, help rendered and also making all the facilities necessary to carry out this project.

ABSTRACT

Our project investigates the Bi-layer Interlock Knitted Structures which are produced by 100% Microfiber Polyester and 100%normal polyester filament with all sort of combinations. The fabrics are studied for transmission behaviour of air, water and thermal in order to asses their suitability for sportswear. The results indicate that thermal resistance of fabrics strongly influenced by heat resistance of the constituent fibre. And areal density of the above produced fabrics were found to be less when compare with previous experiments. It is observed that spray rating is better for micro/micro combinations than normal denier combinations.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The properties of any fabric produced depend on the constituent fiber materials, yarn type, fabric structures and how all these factors interact with each other. The ultimate aim of any apparel fabrics us to satisfy the wearer and make him feel comfortable. Different raw materials and fabric structures have their own merits and demerits, which are inherent and determine the comfort behaviour of the fabric.

Clothing comfort can be divided into following three types: tactile, psychological, and thermo psychological comfort. Tactile comfort is based on distribution of stress generated in fabric over the skin. It is mainly related to fabrics mechanical properties and handle and surface characteristics of the fabric. Thermo physiological comfort means that the ambient body temperature of 37°C is maintained. Whatever heat the human body produces must flow out through the clothing via the body surface. On one hand this is achieved through 'dry' heat transfer by **conduction**, **convection**, and **radiation.** But at high level of physical exertion as during sports the body must sweat, the aim being to cool the body through evaporation of the sweat. So the clothing must ensure a high level of moisture transmission.

But at very high levels of exertion, the fabric may not be able to transmit the total seat produced to the atmosphere instantaneously. So the excess sweat must be stored or 'buffered' by the fabric for evaporation later on. But the fabric should not feel wet to the wearer. So a sportswear must have good air, water and heat transmission and water storage properties.

Textiles serve as both a barrier and transporter of heat, air and moisture from one environment to another. Textile as a sportswear must fulfill the above requirements in terms of comfort aspects. Fiber type, yarn type, fabric structure determines the fabric characteristics.

CHAPTER 2

LITERATURE SURVEY

The prerequisites of ideal sportswear are rapid transport of perspiration away from the body and then its rapid evaporation to keep the fabric dry. This is achieved by bi-layer fabric construction in which the inner layer is made of fabric having good wicking rate. The outer layer is made up of fabric having good absorption character and rapid evaporation. The fiber which is better suited from the physiological Point of view therefore depends on the situation. In other hand there is no single fiber which combines all the different physiological properties to cover all the situations under which sports clothing is worn.

Behera et al [1] from the research entitled on "comfort behaviour of cotton/polypropylene based bi-layer knitted fabrics" concluded that 100%polypropylene on both faces gave lowest areal density and also better water vapor permeability was found. Higher the polypropylene, highest will be the wicking behavior.

According to Anbumani and Sathisbabu[2] the structural principles of bi layered fabrics is given below.

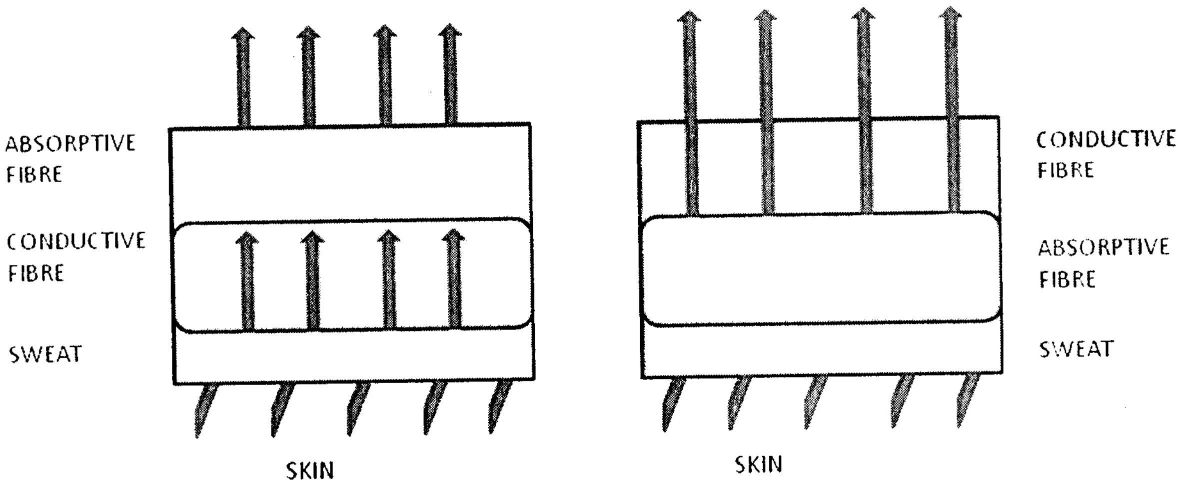

FIGURE 1

Tencel/Polypropylene has higher wickability and thermal conductivity than that of cotton/polypropylene bi-layer knitted fabrics.

