

PRODUCTION OF BILAYER KNITTED FABRICS



A PROJECT REPORT

Submitted by

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In

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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.

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

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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.

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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.

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.

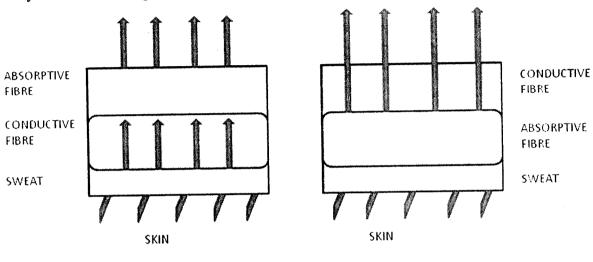


FIGURE 1

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.

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.

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

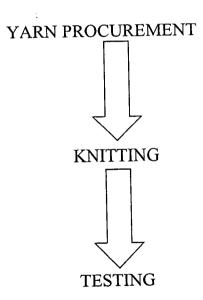


Figure: 2 Processing Sequence

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

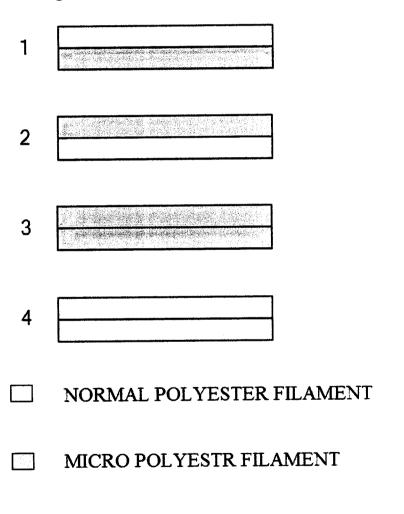


Figure: 3 Fabric Configurations

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
D 1	A		A		A		A	
D2		В		В		В		В
C 1	A		A		A		A	
C2		В		В		В		В
C3		С						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
C 1	X	-	X	-	X	-	X	_
C2	X	-	X		X	_	X	_
C3	X	0	X	•	X	-	X	О

- 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 (6th 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 36th 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 bilayered 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:

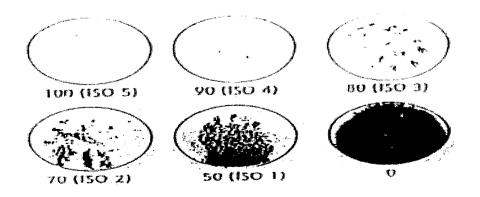


Figure: 4 Standard Spray Test - Ratings

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

RESULT AND DISCUSSION

5.1. FABRIC DIMENSIONAL STABLITY

Table 5.1. Fabric Dimensional Stability

	Normal/Micro		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	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	
(in cm)									
K _c	3.18	2.97	2.97	2.97	2.76	2.76	2.86	2.86	
$\mathbf{K}_{\mathbf{w}}$	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	2.88	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 ² K/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

Samples	Bursting Strength	
	Kgs/sq.cm	
Normal/micro	7.47	
Micro/normal	7.06	
Micro/micro	7.20	
Normal/normal	7.99	
	Normal/micro Micro/normal Micro/micro	

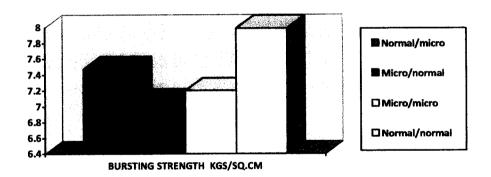


Figure 5

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
			<u> </u>

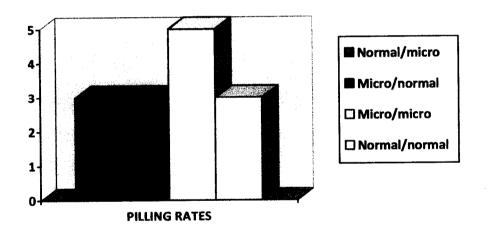


Figure 6

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.

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.

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.

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ur Reference No. & Date : KCT/TXT/STUPRJ/2010(NJ)/2 19/02/2010

mber of Samples

: 3

mple Received on

r Test Report No.

: 24/02/2010 : KTR.No. : 1586

mple No.

