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Influence of Fabric Parameterso Wicking Behaviour of Polyester/Lycra Knitted Fabrics

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Abstract: ***Wicking is one of the important properties of fabrics which decide its utility. The sweat generated in the body should be absorbed by the fabric as otherwise it may lead to skin diseases. It is advised that cotton fabrics should be worn net to the skin in order to get comfort to the wearer. This article is concerned with wicking which plays a vital role in determining comfort and moisture transport behavior of fabric and also into find out the effect of four parameters of single jersey, rib and pique knitted structures on the wickability. Parameters taken for the study were polyester cross-section, lycra denier used, plated structure and loop length.***

Keywords: ***Loop length, Lycra, Plated, Polyester, Wicking.***

I. INTRODUCTION

Liquid on the body surface or inner layer of clothing should be transferred to the outer layer in order to keep the skin dry and it must be evaporated from the outer layer to the environment; otherwise, it creates a sense of dampness and clamminess and can even reduce body heat, making people tired. Wear comfort is influenced by the ability of the clothing material to transport moisture vapour and to dry quickly, especially when sweating conditions are considered. The movement or wicking of water in fabrics is of current interest because of the recent introduction of fibres, yarns and fabrics which manufacturer claim impart great personal comfort to the wearer. This comfort is said to be due to the fibre, yarn or fabric's ability to wick perspiration away from the skin, leaving the wearer dry and warm. As part of an ongoing study on the movement of water in and through textile materials, this paper examines the vertical wicking of water along a strip of textile material, a common method of evaluating the wicking behavior of fabrics [1-4].

Synthetic fibres, especially the polyester staple fibre, have made a tremendous growth in clothing applications. 100% polyester staple fibres are rarely used for clothing purpose but in many cases when these are blended with other fibres like cotton and viscose fibres, they are widely used [5-7].

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This article is concerned with wicking which plays a vital role in determining comfort and moisture transport behavior of fabric and also into find out the effect of four parameters of single jersey, rib and pique knitted structures on the wickability. Parameters taken for the study were polyester cross-section, lycra denier used, plated structure and loop length.

II. DESIGN OF EXPERIMENTS

In this study, four independent factors and two levels of each factors were chosen to conduct the experiments. The parameters selected as independent factors were as follows

(i) Polyester circular and trilobal Cross section fabric
(ii) Lycra denier with 40 denier and 20 denier
(iii) Polyester fabric with half plated structure and full plated structure
(iv) Variation in Loop length of 2.9 mm, 3.1 mm and 3.3 mm

Table 1: Sample details with respect to polyester cross-section

Sample Code	Polyester cross section	Lycra denier	Loop length (mm)
SJ 1	Circular	40 D	2.9
SJ 2	Trilobal		
R 1	Circular		
R 2	Trilobal		
P 1	Circular		
P 2	Trilobal		

Table 2: Sample details with respect to Lycra denier

Sample Code	Lycra denier	Polyester cross section	Loop length (mm)
SJ 1	40 D	Circular	2.9
SJ 3	20 D		
R 1	40 D		
R 4	20 D		
P 1	40 D		
P 3	20 D		

Table 3: Sample details with respect to Plated structure

Sample Code	Plated structure	Polyester cross section	Loop length (mm)
SJ 4	Full plated	Circular	2.9
SJ 5	Half plated		
R 4	Full plated		
R 5	Half plated		
P 4	Full plated		
P 5	Half plated		

Table 4: Sample details with respect to loop length

Sample Code	Loop length (mm)	Polyester cross section	Plated structure
SJ 1	2.9	Circular	Full plated
SJ 5	3.1		
SJ 6	3.3		
R 1	2.9		
R 5	3.1		
R 6	3.3		
P 1	2.9		
P 5	3.1		
P 6	3.3		

III. RESULTS AND DISCUSSION

The experimental wicking values (mm) with respect to time (min) for Single jersey, rib and pique knitted fabrics were tabulated in Table 5 to 7.

Table 5: Wicking height Vs Time for single jersey fabric

Time	Wicking height (mm) S 1 Wale	S 1 Course	S 2 wale	S 2 course	S 3 wale	S 3 Course	S 4 Wale	S 4 Course	S 5 wale	S 5 course	S 6 wale	S 6 course
1 min	0.5	1.8	0.6	1.5	0.6	1.5	1.8	2.5	1.5	2.4	0.6	1.2
2 min	1	2.7	1.3	2.5	1.3	2.4	2.5	3.9	2.1	3.5	1.4	2
3 min	1.5	3.5	1.8	3.3	2	3.1	3.5	5.1	2.8	4.1	2	2.8
4 min	1.9	4.1	2.2	4	2.3	4	4	5.5	3.4	4.8	2.3	3
5 min	2.2	4.6	2.5	4.7	2.6	4.6	4.8	6.3	3.7	5.2	2.8	3.5
6 min	2.6	5.1	2.8	5.2	3	5	5.2	6.6	4	5.7	3.1	3.8
7 min	2.8	5.8	3	5.7	3.4	5.5	5.7	7.2	4.4	6	3.5	4.1
8 min	3	6	3.3	6.1	3.7	5.8	6.1	7.5	4.7	6.3	3.9	4.3
9 min	3.2	6.2	3.6	6.4	4	6.1	6.3	7.7	5	6.5	4.2	4.8
1o min	3.5	6.5	3.8	6.7	4.3	6.4	6.9	8	5.2	6.8	4.4	5.1