Piller[3] has concluded from his research the significant change in moisture transport, thermal conductivity and air permeability for the multilayered knitted fabrics which were produced for the sportswear.

High tech textiles for sports clothing and leisurewear [4] thermostat fabrics gave high thermal comfort good moisture transport and good body comfort.

CHAPTER 3

AIM AND SCOPE

- To produce Bi-Layered knitted fabrics using Micro fiber polyester and normal polyester.

- Analyze and characterize the above produced fabrics by various tests such as
    - Areal density.
    - Thermal resistance value.
    - Air permeability test.
    - Bursting strength.
    - Pilling.

CHAPTER 4

MATERIALS AND METHODS

4.1. MATERIALS

The materials used for producing bi-layered knitted fabrics are Polyester microfilament having 80 denier with 108 filament specification and normal polyester filament having 80 denier with 36 filaments.

4.2. PROCESS SEQUENCE

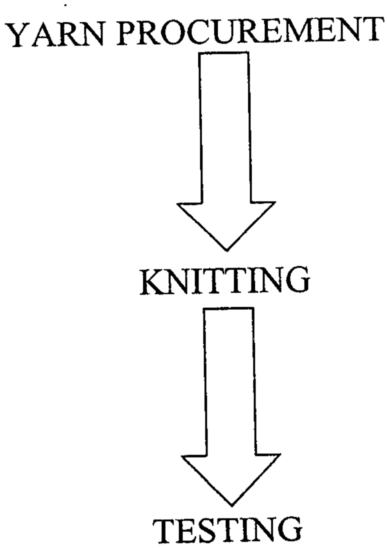

Figure: 2 Processing Sequence

4.2.1. Yarn Procurement

We have procured Polyester microfiber filament yarn of 80 denier and with 108 filaments and normal Polyester of 80 denier with 36 filaments.

4.2.2. Knitting

We have produced bi-layered knitted fabrics in four types of configuration using micro fiber polyester and normal fiber polyester.

4.2.2.1. Fabric Configuration

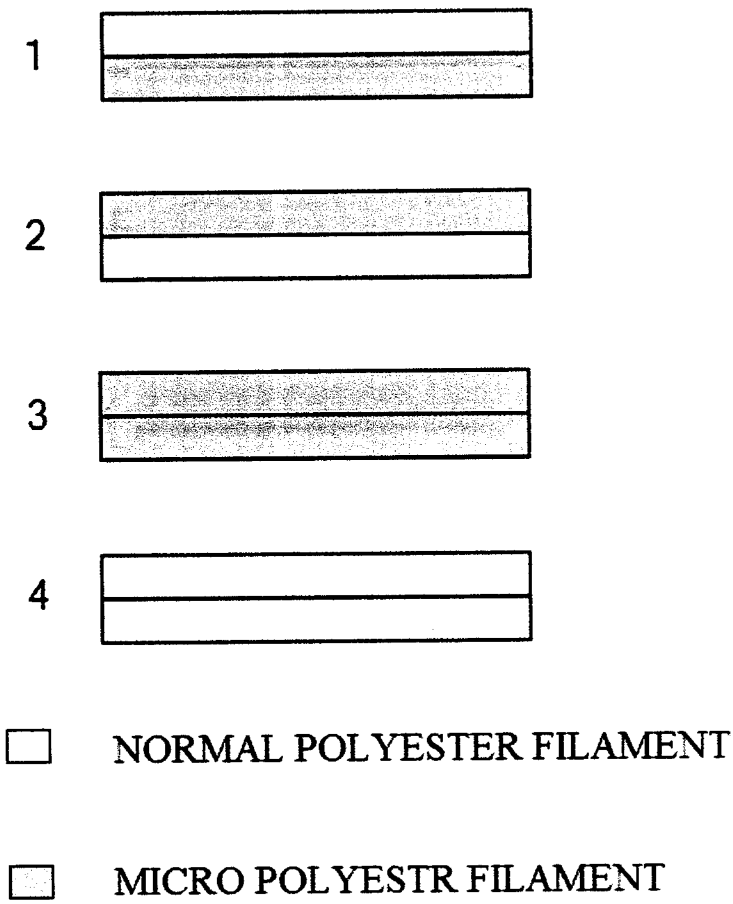

Figure: 3 Fabric Configurations

4.2.2.2. Sample Preparation

The fabric is constructed in an interlock knitting machine with jacquard feature. Fabric which has to form as inner layer is fed in the dial needle and the outer later is fed in the cylinder needle.