: KC-1243, KC-1244, KC-1245

: T-15585

ll No. & Inward No.

1603

KNITTING DIVISION - TEST RESULTS

mple No.: KC-1243 Sample Particulars: 80DENIER BILAYER KNITTED FABRIC- 1

80DENIER BILAYER KNITTED FABRIC- 2 KC-1244

80DENIER BILAYER KNITTED FABRIC- 3 KC-1245

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

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

per given condition of the samples

Head of the Knitting and Weaving Division

ncl. : Bill



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Fabric Test	Report No.:9	Mr.M.Sathish Kumar	ar segar ara. Hawar negar agreement in arrangement agger agger agger agger	be rough before the or again before before about more finder made before	page gapas again satura sergia sergi (con selection)
And the long server plant to per organ report makes and longer record	Samples Tested at : F	R.H. 65% +/- 2% and Temp.	21 Degree C +/- 1 D	egree C	anga angga tangga sanan sasar sasar sa isa sa tangga
Lab Code No.	and a first reaction from the second	C_914	C_915	C_916	C_917
Sample Particulars.:	and the state of t	KNITTED FABRIC MARK-T-1	KNITTED FABRIC MARK-T-2	KNITTED FABRIC MARK-T-3	KNITTED F MARK-T-4
FABRIC — BUF (As per IS 1966-1975	RSTING STRENGTH) Reaffirmed 1999		•		
Kgs/sq.cm		7.47	7.06	7.20	7.99
FABRIC - PIL (As per IS:10971-94)					
Pilling Rating:		3	3	5	3
Rating	Degrees of Pilling				
1 2 3 4 5	Very Severe Pilling Severe Pilling Moderate Pilling Slight Pilling No Pilling				

End of Report

Page 2 of 2

R. Parjuty

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

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

Lab Code No.

C_914

C_915

KNITTED FABRIC KNITTE

Sample Particulars.:

KNITTED FABRIC KNITTED FABRIC KNITTED FABRIC MARK-T-1 MARK-T-2 MARK-T-1

MARK-T

Thermal Resistance

Thermal Resistance Mean Value (Squ.m k / watt) 0.0565 0.0478 0.0113 0.0

End of Report

Page 2 of 2

SITRA Operator P.SUBRAMMIAN Ref NO 914T-1	10	O ofame	ecription							
2.0.000 Rct0 0.0730 T-times 15 Comment KNIITED SAMPLE MARKE 2.0.0 R/H set 65.0 Tm-Ts 15.0 Comment KNIITED SAMPLE MARKE 2.0.0 R/H set 65.0 Tm-Ts 15.0 Tm-Ts 15.0 2.3.555 2.387 56.226 89.763 5.608 35.00 19.99 5.70 2.3.552 2.386 56.273 89.414 5.591 4.99 19.99 5.00 2.3.548 2.387 56.209 86.569 5.407 4.98 5.50 19.99 5.00 2.3.548 2.387 56.209 86.569 5.407 4.98 5.50 20.00 5.09 5.00 2.3.548 2.386 56.138 88.474 5.519 4.98 5.00 20.00 5.00 2.3.548 2.386 56.174 87.509 5.402 5.00 5.00 5.00 5.00 2.3.548 5.6.174 87.509 5.462 5.00	" -	allipie D	TO COL	TPA		Operator	P.SUBRAMANIAN	Ref NO	91	47-1
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Volts Amps Power T.Mu Watts Temp Mul Temp Mul <th>+</th> <th>20.0</th> <th>R/H set</th> <th>65.0</th> <th>Tm-Ts</th> <th>15.0</th> <th></th> <th></th> <th></th> <th></th>	+	20.0	R/H set	65.0	Tm-Ts	15.0				
23.555 2.387 56.226 89.763 5.608 35.06	₩ 500	0.02			T.M.	Waffs	Temp Mu	Temp Air	RIH	30.30
23.555 2.380 56.273 89.414 5.591 34.99 24.99 64.99 64.99 23.555 2.386 56.273 89.414 5.591 34.99 34.99 64.99 64.99 23.548 2.387 56.209 86.569 5.407 34.98 55.00 19.99 64.99 23.548 2.384 56.218 87.578 5.474 34.98 55.00 20.00 64.99 23.548 2.384 56.181 87.986 5.492 35.00 20.00 65.00 23.548 2.386 56.174 87.509 5.462 35.00 19.99 65.00	33.36 33.36	Volts	25		90 763	5 608	(S) 1713 (S) 1713	66.61	ି ବିଦ ୍ଧିକ୍ତ	
23.555 2.389 56.273 89.414 5.591 34.39 5.591 34.39 35.378 35.00	٠,	23.555	7.38/	20.220	09.760) i		(9) a (9) k	(6) (6) (7) (6)	Jr. 6
23.552 2.386 56.195 86.139 5.378 \$6.00 \$6.00 \$6.209 \$6.209 \$6.569 5.407 \$4.98 \$6.00 \$6.00 \$6.209 \$6.109 \$6.209 \$6.209 \$6.209 \$6.209 \$6.569 \$6.407 \$4.98 \$6.00 \$6.00 \$6.00 \$6.109 \$6.		23.555	2.389	56.273	89.414	5.591			60	A CONTRACTOR OF THE PARTY OF TH
23.548 2.387 56.209 86.569 5.407 4.98 35.00 19.99 64.99 23.547 2.389 56.254 87.578 5.474 24.98 35.00 20.00 64.99 23.548 2.384 56.138 88.474 5.519 24.92 35.00 20.00 64.00 23.546 2.386 56.181 87.509 5.462 35.00 19.99 65.00 23.543 2.386 56.174 87.509 5.462 35.00 19.99 65.00		23.552	2.386	56.195	86.139	5.378)	AM Co	(#16)(G)* (1)
23.547 2.389 56.254 87.578 5.474 34.58 \$6.00 20.00 54.99 23.548 2.384 56.181 87.986 5.519 36.00 20.00 65.00 23.546 2.386 56.181 87.509 5.462 35.00 19.29 65.00 23.543 2.386 56.174 87.509 5.462 35.00 19.29 65.00		23.548	2.387	56.209	86.569	5.407		(¥6) €(8)	\$16° 1516	7/65619 (1)
23.548 2.384 56.181 88.474 5.519 35.00 35.00 35.00 35.00 35.00 23.546 2.386 56.174 87.509 5.462 35.00 35.00 35.00 35.00		23 547	2.389	56.254	87.578	5.474		<u>20,00</u>	(5/6° 17.2)	0.034
23.546 2.386 56.174 87.509 5.462 35.00 35.00 19.99 65.00		23.548	2 384	56.138	88.474	5.519		201.600	36. (16)	
23.543 2.386 56.174 87.509 5.462 35.00 35.00 19.99 20 35.00		22.52	2386	56.181	87.986	5.492		7010) (BZ	(\$\circ\circ\circ\circ\circ\circ\circ\cir	0,000
		23.543	2.386	56.174	87.509	5.462		(E) (E)	: %% :.(0)(0):	0.05445
	a.									
		-								

9147-2	RK 1-1			ंड्र	0.0579		410000000000000000000000000000000000000		0 (05%)	() ()\$P\$()	() () () () ()		
91,	KNITTED SAMPLE MARK T-1			RVFI	00 egg			ୀ ୃତ୍	÷€ 129	(310) (316)	NO 17(0)		
Ker NO	KNITTEDS			Temp Air	36 6U		2401.000	ି (ଜ୍ୟୁ	20.00	(516) TON:	ALC LOW	SPERIO	
		Comment		Temp Grd	(5(5) 17%	\$ {	()()********	36 F	3 (2) (0)(0)	(3.6.41.8	(J)(j) (j)(6	(a) (a)	MA TOC
ア、ひつなれないないだとい		Comr		Tempilia	2.41 G/e	(A) P = (A)	SE 175	(A) 17/2	(5)5 17C	(\$(\$ 17.5)	(a) (7) (a)		(\$\$5) (U())
	1	15	15.0	Watts	E 24E	0.0.0	5.476	5.456	5.456	5.451	5.458) (5.464
		T-times	Tm-Ts			83.140	87.672	87.382	87.382	87.266	87.382	1000	87.461
\Q!	SILVA	0.0730	65.0	Dower		56.186	56.211	56.195	56.195	56.219	56.210 56.210	20.7	56.226
170	110	Rct0	R/H set		VOIES	2.386	2.387	2 386	2386	7 387	700.0	7.307	2.387
		0.0000	20.0	20.07	VOIES	23.548	23.549	23 552	23.532	20.00	20.00	73.552	23.555