Table 6: Wicking height Vs Time for rib fabric

Viking time (min)	Wicking height H (cm) R 1 wale	R 1 course	R 2 wale	R 2 course	R 3 wale	R 3 course	R 4 Wale	R 4 Course	R5 Wale	R5 Course	R 6 wale	R 6 course
1	3.3	3	3.8	3.3	4.5	3.6	4.4	4.3	3.4	3.3	3	3.9
2	4.5	4	4.5	4.5	5	5	5.8	5.8	4.5	4.3	3.5	5
3	5.5	4.4	5.3	5	5.6	5.6	6.5	6.5	5.9	5.2	4	5.6
4	6.1	4.8	6	5.5	5.9	6.2	7.2	7.2	6.6	5.7	4.5	6.1
5	6.6	5.3	6.5	6	6.5	6.7	7.8	7.8	7.3	6.3	5	6.5
6	7.1	5.9	7	6.3	7.1	6.9	8	8.3	8.4	6.7	5.4	6.8
7	7.6	6.2	7.4	6.5	7.8	7.3	8.6	8.7	8.8	7	5.8	7.1
8	8	6.5	7.7	6.7	8.3	7.5	9.2	9	9.3	7.3	6.2	7.4
9	8.4	6.8	8	7	8.5	7.7	10	9.2	9.8	7.6	6.4	7.6
10	8.7	7.1	8.4	7.2	8.9	7.8	10.3	9.4	10	8	6.7	7.8

Table 7: Wicking height Vs Time for Pique fabric

Wicking time (min)	Wicking height H (cm) P 1 Wale	P 1 course	P2 Wale	P2 Course	P 3 wale	P 3 course	P 4 wale	P 4 course	P 5 wale	P 5 course	P 6 wale	P 6 course
1	1.7	2.2	4.5	4	2	4.5	2.5	3.3	3.4	3.8	4.5	5.3
2	2.8	3.4	5	5.5	3	5	3.8	4.5	4.6	5.1	5.5	6.6
3	3.5	4.4	6.1	6.5	3.5	5.5	4.5	5.2	5.5	5.8	6.8	7.5
4	4.3	5.1	7	7.3	4.3	6.2	5.2	5.7	6.1	6.4	7.4	8.5
5	5	5.7	7.8	8	4.9	6.5	5.8	6.1	6.7	6.8	8.1	9.2
6	5.5	6	8.3	8.5	5.3	7	6.3	6.7	7.3	7.2	8.8	9.7
7	5.8	6.3	8.6	9	5.6	7.5	6.7	7	7.6	7.6	9.1	10.2
8	6	6.8	9	9.5	6	8	7	7.2	7.9	7.9	9.4	10.5
9	6.3	7.2	9.4	10	6.8	8.4	7.3	7.4	8.2	8.1	9.7	10.9
10	6.5	7.5	9.8	10.2	7.3	8.8	7.6	7.6	8.5	8.8	10	11.3

A. Influence of polyester cross-section on vertical wicking behaviour of polyester/lycra knitted fabrics

In order to study the effect of polyester cross-section on fabric wickability, two different cross-sections of polyester filament namely circular and trilobal were used.

Table 8: Comparison of Regression of samples with circular and trilobal cross-section

Sample Code	Polyester cross section	Wale Slope	Wale Constant	Wale R2	Wale Coefficient of Regression	Course Slope	Course Constant	Course R2	Course Coefficient of Regression
SJ 1	Circular	0.8296	-0.5889	0.9879	0.9939	0.5665	0.609	0.9961	0.9980
SJ 2	Trilobal	0.5946	0.5701	0.9947	0.9973	0.494	0.998	0.98	0.9899
R 1	Circular	0.4179	1.2147	0.9978	0.9989	0.3714	1.0943	0.9935	0.9967
R2	Trilobal	0.3721	1.4893	0.9985	0.9992	0.3379	1.495	0.9923	0.9961
P 1	Circular	0.5471	0.6917	0.9951	0.9975	0.3023	1.4293	0.9631	0.9814
P 3	Trilobal	0.3638	1.4417	0.9795	0.9897	0.4057	1.4117	0.9975	0.9987

From the above table, samples produced from trilobal cross-section show higher intercept values both in wale direction and course directions in comparison with those produced from circular cross section [8-10].