Table: 4.1 Knitting Machine Details

Make	Mayer & Cie-OVJA36
Speed	15 rpm
Needle	Groz – Beckert
No of feeders	36
Diameter	30 inches
Gauge	20 needles/inch

Table 4.2 Needle Set Out

	N1	N2	N3	N4	N5	N6	N13	N14
D1	A		A		A		A	
D2		B		B		B		B
C1	A		A		A		A	
C2		B		B		B		B
C3		C						C

DN1 – Dial needle track 1

DN2 – Dial needle track 2

CN1 - Cylinder needle track 1

CN2 – Track 2

CN3 – Track 3

A – Needles moving in track 1

1,3,5,7,9,11,13,15,17

B – Needles moving in track 2

2, 4, 6,8,10,12,14,16

C – Needle moving in track 3

2, 14

Table 4.3 Cam Set Out

	F1	F2	F3	F4	F5	F6	F19	F20
D1	-	X	-	X	-	X	-	X
D2	-	X	-	X	-	X	-	X
C1	X	-	X	-	X	-	X	-
C2	X	-	X	-	X	-	X	-
C3	X	O	X	-	X	-	X	O

X Knit cam

\- Miss cam

O Tuck cam

Feeder 1, 3, 5, 7.......

Feeder 2, 4, 6, 8.......

Dial cam has two tracks of DN1 and DN2.The needles A and B are moving in the track 1 and 2 respectively. Cylinder cam has four tracks, out of which the fourth track is kept idle. The A and B needles are moving in track 1 and 2 respectively and the C needle is moving in track 3.This is clearly shown in the needle set out diagram.

The dial and cylinder needle will perform miss and knit stitch simultaneously during fabric production. That is yarn from feeder 1 forms miss stitch with the cylinder needle. The yarn from feeder 2 produces knit stitch with dial needle and miss stitch with the cylinder needle. This has been repeat up to third course (6^{th} feeder).In the fourth course, the yarn form feeder 7 produces miss stitch with dial and knit stitch with cylinder. The yarn from feeder 8 fed to the dial needle produces knit stitch. Third track 36^{th} cylinder needle makes tuck stitch with the dial needle to produce bi-layered knitted fabric .This cycle has been repeated throughout the knitted fabric production. This is shown in the cam set out diagram.

4.2.3. Testing Methods

The following test methods are used to test the comfort properties such as wetting, absorbency, thermal conductivity and dimensional stability of bi-layered knitted fabric.

- Fabric properties.
- Thermal resistance value.
- Bursting strength ASTM D 3887.
- Pilling test.
- Spray test
- Air permeability.

4.2.3.1. Fabric Properties

Fabric properties have been studied by conducting various tests. Courses per cm, Wales per cm, areal density, stitch density, loop length, tightness factor. The above tests were done using gsm cutter and counting class.

4.2.3.2. Bursting Strength

Table 4.4 Bursting Strength Detail

Standard	(IS 1966-1975 reaffirmed 1999)
Unit	kgs/sq.cm
RH	65%
Temperature	21 deg

The sample to be tested is placed in the diaphragm and the air is blown. This is used to test the bursting strength of the fabric.

4.2.3.3. Air Permeability

Table 4.5 Air Permeability Details

Standard	ASTM D 737
Unit	CC/sq.cm/sec
Pressure	125Pa
Sample	38 sq.cm
RH	65%
Temperature	21 deg

Air permeability is used to measure the amount of air passing through the fabric in a given time for a given amount of air. The fabric is placed in the diaphragm and the air is sucked through it then the level of pointer is noted down and the air permeable value is found out.

4.2.3.4. SPRAY TEST:

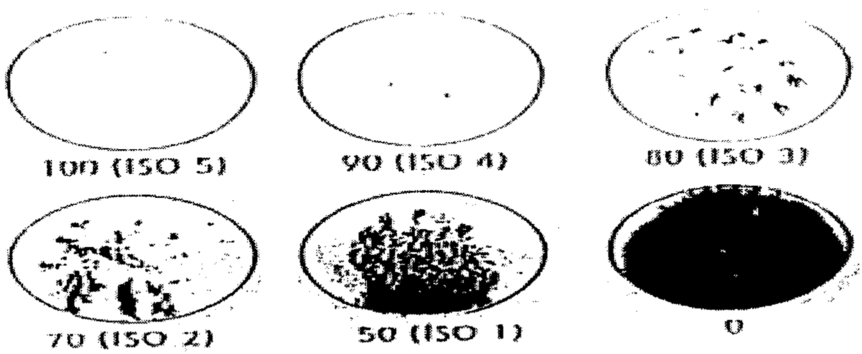

Figure:4 Standard Spray Test - Ratings

SPRAY RATING

- 100 ISO 5- No Sticking or wetting of the specimen face
- 90 ISO 4 - Slight Random sticking or wetting of the specimen face
- 80 ISO 3 - Wetting of Specimen face at spray points
- 70 ISO 2 - Partial wetting of specimen face beyond the spray points
- 50 ISO 1 - Complete wetting of the entire specimen face beyond the Spray points
- 0 - Complete wetting of the entire face of the specimen

Table 4.6 Spray Test Details

Standard	AATCC-22 & CNS 10461
Sample size	152 sq mm

The above figure shows the spray test result .It is a standard comparison for the fabric after the spray of water is done on the fabric. Each standard indicates different absorbency of the fabric sample at each process. It is passed with 250 ml water is sprayed on Sample size.