20.0000 Rct0 0.0730 T-times 15 Comment KNITTED SAMPLE IMARK T-1 20.00 Rct0 0.0730 T-times 15 Comment KNITTED SAMPLE IMARK T-1 20.00 R/H set 65.0 Tm-Ts 15.0 Comment KNITTED SAMPLE IMARK T-1 20.00 R/H set 65.2 Tm-Ts 15.0 Tm-Ts 15.0 Tm-Ts 23.553 2.387 56.221 85.385 5.384 \$0.0 \$0.0 \$0.00 \$0.00 23.554 2.387 56.221 84.571 5.284 \$0.0 \$0.00	0	O ofame	secription							
Rcto	2	allipic D	in diameter			Onorator	D STIBRAMANIAN	Ref NO	914	17-3
0.0000 Rct0 0.0730 T-times 15.0 Comment RNITTED SAMIPLE IMARKS 2.0.0 R/H set 65.0 Tm-Ts 15.0 Comment Family Ref Fa				KA	•	Operator			V 88 1 1031	01/ T 4
20.0 R/H set 65.0 Tm-Ts 15.0 Temp Mul Temp Gra Temp All Temp All <th>+</th> <th>0.000</th> <th>Rct0</th> <th>0.0730</th> <th>T-times</th> <th>15</th> <th>Comment</th> <th>KNITTED ST</th> <th>AMPLE MAI</th> <th>1-1 VX</th>	+	0.000	Rct0	0.0730	T-times	15	Comment	KNITTED ST	AMPLE MAI	1-1 VX
23.553 2.387 56.221 85.385 5.334 7.00	+-	20.0	R/H set	65.0	Tm-Ts	15.0				
23.553 2.387 56.221 85.385 5.384 56.00 50.0 19.99 64.98 23.557 2.387 56.231 84.571 5.284 35.00 50.0 19.99 64.99 23.554 2.386 56.280 84.339 5.266 35.00 50.00 64.99 23.559 2.389 56.282 82.516 5.185 84.99 50.0 86.00 64.99 23.554 2.387 56.280 82.910 5.185 84.99 5.01 19.99 64.99 23.554 2.386 56.207 83.179 5.185 54.98 5.00 5.00 60.00 64.99 23.557 2.386 56.216 83.062 5.186 54.98 50.00 50.00 64.99 64.00 23.551 2.387 56.216 83.027 5.186 54.98 56.00 50.00 50.00 64.99 64.00 23.551 2.387 56.216 83.027 5.186 54.99		Volts	**Amps	Power	T-Mu	Watts	100.000	North Asset	A 40 PM	15GF
23.557 2.387 56.231 84.571 5.284 85.00 5.00 19.99 64.99 23.554 2.386 56.200 84.339 5.266 35.00 36.00 20.00 64.99 23.559 2.389 56.282 82.538 5.162 35.00 36.00 20.00 64.99 23.554 2.389 56.280 82.910 5.185 34.99 5.01 19.99 64.99 23.554 2.386 56.207 83.062 5.185 34.99 5.01 19.99 64.99 23.557 2.386 56.207 83.179 5.186 34.98 5.00 20.00 50.00 23.551 2.387 56.216 83.027 5.186 34.99 50.00 20.00 64.99		23.553	2.387	56.221	85.385	5.334	(Q)) (A): (Q)(Q) (A): (Q)(Q) (A): (Q)(Q)	(B) (B)	\$\displays	6
23.554 2.386 56.200 84.339 5.266 55.00 55.00 20100 64.99 23.559 2.389 56.282 82.538 5.162 5.162 5.162 5.162 5.163 64.99 64.99 23.554 2.387 56.223 82.910 5.185 54.98 5.19 64.99 64.99 23.557 2.386 56.207 83.062 5.189 54.98 6.00 66.00 65.00 23.551 2.387 56.216 83.027 5.186 54.98 64.99 66.00 66.00 23.551 2.387 56.216 83.027 5.186 54.98 66.00 66.00 66.00 66.00		23.557	2.387	56.231	84.571	5.284		ાં કોઈ દુકા	(36) 17:0	1.000
23.559 2.389 56.282 82.538 5.162 35.00 56.00 46.00 66.00		23.554	2.386	56.200	84.339	5.266		(9)(9) (9)75	(a) (a) (b) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c	
23.558 2.389 56.280 82.910 5.185 94.99 6.01 19.99 6.4.90 6.4.90 6.4.90 6.4.90 6.4.90 6.4.90		23,559	2.389	56.282	82.538	5.162	35.000 . SS 600.		(a) (a) (a)	*** *** *** ***
23.554 2.387 56.223 83.062 5.189 34.98 34.99 35.00	· (O	23.558	2.389	56.280	82.910	5.185	34 9B) (5 Cr)	(a) (a)	(A)	
23.557 2.386 56.207 83.179 5.195 34.98 4.00 20.09 65.00 23.551 2.387 56.216 83.027 5.186 34.99 35.00 20.00 64.99		23.554	2.387	56.223	83.062	5.189	7.5	(a) (a) (a)	(376) (376)	0
23.551 2.387 56.216 83.062 5.188 341.39 35.00 20.00 20.00 341.39 35.00 20.00 341.39		23.557	2.386	56.207	83.179	5.195	(D) ~ (B) 176	. 919 97	(N) (CE)	(a) (a) (b)
23.551 2.387 56.216 83.027 5.186 34.99 35.00 20.00 64.99	_	23.551	2.387	56.216	83.062	5.188	: 24 08	- 1910 (OK	(0,000)	
	က	23.551	2.387	56.216	83.027	5.186	(6 (6):38: (6(6):48: -		(36) (4)	X