B. Influence of Lycra denier on vertical wicking behaviour of polyester/lycra knitted fabric

Table 9: Comparison of Regression of samples with 20Denier lycra and 40 Denier lycra

Sample Code	Lycra denier	Wale				Course			
		Slope	Constant	R2	Coefficient of Regression	Slope	Constant	R2	Coefficient of Regression
SJ 1	40 D	0.8296	-0.5889	0.9879	0.9939	0.5665	0.609	0.9961	0.9980
SJ 6	20 D	0.8286	-0.3473	0.9803	0.9901	0.6017	0.2572	0.9875	0.9937
R 1	40 D	0.4179	1.2147	0.9978	0.9989	0.3714	1.0943	0.9935	0.9967
R 6	20 D	0.3677	1.0326	0.9828	0.9914	0.2961	1.3863	0.9963	0.9981
P 1	40 D	0.5471	0.6917	0.9951	0.9975	0.3023	1.4293	0.9631	0.9814
P 2	20 D	0.5854	0.6007	0.9856	0.9928	0.5205	0.8541	0.9881	0.9940

The influence of lycra denier on the wickability is not so pronounced as indicated in Table 9. There is no evidence to show that fibre denier affects wickability.

C. Influence of Plating on vertical wicking behaviour of polyester/lycra knitted fabric

Table 10: Comparison of Regression of samples with Full plated and half plated structures

Sample Code	Plated Structure	Wale				Course			
		Slope	Constant	R2	Coefficient of Regression	Slope	Constant	R2	Coefficient of Regression
SJ 1	Full plated	0.8296	-0.5889	0.9879	0.9939	0.5665	0.609	0.9961	0.9980
SJ 3	Half plated	0.55	0.406	0.995	0.9975	0.447	0.916	0.994	0.9970
R 1	Full plated	0.4179	1.2147	0.9978	0.9989	0.3714	1.0943	0.9935	0.9967
R6	Half plated	0.488	1.212	0.994	0.9970	0.381	1.206	0.997	0.9985
P 5	Full plated	0.5471	0.6917	0.9951	0.9975	0.3023	1.4293	0.9631	0.9814
P 6	Half plated	0.36	1.497	0.993	0.9965	0.333	1.665	0.997	0.9985

To study the effect of plating on wickablity of the fabrics, samples were produced with lycra in every courses and lycra in alternating courses. In the table 10, single jersey fabrics with full plated structure show the greater slope than that of the rib and pique fabrics irrespective of full/half plated structures. The effect of plating has a significant effect on wickability of the knitted fabrics. While in course direction there is a clear relation in that half-plated fabrics show higher wickability, in wales direction no clear-cut conclusion can be made [11].

D. Influence of Loop length on vertical wicking behaviour of polyester / lycra knitted fabric

Table 11: Comparison of Regression of samples with different loop length

Sample Code	Loop length	Wale				Course			
		Slope	Constant	R2	Coefficient of Regression	Slope	Constant	R2	Coefficient of Regression
SJ 1	2.9	0.8296	-0.5889	0.9879	0.9939	0.5665	0.609	0.9961	0.9980
SJ 2	3.1	0.7636	-0.3551	0.9788	0.9893	0.6535	0.4535	0.9949	0.9974
SJ 3	3.3	0.8182	-0.365	0.9815	0.9907	0.6395	0.4402	0.9931	0.9965
R 1	2.9	0.4179	1.2147	0.9978	0.9989	0.3714	1.0943	0.9935	0.9967
R 2	3.1	0.3567	1.2981	0.9938	0.9969	0.3279	1.2387	0.9896	0.9948
R 3	3.3	0.314	1.419	0.95	0.9747	0.328	1.341	0.981	0.9905
P 1	2.9	0.5471	0.6917	0.9951	0.9975	0.3023	1.4293	0.9631	0.9814
P 2	3.1	0.4756	0.9684	0.9929	0.9964	0.3594	1.2319	0.9923	0.9961
P 3	3.3	0.398	1.2481	0.9961	0.9980	0.3435	1.3643	0.9941	0.9970

The effects of loop length on wickability of the knitted fabrics were analyzed by varying the loop length as 2.9 mm, 3.1 mm and 3.3 mm According to the values indicated in Table 11, irrespective of the constructed structure, as the loop length increases the slope gets decreased to a significant level. can come to a conclusion that as loop length increases, the wickability of the fabrics increases.

IV. CONCLUSIONS

It is apparent that wickability improves with longer loop lengths in single jersey fabrics. This is due to the lower tightness factor and more porosity.

The following conclusions were emerged out of this study.

- Wickability is found to be higher in knitted fabrics produced with trilobal polyester cross section
- Use of 40 denier lycra is found to improve wickability in a few cases.
- Half plating structure with lycra has led to better wickability.
- As the loop length increases, there is an improvement in wickability.

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