4.2.3.5. Thermal Resistance Value

Thermal insulation measures the resistance of a fabric and its associated layer of air to dry or conductive heat loss. Thermal insulation, unlike intrinsic thermal insulation, will vary with wind speed. Increasing wind speeds decrease the thermal insulation afforded by the layer of air. Thermal conductivity of fabric determines the rate of transmission of heat through a fabric. Thermal conductivity is the reciprocal of thermal insulation or resistance. It is measured by conductive and radiative heat transfer from the body and environment.

4.2.3.6. Pilling Test

The pilling of garments is a very complex property because it is affected by various factors such as fibre length and denier, fibre mechanical properties, yarn twist level, fabric construction, and fabric finishing treatments. There are three ASTM test methods for evaluating the pilling resistance of fabrics (D-3511, D-3512, and D-3514).

Table 4.7 Pilling Rate

RATING	DEGREE OF PILLING
1	Very severe pilling
2	Severe pilling
3	Moderate pilling
4	Slight pilling
5	No pilling

CHAPTER 5

RESULT AND DISCUSSION

5.1. FABRIC DIMENSIONAL STABLITY

Table 5.1. Fabric Dimensional Stability

	Normal/Micro		Micro/Normal		Micro/Micro		Normal/Normal	
	Face	Back	Face	Back	Face	Back	Face	Back
Course/cm	11.8	11.02	11.02	11.02	10.23	10.23	10.62	10.62
Wales/cm	14.17	13.38	13.38	13.38	14.17	14.17	13.38	13.38
Stitch ensity/cm^2	167.20	147.44	147.44	147.44	144.95	144.95	150.48	150.48
oop length (in cm)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
K_c	3.18	2.97	2.97	2.97	2.76	2.76	2.86	2.86
K_w	3.82	3.61	3.61	3.61	3.82	3.82	3.61	3.61
$K_s=k_c*k_w$	12.18	10.72	10.72	10.72	10.55	10.55	10.32	10.32
Tightness factor	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
oop shape ctor(k_c/k_w)	0.832	0.822	0.822	0.823	0.643	.643	0.793	0.793
Areal density (GSM)	102.88		98.66		95.75		97.37	

From the above table we can observe that the fabrics are less dimensionally stable. This is because of very poor loop shape factor. And also areal density of micro/micro combination is lower. This may be attributed due to more fineness of the fibres.

5.2. THERMAL RESISTNCE VALUE

Table 5.2. Thermal Resistance Value of Fabric

S.no	Samples	Thermal Resistance m^2K/watt
1	Normal/micro	0.0564
2	Micro/normal	0.0477
3	Micro/micro	0.0112
4	Normal/normal	0.0416

From the above table we found that sample 3 shows lowest thermal resistance value. This sample is of both sides micro polyester. This may be attributed due to more number of filaments in the cross section and less heat resistance than normal polyester.

5.3. BURSTING STRENGTH

Table5.3 Bursting Strength Details

S.no	Samples	Bursting Strength Kgs/sq.cm
1	Normal/micro	7.47
2	Micro/normal	7.06
3	Micro/micro	7.20
4	Normal/normal	7.99

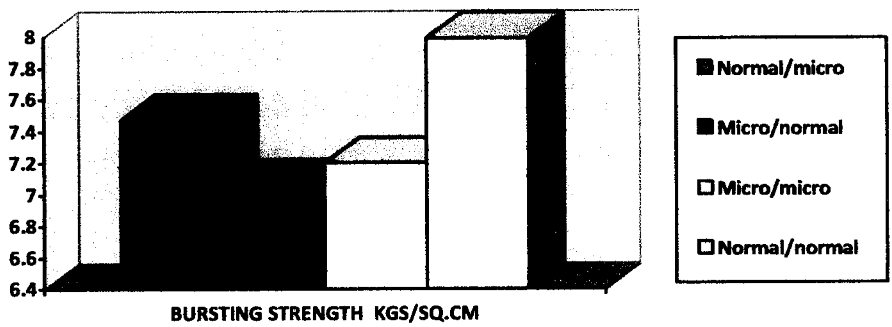

Figure 5

From the above table and figure we observed that highest bursting strength for the sample number 4 followed by sample 1,3 and 4.This may be due to elongation properties of the normal denier polyester.