	SITRA	RA		Operator	P.SUBR,	P.SUBRAMANIAN	Ref NO	918	915T - 1
0.0000	Rct0	0.0730	T-times	15		Comment	KNITTED SAMPLE MARK T-2	AMPLE MA	RK T-2
20.0	R/H set	65.0	Tm-Ts	15.0					
	Amps	Power	T-Mü	Watts	Тетр Ми»	Temp Grd	Temp Air	RH	Roi
23.552	2.389	56.266	94.803	5.927	(ই) প্র	(310° OE)	(36 i 3);	(3 (5) (9.9)	(6) (6) (4)
23.553	2.389	56.268	93.642	5.855	(2) (3) (3)	00.88	(6)6 (6)k.	(318° 174 9)	O CALED
23.554	2.387	56.223	93.375	5.833	. 35 U	GATHE	ୀରିକ୍'ରୈ∤ା	(a)8 1 7.0	0.400
23.560	2.386	56.214	84.711	5.291	ું કું <mark>કું</mark> કું કું કું	\$\@`\# & **	20 0,00	⊮(∻ /Æ)∷	(0) (0) Signature
23.556	2.387	56.228	92.828	5.799	3/5 F.G.	34.038	্ 'কুই (জুব	(a) (a) (b) (b)	7700
23.552	2.387	56.219	93.247	5.825	(<u>31</u> 0.4 3 8)	(9))# 3 { 2 *;	Z0, 90)	(j)) (3)	3.087(0)7(0)
23.549	2.387	56.211	92.516	5.778	() (3)		(de 6)	3	2/17(3)(9)
23.546	2.386	56.181	92.364	5.766	ે. કોર્ક્સ લાલ	:3)() (<u>\$</u>	20 00	()	
23.543	2.386	56.174	92.120	5.750	35.00	00 4	(616 (61)	(1)() (2 %)	
23.539	2.384	56.117	90.692	5.655	(664 78			()() (36)	
23.537	2.384	56.112	91.064	5.678	3/1 (0)	00,45	20,00	()() ලේ	61.24 40).(0)
23.535	2.383	56.084	91.333	5.691	34.98	35,00	19:50	64:88	(C) (C) (E)