5.4. PILLING RATING

Table 5.4 Pilling Test Results

S.no.	Samples	Pilling rates
1	Normal/micro	3
2	Micro/normal	3
3	Micro/micro	5
4	Normal/normal	3

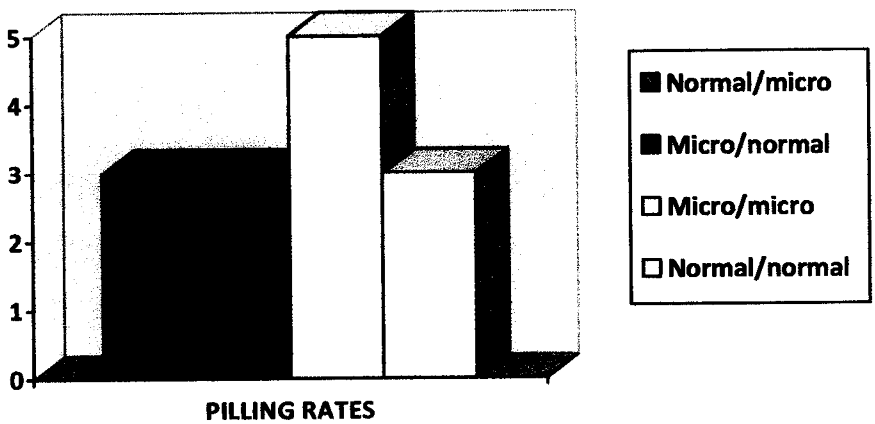

Figure 6

From the above table and figure we observed that sample number 3 has no pilling. This sample is of both sides micro polyester. This may be attributed due to more number of filaments in the cross section..

5.5. SPRAY TEST RATINGS

Table 5.5 Spray Test Rating Details

S.no	Samples	Spray Ratings
1	Normal/micro	70 –ISO 2
2	Micro/normal	70-ISO 2
3	Micro/micro	50-ISO 1
4	Normal/normal	70-ISO 1

From the above table we can see but micro/micro configuration fabrics was partially wetting when comparing with other samples. This is because of more number of filaments and pores.

5.6. AIR PERMEABILITY

Table 5.6.Air Permeability Results

S.no	Samples	Air Permeability cc/sec/cm^2
1	Normal/micro	84.33
2	Micro/normal	88.88
3	Micro/micro	97.22
4	Normal/normal	90.22

From the above table we can see micro/micro configuration fabrics were having higher air permeability when compare to other fabric samples. This is because of low loop shape factor.

CHAPTER 6

CONCLUSION

From the above study we conclude the following:

- Thermal resistance of micro/micro combination is very low because of less heat resistance.
- Spray rating is better for micro/micro combinations because of more number of pores and filaments.
- Dimensional stability is poor because of very poor loop shape factor.
- Air permeability is very high because of open structure of fabric.
- Micro/micro bi-layer knitted fabrics can be used for sportswear.

CHAPTER 7

SCOPE FOR FUTURE WORK

- Micro fibre spun yarns can be used for producing bi-layer knitted fabrics.
- Knitting parameters can be varied and optimization can be arrived.
- Subjective tests can be done and correlated with respective sports.

REFERENCES

1) Behera B K, Mani M.P ,Amit K Mondal and Nitin Sharma , "Comfort behaviour of cotton polypropylene based bi–layer knitted fabrics", Asian Textile Journal , may 2002, 61-67.

2) Anbumani N and Sathish Babu B, "Comfort properrties of bi-layer knitted fabrics", Indian Textile Journal ,August 2008 17-28.

3) Piller B, Melliand Textileberichte (English), June 1986, 183-186.

4) Report on high-tech textiles for sports clothing and leisurewear, knitting technique , 16, March 1994, 178-179.

APPENDIX

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

P.B.No. : 3205, Coimbatore Aerodrome Post, Coimbatore - 641 014, INDIA

Grams : SITRA Ph : (0422) 2574367-9, 6541488, 6544188 Fax : (0422) 2571896

Email: sitraindia@dataone.in Website:http://www.sitra.org.in

Address all correspondence to the Director

/4/9668/10 24/02/2010

.M.Sathish Kumar
partment of Textile Technology
maraguru College of Technology
imbatore - 641 008

ur Reference No. & Date	:	KCT/TXT/STUPRJ/2010(NJ)/2 19/02/2010
mber of Samples	:	3
mple Received on	:	24/02/2010
r Test Report No.	:	KTR.No. : 1586
mple No.	:	KC-1243,KC-1244,KC-1245
ll No. & Inward No.	:	T-15585 1603

KNITTING DIVISION - TEST RESULTS

mple No. : **KC-1243** Sample Particulars : 80DENIER BILAYER KNITTED FABRIC- 1
KC-1244 80DENIER BILAYER KNITTED FABRIC- 2
KC-1245 80DENIER BILAYER KNITTED FABRIC- 3

e given samples were tested and their results are given below:

est particulars	KC-1243	KC-1244	KC-1245
ales per inch (Face)	30	28	26
ales per inch (Back)	28	28	26
ourses per inch (Face)	36	34	36
ourses per inch (Back)	34	34	36
SM	102.88	98.66	95.75

s per given condition of the samples

Head of the Knitting and Weaving Division

ncl. : Bill

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
SITRA PHYSICAL LABORATORY

13/37, Avinashi Road, Coimbatore Aerodrome Post, Coimbatore - 641 014, INDIA.
Grams : SITRA Phone : (0422) 2574367-9, 6541488, 6544188 Fax : (0422) 2571896
E-mail : sitraindia@dataone.in Website:http://www.sitra.org.in
Address all correspondence to the Director ISO/IEC 17025:2005 NABL ACCREDITED

Cert. Number:T-358

Fabric Test Report No.:9 Mr.M.Sathish Kumar

Samples Tested at : R.H. 65% +/- 2% and Temp. 21 Degree C +/- 1 Degree C

Lab Code No.	C_914	C_915	C_916	C_917
Sample Particulars.:	KNITTED FABRIC MARK-T-1	KNITTED FABRIC MARK-T-2	KNITTED FABRIC MARK-T-3	KNITTED F MARK-T-4
FABRIC - BURSTING STRENGTH (As per IS 1966-1975) Reaffirmed 1999				
Kgs/sq.cm	7.47	7.06	7.20	7.99
FABRIC - PILLING TEST (As per IS:10971-94) (Reaffirmed 2004)				
Pilling Rating:	3	3	5	3

Rating	Degrees of Pilling
1	Very Severe Pilling
2	Severe Pilling
3	Moderate Pilling
4	Slight Pilling
5	No Pilling

End of Report

R. [signature]

THE SOUTH INDIA TEXTILE RESEARCH ASSOCIATION

P.B.No. : 3205, Coimbatore Aerodrome Post, Coimbatore - 641 014, INDIA

Grams : SITRA Ph : (0422) 2574367-9, 6544188 Fax : (0422) 2571896

Email: sitraindia@dataone.in Website:http://www.sitra.org.in

Address all correspondence to the Director

Fabric Test Report No.:9 Mr.M.Sathish Kumar

Samples Tested at : R.H. 65% +/- 2% and Temp. 21 Degree C +/- 1 Degree C

Lab Code No.	C_914	C_915	C_916	C_91
Sample Particulars.:	KNITTED FABRIC MARK-T-1	KNITTED FABRIC MARK-T-2	KNITTED FABRIC MARK-T-3	KNITTE MARK-T
Thermal Resistance				
Thermal Resistance Mean Value (Squ.m k / watt)	0.0565	0.0478	0.0113	0.04

End of Report

R. Dampathy

	Sample Description									
	SITRA				Operator	P.SUBRAMANIAN		Ref NO	914T-1	
	0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-1		
	20.0	R/H set	65.0	Tm-Ts	15.0					
	Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
9	23.555	2.387	56.226	89.763	5.608	35.00	34.99	19.99	65.56	0.0511
5	23.555	2.389	56.273	89.414	5.591	34.99	34.99	19.99	64.99	0.0515
5	23.552	2.386	56.195	86.139	5.378	35.00	35.01	19.99	65.00	0.0564
4	23.548	2.387	56.209	86.569	5.407	34.98	35.00	19.99	64.99	0.0557
5	23.547	2.389	56.254	87.578	5.474	34.98	35.00	20.00	64.99	0.0541
5	23.548	2.384	56.138	88.474	5.519	34.99	35.00	20.00	65.00	0.0531
4	23.546	2.386	56.181	87.986	5.492	35.00	35.00	20.00	65.00	0.0537
35	23.543	2.386	56.174	87.509	5.462	35.00	35.00	19.99	65.00	0.0544

Sample Description									
SITRA				Operator	P.SUBRAMANIAN		Ref NO	914T-2	
0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-1		
20.0	R/H set	65.0	Tm-Ts	15.0					
Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
23.548	2.386	56.186	85.140	5.315	34.99	34.99	19.99	65.00	0.0579
23.549	2.387	56.211	87.672	5.476	34.99	35.00	20.00	65.00	0.0541
23.552	2.386	56.195	87.382	5.456	34.99	34.99	19.99	65.00	0.0546
23.552	2.386	56.195	87.382	5.456	34.99	35.00	20.00	64.99	0.0546
23.552	2.387	56.219	87.266	5.451	34.99	34.99	19.99	65.00	0.0547
23.552	2.387	56.219	87.382	5.458	34.99	35.00	19.99	64.99	0.0545
23.555	2.387	56.226	87.461	5.464	35.00	35.00	20.00	64.99	0.0544

	Sample Description									
	SITRA				Operator	P.SUBRAMANIAN		Ref NO	914T-3	
	0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-1		
	20.0	R/H set	65.0	Tm-Ts	15.0					
	Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
5	23.553	2.387	56.221	85.385	5.334	35.00	35.00	19.99	64.98	0.0575
6	23.557	2.387	56.231	84.571	5.284	35.00	35.00	19.99	64.99	0.0587
6	23.554	2.386	56.200	84.339	5.266	35.00	35.00	20.00	64.99	0.0592
5	23.559	2.389	56.282	82.538	5.162	35.00	35.00	20.00	65.00	0.0618
6	23.558	2.389	56.280	82.910	5.185	34.99	35.01	19.99	64.99	0.0612
6	23.554	2.387	56.223	83.062	5.189	34.98	34.99	19.99	65.00	0.0611
5	23.557	2.386	56.207	83.179	5.195	34.98	35.00	20.00	65.00	0.0610
51	23.551	2.387	56.216	83.062	5.188	34.98	35.00	20.00	65.00	0.0611
16	23.551	2.387	56.216	83.027	5.186	34.99	35.00	20.00	64.99	0.0612