	9151-2	ADK T.2	7-1 006		3,000			66					
	91	ANADIE ANA	AMPLE W		D/D	TO SOUTH	\$ 6 C	A.1 e.e.			(a)6 17:3		
	Ref NO	CANADIE MARKT.	KNIIIED S		7. V - 2 - 2 - 4	 remp.ank	(S) (S)	(9)(9) (4)	(A) (A)	70, 000	20,00	160 0161	
	PSIIBRAMANIAN		Comment			тетр Мід 📗 Гетр Січа	(6)(6) (7)			35 00 35 00	35 (10) 35 (10)		(1) (1) (1) (1) (2) (2) (1) (2) (2) (2) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3
	Opprator	Operator	15	15.0	The second secon	Wafts	5.765) (5.669	5.658	5 664	00.0	5.662
			T-times	Tm-Ts	The state of the s	T-Wa	92 503	2000	90.831	90.645	00 680	30.000	089.06
		SILKA	0.0730	65.0	2	Power	56 089	20.00	56.174	56.181	7 70	50.714	56.193
scription			Rct0	D/H cat	126 117	Amps	7 202	7.303	2.386	2.386	0 0	2.38/	2.386
Sample Description	2		0.0000	000	70.07	Volts	200.00	73.53/	3 23.543	2 - 23 546	010.03	23.550	3 23.551

	Operator P.SUBRAMANIAN Ref NO 915T -3	15 KNITTED SAMPLE MARK T-2	15.0	Watts Temp Mu Temp Grd Temp Air Rith	5.908 34 98 35 00 20 00 64 98	5.971 341 980 35 00 19 389 85.000	5.954 35 010 35 010 20 000 34 39	5.960 35 010 35 010 35 010 00 34 36 010 36 1	5.889 第5.00 35.00 19.00 19.99 64.99 (14.52
	900	T-times	Tm-Ts 1	T- T-WU-T	94.618 5	95.581 5	95.304 5	95.431 5	94.188 5
	RA	0.0730	65.0	Power	56.197	56.221	56.228	56.205	56.271
scription	SITRA	Rct0	R/H set	. Amps	2.386	2.387	2.387	2.386	2.389
Sample Description		0.0000	20.0	Volts =	23.553	23.553	23.556	3 23.556	73.554

0.0000 Rct0 0.0730 T-times 15 Comment RNITTED SAM 20.0 R/H set 65.0 Tm-Ts 15.0 Tempillar Tempillar	1	1	ころことのなり								
Rct0 0.0730 T-times 15.0 Comment R/H set 65.0 Tm-Ts 15.0 Temp/Mu Temp/Grd 3.386 56.193 136.092 8.497 \$5.00 \$5.00 2.386 56.195 133.808 8.354 \$5.00 \$5.00 2.386 56.195 134.002 8.367 \$4.93 \$5.00 \$5.00 2.386 56.195 134.584 8.403 \$5.00 \$5.00 \$5.00	-		SIT	RA		Operator	P.SUBRA	MANIAN	Ref NO	91	916T - 1
20.0 R/H set 65.0 Tm-Ts 15.0 Temp/Mul Temp/Ed Temp/Ed<	 	0.0000	Rct0	0.0730	T-times	15	mo)	ment	KNITTED SA	AMPLE M,	4RK 7-3
Volts Amps Fower T-Mu Watts Tremp Mu Temp Grd Temp Au 23.551 2.386 56.193 136.092 8.497 \$5.00 \$5.00 (9.99) 23.551 2.386 56.193 133.808 8.354 \$5.00 \$5.00 (9.99) 23.552 2.386 56.195 134.584 8.403 \$5.00 \$500 (19.99)		20.0	R/H set	65.0	Tm-Ts	15.0					
23.551 2.386 56.193 136.092 8.497 % 00 49.99 23.551 2.386 56.193 133.808 8.354 % 00 \$6.00 \$9.99 23.552 2.386 56.195 134.002 8.367 \$4.99 \$6.00 \$6.00 \$6.00 23.552 2.386 56.195 134.584 8.403 \$5.00 \$6.00 \$6.00 \$6.00	,	Volts	Amos	Power		Watts		Temp Grd	Тетр Ал	RIH	(<u>)</u>
23.551 2.386 56.193 133.808 8.354 \$5.00 \$5.00 \$5.00 \$9.99 23.552 2.386 56.195 134.584 8.403 \$5.00 \$5.00 1999	4	23.551	2.386	56.193		8.497	95 GC	(H) (H)	්ර්ලි (මු)		(a) (3/0/834)
23.552 2.386 56.195 134.002 8.367 34.58 35.00 35.00 45.00 45.00	တ	23.551	2.386	56.193	133.808	8.354	0.00	(JID) 'GKE	ઉત્€િ ઉ	(5%) (5%)	
23.552 2.386 56.195 134.584 8.403 35.00 35.00 1999	6	23.552	2.386	56.195	134.002	8.367	(a)(a) 1770 1770	1.70)/1985	20 00)	ે. જેફ 179	(3) (b) (a)
	6	23.552	2.386	56.195	134.584	8.403	3 5 ((()	\$\$!(O(C)	(3) (54) (54)	(3)(8) (3)(8)	9/6/6/6/
(36)(a).	8	23.552	2.387	56.219	133.842	8.360	00 SE	3kg.(0.0)	. 16) (36)	<u> </u>	301.000

Sample L	Sample Description								
- - 	LIS	SITRA		Operator	P.SUBRAMANIAN	MANIAN	Ref NO	916	916T - 2
0.0000	Rct0	0.0730	T-times	15	Comment	nont	KNITTED SAMPLE MARK T-3	MPLE MAI	RK T-3
20.0	R/H set	65.0	Tm-Ts	15.0					
Volts	Amps	Power	T-Mus	Watts	பு பூர்	Temp Grd	Temp Ar	RVH	, ? (%)
23.552	2.387	56.219	132.670	8.287	(*)(5° 577°	(j.6) <u>(34)</u>	(50) (61)	(316) 1749	0440
23.548	2.386	56,186	132.324	8.261	365 (016)	(1)(i) (S)(i)	370,000	ितः होह	
23.548	2.387	56.209	131.971	8.242	3.5.(B)(B)	3EMB(0)	ं है।	(45) (A)	
23.548	2.386	56.186	131.320	8.198	(A) 17/2	355.000)	্ইছি <u>তি</u>	(B) 1769	64 46 49
23.540	2.386	56.188	131.503	8.210	(S) (S) (C)	(36) 17E	20.00	(3)6 17.8	

 	Sample Do	Sample Description							9
+		LIS	CITDA		Operator	P.SUBRAMANIAN	Ref NO	916	9161 - 3
-		110	5		2		WAITTED SAMDIF MARK T-3	AM 7 IGM	RK 1-3
\vdash	0.0000	Rct0	0.0730	T-times	15	Comment	SALL PER		
+	000	\$00,17,0	65.0	Tm-Te	15.0				
_	70.0	LVII Sel	0.00		200				15 G
	Volts	- Amps -	Power	Tellia	Watts	Trende Mei Temp Grei	//emp/4///		Y SA
L	OO KEO	2 384	56 148	131.276	8.190	345, (8,00)	(1) (1) (1)	36 76	
<u>Ω</u>	70.07	7.00.1	-			1978) (1978)	3767 670	S. 100	10 C 11 W 10
16	23.553	2.386	56.197	131.149	8.189		(No. 19)		
. 4	22 551	2386	56 200	131.217	8.194	1919 SE (0,0) SE (0,0)	% 6 €1.	970 CA	
0	100.03	2000	000	121 160	8 190	35 010	2(0), (0(6)	(A)() (D)(E)	0.600
15	23.554	2.380	20.200	131.100	0.130		(A) (B)		
16	23.554	2.386	56.200	131.160	8.190	3(2) (Q(2)	40,00v)		Commence of the Commence of th

	•									
1/10/2010	3/10/2010 Sample Description	scription								7 1
ny		SITRA	RA		Operator	P.SUBR	P.SUBRAMANIAN	Ref NO	116	1-1/16
מוֹ	0.0000	Rct0	0.0730	T-times	15	000	Comment	KNITIED SAMPLE MARK 1-4	MMPLE MA	KA 1-4
Air set	20.0	R/H set	65.0	Tm-Ts	15.0					
Time	Time Volts		Power	T-Mu	Watts	Temp Mur	Temp Mus Temp Grds	Temp Air	RVF!	।हतः
12.44.20	23.556		56.275	97.815	6.116)()(SE	(88 48	(3)	378° 778°	EMMES (9
12:59:20	23.554	2.387	56.223	97.579	960.9	(919) (353)	35.00	3 (0) (0)(0)	65 5 (16	(S) 1
13:14:53	23.545	2.386	56.178	97.185	990.9	35 ,000	<u>\$5</u> (6)(6)	200 . (0.0)	(5)(5)(6))_ 570°(6)
13:29:20	23.545	2.386	56.178	97.231	690.9	35 (I)	35 .00	20. (0.0)	මන් මැග	ONOM: LL
13:44:20	23.543	2.386	56.174	96.661	6.033	3 5 ,000	(8) (8) (8)	କଟ ିଆ ,	(9)() (5)	()/(8K)//()
13:59:20	23.539	2.384	56.117	96.360	900.9	9 9)(9)?	()(9):93 :	. 20 00:	(92.0 (i)	(0), (22/2/8)
14:14:19	23.537	2.384	56.112	96.963	6.045	1)(c K c	. 310° EX		32.3 8	() (C) (Z)