	Sample Description									
	SITRA				Operator	P.SUBRAMANIAN		Ref NO	915T - 1	
	0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-2		
	20.0	R/H set	65.0	Tm-Ts	15.0					
	Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
1	23.552	2.389	56.266	94.803	5.927	34.99	35.00	19.99	65.89	0.0444
2	23.553	2.389	56.268	93.642	5.855	35.00	35.00	19.99	64.99	0.0452
2	23.554	2.387	56.223	93.375	5.833	35.00	34.99	19.99	64.99	0.0463
0	23.560	2.386	56.214	84.711	5.291	35.06	34.98	20.00	67.91	0.0585
0	23.556	2.387	56.228	92.828	5.799	34.98	34.98	19.99	64.98	0.0470
0	23.552	2.387	56.219	93.247	5.825	35.00	35.00	20.00	65.00	0.0460
9	23.549	2.387	56.211	92.516	5.778	35.00	35.00	19.99	65.00	0.0475
0	23.546	2.386	56.181	92.364	5.766	35.00	35.00	20.00	65.00	0.047[illegible]
0	23.543	2.386	56.174	92.120	5.750	35.00	35.00	19.99	65.00	0.048[illegible]
9	23.539	2.384	56.117	90.692	5.655	34.99	35.00	20.00	65.00	0.050[illegible]
0	23.537	2.384	56.112	91.064	5.678	34.98	35.00	20.00	65.00	0.0496
0	23.535	2.383	56.084	91.333	5.691	34.98	35.00	19.99	64.99	0.0493

	Sample Description									
	SITRA				***Operator***	***P.SUBRAMANIAN***		***Ref NO***	***915T - 2***	
	0.0000	***Rct0***	***0.0730***	***T-times***	***15***	***Comment***		***KNITTED SAMPLE MARK T-2***		
	20.0	***R/H set***	***65.0***	***Tm-Ts***	***15.0***					
	Volts	***Amps***	***Power***	***T-Mu***	***Watts***	***Temp Mu***	***Temp Grd***	***Temp Air***	***R/H***	***Rct***
2	23.537	2.383	56.089	92.503	5.765	35.00	34.99	19.99	64.98	0.0477
3	23.543	2.386	56.174	90.831	5.669	35.00	35.00	19.99	64.99	0.0498
3	23.546	2.386	56.181	90.645	5.658	35.00	35.00	20.00	64.99	0.0500
2	23.550	2.387	56.214	90.680	5.664	35.00	35.00	20.00	64.99	0.0499
3	23.551	2.386	56.193	90.680	5.662	35.00	35.00	19.99	65.00	0.0499

Sample Description									
SITRA				Operator	P.SUBRAMANIAN		Ref NO	915T -3	
0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-2		
20.0	R/H set	65.0	Tm-Ts	15.0					
Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
23.553	2.386	56.197	94.618	5.908	34.98	35.00	20.00	64.99	0.0448
23.553	2.387	56.221	95.581	5.971	34.99	35.00	19.99	65.00	0.0436
23.556	2.387	56.228	95.304	5.954	35.00	35.00	20.00	64.99	0.0439
23.556	2.386	56.205	95.431	5.960	35.00	35.00	20.00	64.99	0.0438
23.554	2.389	56.271	94.188	5.889	35.00	35.00	19.99	64.99	0.0452

0	Sample Description									
	SITRA				Operator	P.SUBRAMANIAN		Ref NO	916T - 1	
	0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-3		
et	20.0	R/H set	65.0	Tm-Ts	15.0					
	Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
54	23.551	2.386	56.193	136.092	8.497	35.00	35.00	19.99	65.84	0.0089
19	23.551	2.386	56.193	133.808	8.354	35.00	35.00	19.99	64.99	0.0102
19	23.552	2.386	56.195	134.002	8.367	34.99	35.01	20.00	64.99	0.0102
19	23.552	2.386	56.195	134.584	8.403	35.00	35.00	19.99	64.99	0.0098
18	23.552	2.387	56.219	133.842	8.360	35.00	35.00	19.99	64.99	0.0102

	Sample Description									
	SITRA				Operator	P.SUBRAMANIAN		Ref NO	916T - 2	
	0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-3		
	20.0	R/H set	65.0	Tm-Ts	15.0					
	Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
3	23.552	2.387	56.219	132.670	8.287	34.99	35.00	19.99	64.99	0.0110
3	23.548	2.386	56.186	132.324	8.261	35.00	35.00	20.00	64.99	0.0113
7	23.548	2.387	56.209	131.971	8.242	35.00	35.00	19.99	65.00	0.0115
3	23.548	2.386	56.186	131.320	8.198	34.99	35.00	19.99	64.99	0.0119
3	23.549	2.386	56.188	131.503	8.210	34.98	34.99	20.00	64.99	0.0118

0	*Sample Description*									
	SITRA				*Operator*	*P.SUBRAMANIAN*		*Ref NO*	*916T - 3*	
	0.0000	*Rct0*	*0.0730*	*T-times*	*15*	*Comment*		*KNITTED SAMPLE MARK T-3*		
et	*20.0*	*R/H set*	*65.0*	*Tm-Ts*	*15.0*					
	Volts	***Amps***	***Power***	***T-Mu***	***Watts***	***Temp Mu***	***Temp Grd***	***Temp Air***	***R/H***	***Rct***
15	23.552	2.384	56.148	131.276	8.190	35.00	35.00	19.99	64.99	0.0120
16	23.553	2.386	56.197	131.149	8.189	35.00	35.00	20.00	64.99	0.0120
16	23.554	2.386	56.200	131.217	8.194	35.00	35.00	19.99	65.00	0.0119
15	23.554	2.386	56.200	131.160	8.190	35.00	35.00	20.00	65.00	0.0120
·16	23.554	2.386	56.200	131.160	8.190	35.00	35.00	20.00	65.00	0.0120

3/10/2010	Sample Description									
ny	SITRA				Operator	P.SUBRAMANIAN		Ref NO	917T-1	
α	0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-4		
Air set	20.0	R/H set	65.0	Tm-Ts	15.0					
Time	Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
12:44:20	23.556	2.389	56.275	97.815	6.116	35.00	34.99	19.99	64.98	0.0408
12:59:20	23.554	2.387	56.223	97.579	6.096	35.00	35.00	20.00	65.00	0.0412
13:14:53	23.545	2.386	56.178	97.185	6.066	35.00	35.00	20.00	65.00	0.0417
13:29:20	23.545	2.386	56.178	97.231	6.069	35.00	35.00	20.00	65.00	0.0417
13:44:20	23.543	2.386	56.174	96.661	6.033	35.00	35.00	19.99	65.00	0.0424
13:59:20	23.539	2.384	56.117	96.360	6.008	35.00	35.00	20.00	65.00	0.0428
14:14:19	23.537	2.384	56.112	96.963	6.045	35.00	35.00	19.99	64.99	0.0421

o	Sample Description									
	SITRA				Operator	P.SUBRAMANIAN		Ref NO	917T-2	
	0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-4		
t	20.0	R/H set	65.0	Tm-Ts	15.0					
	Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
36	23.541	2.384	56.122	95.070	5.928	35.00	35.00	19.99	64.99	0.0444
37	23.548	2.387	56.209	90.529	5.654	35.00	35.00	20.00	64.99	0.0501
37	23.549	2.384	56.141	91.064	5.680	34.98	35.00	19.99	64.99	0.0495
36	23.550	2.386	56.190	91.284	5.699	34.98	35.00	19.99	65.00	0.0491
37	23.554	2.386	56.200	91.497	5.713	34.98	35.00	19.99	65.00	0.0488
36	23.555	2.386	56.202	91.679	5.725	34.98	34.99	20.00	64.99	0.0486
09	23.555	2.389	56.273	91.807	5.740	34.99	35.00	20.00	65.00	0.0482

0	Sample Description									
	SITRA				Operator	P.SUBRAMANIAN		Ref NO	917T-3	
	0.0000	Rct0	0.0730	T-times	15	Comment		KNITTED SAMPLE MARK T-4		
t	20.0	R/H set	65.0	Tm-Ts	15.0					
	Volts	Amps	Power	T-Mu	Watts	Temp Mu	Temp Grd	Temp Air	R/H	Rct
00	23.556	2.387	56.228	103.735	6.481	34.99	35.00	19.99	65.19	0.0344
52	23.544	2.384	56.129	103.643	6.464	35.00	34.99	19.99	65.01	0.0347
52	23.542	2.384	56.124	104.211	6.499	35.00	35.00	19.99	64.99	0.0341
53	23.545	2.386	56.178	104.392	6.516	34.99	35.00	19.99	64.99	0.0338
51	23.548	2.386	56.186	104.176	6.504	34.98	35.00	20.00	65.00	0.0340
52	23.546	2.386	56.181	105.801	6.604	35.00	35.00	20.00	65.00	0.0324
52	23.544	2.386	56.176	104.641	6.531	35.00	35.00	20.00	65.00	0.0316
51	23.541	2.384	56.122	104.235	6.500	35.00	35.00	20.00	65.00	0.0341
52	23.538	2.384	56.115	103.770	6.470	35.00	35.00	19.99	65.00	0.0346