0	0 Sample Description	scription								
		SIT	SITRA		Operator	P.SUBRAMANIAN	MANIAN	Ref NO	917	9177-2
1	0.0000	Rct0	0.0730	T-times	15	Common	lont	KNITTED SA	KNITTED SAMPLE MARK T-4	RK 1-4
+	20.0	R/H set	65.0	Tm-Ts	15.0					
	Volts	Amps	Power	T-Mu	Watts	_Temp Mu	Temp Grd	Temp Air	RH	द्ध
စ္တ	23.541	2.384	56.122	95.070	5.928	\$\\delta_{\mathcal{L}}(\text{\tin}\text{\tetx}\text{\tetx}\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\texi}\text{\text{\text{\text{\texi}\text{\text{\text{\texi}\texint{\texi}\text{\text{\texi}\tint{\text{\texi}\text{\texi}\text{\texit{\texi}\text{\texi}	345). (B)(b)	(2) (6)	()	Charles (
24	23.548	2.387	56.209	90.529	5.654	36) (8)6	3K5/, QXE)	Z6,0 0	(3 6) 179	((V5X0)+1
22	23.549	2.384	56.141	91.064	5.680	- 34 20	3,55, (0)(0)	(6) 600 (8)	(a) §≱\$	(%)
36	23.550	2.386	56.190	91.284	5.699	34,98	3.5.0(d)	୍ର (ପ୍ରତିଶ୍ୱର	65 (18)	14 3 770
37	23.554	2.386	56.200	91.497	5.713	36 175	345 BIB	(\$16) 16 i	(9)0) (639	(
36	23.555	2.386	56.202	91.679	5.725		(3)\$-578	ZO 60	(SK) (SK)	01947 J
60	23.555	2.389	56.273	91.807	5.740		\$ \ 5\6\0)	2(6), 6)(6)	(9)G <u>(5</u> 6)	250 A. C.

0	0 Sample Description	escription								
		SIT	SITRA		Operator	P.SUBRAMANIAN	IANIAN	Ref NO	91	9177-3
	0.0000	Rct0	0.0730	T-times	15	Common	ont	KNITTED S,	KNITTED SAMPLE MARK T-4	IRK T-4
+	20.0	R/H set	65.0	Tm-Ts	15.0				The state of the s	
	Volts	Amps	Power	T-Ma	Watts	Temp/Nu = 1	Temp Grd	Temp Air	RIFT	?Gê
0	23.556	2.387	56.228	103.735	6.481	(36) in	(3)(3) (3)(3)	(9) (9)	(0) (0)	17 (03/1/12)
23	23.544	2.384	56.129	103.643	6.464	(30.65)	ব্ৰীক্ত বু <i>ন</i> ু	(3) (3)	1000 P	
23	23.542	2.384	56.124	104.211	6.499	\$155. EVO!		(3)6 (3)	(3) (3) (3) (4) (4) (4) (4) (4) (4) (4) (4) (4) (4	14. F. C. J. C.
53	23.545	2.386	56.178	104.392	6.516	(86 mg	345,4040)	(3)6 (5)	8% SE	() ()) 3 kg/s
7	23.548	2.386	56.186	104.176	6.504	(S) 77.7	30 C.C.	2.0) (0)(0)	(A) (A)	0.00
22	23.546	2.386	56.181	105.801	6.604	90 Fg	000	0000	000	
22	23.544	2.386	56.176	104.641	6.531	SEST (BYO)	(30) (3)	. igo	(31) (49	
51	23.541	2.384	56.122	104.235	6.500		(A)(A)(A)	(0)6*(5);	0,000	(C) 5/45 1
52	23.538	2.384	56.115	103.770	6.470		3:5):(0)(0)	(36 *164	(AS).(3(B)	Christian (