THE EFFECT OF MATERIAL AND STRUCTURAL ANALYSIS ON COMFORT PROPERTIES OF BILAYER MODAL POLYESTER FABRICS

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***Abstract**:* The paper focuses on the development of a bilayer knitted fabric and studying the effect of structure design and material type on its comfort properties. Outer layer was with modal yarn, while two different knitted structures of polyester were used for the inner layer. The comfort properties of fabric including air permeability, thermal resistance, water vapour resistance and Moisture management were determined. It was found that both the layers of fabric as a whole contribute to the comfort properties of bilayer fabric.

***Keywords* - Bilayer fabric, comfort, thermal resistance, water vapour permeability, air permeability**

I. INTRODUCTION

Comfort is both physiological and psychological phenomena; showing the condition of ease or wellbeing of the wearer that is influenced by the textile material properties [1]. Comfort properties of the fabric can be determined by interactions and inter-relationship of the properties of its constituent fibres, yarn, fabric structure, and chemical finishes applied during the production of the fabric [2]. Polyester has outstanding dimensional stability and offer excellent resistance to dirt, alkalis, decay, mold and most common organic solvents. Being durable, yet lightweight, elasticity and a comfortable smooth feel, these are all important qualities to consumers for wide variety sportswear applications. Excellent heat resistance or thermal stability is also an attribute of polyester [3]. It is the fiber used most commonly in base fabrics for active sportswear because of its low moisture absorption, easy care properties and low cost. The cellulose and polyester blended fabrics give better liquid absorption and transport efficiency. Good moisture management means quick absorption and release of moisture, which give better level of comfort. Synthetic fibres like polyester have very low moisture absorption and do not get wet, giving better moisture release simultaneously. The fabrics produced from 100% cotton or 100% polyester yarn do not exhibit better moisture management properties; blending the both at fibre level produces good results [4]. The comfort of the fabric is attained through transmission of sensible and insensible perspiration. This can be achieved by enhancing the moisture management properties of knitted fabrics. In this article, the moisture management properties of bi-layer knitted fabrics were analyzed for active sportswear. Liquid transfer property is the key factor in comfort to be considered in clothing design of sportswear. In this study, the sportswear are developed from polyester and modal fibers by using a knitting technique, jacquard structure (bi- layer knitted fabric by interlock structure) and analyzed for their various properties such as structural, mechanical and comfort properties of the knitted fabric samples. The objective fabric test was carried out to find out the moisture management properties of bi-layer knitted fabrics. The results indicate that the micro-fibre polyester (inner layer) and modal (outer layer) bi-layer knitted fabric have better moisture management property because of better wetting time, high wetting radius, good absorption rate and good spreading speed of sweat, and hence provide high level of comfort and can be preferred for active sportswear.

II. MATERIALS AND METHODS

2.1 Selection of Yarn

Two different types of yarns, namely modal of 30's count and polyester of 80's denier were used for sample preparation.

2.2 Fabric

Bi-layer knitted fabrics were developed on a plaited jacquard knitting machine with machine parameters.

Machine parameters			
S.No	**Machine Details**	**Sample A**	**Sample B**
1	Type	Bonded fabric (plaited jacquard)	Interlock jacquard knitting machine
2	Make	Kumyong	Mayer &cie (Drum jacquard)
3	Feeders 1 & 3	Polyester (navy)	Polyester (navy)
4	Feeder 2 & 4	Modal	Modal
5	Gauge	18 needles/inch	20 needles/inch
6	Diameter	32 inches	32 inches
7	Total needle count	3600	3744
8	No of feeders	72	36
9	Knitting speed	20 rpm	15 rpm

3. TESTING

Comfort properties such as wicking, water absorbency, drying rate, water vapour permeability and thermal conductivity of the fabric samples were determined.

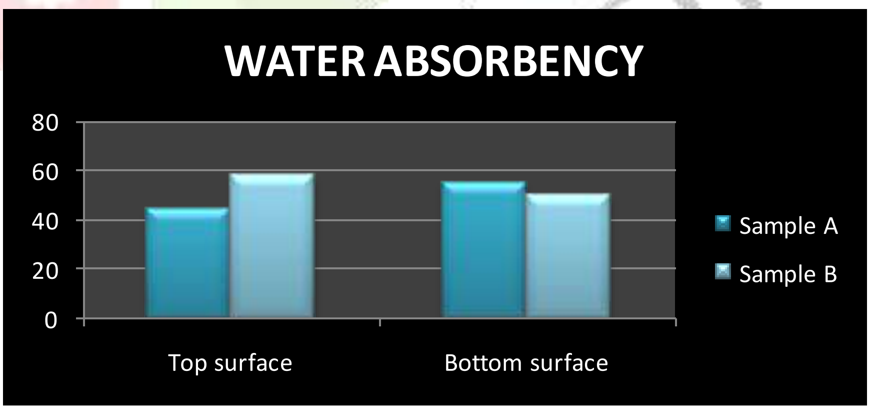
3.1 WATER ABSORBENCY TEST AATCC 195:2012

Water absorbency is a quality of fabric to absorb water. It is a method for measuring the total amount of water that a fabric will absorb. In this test, a sample of 20x20cm was dipped in the solution for 5 minutes. Then it is hung vertically for 5 minutes and weighed. Percent gain in weight of fabric sample was taken as water absorbency of the fabric. Four specimens were tested for each sample.

Table. 1 Water Absorbency

Test	Sample A	Sample B
	Absorbency in %/ sec	
Top surface	43.9475	57.6789
Bottom surface	54.8819	49.7286

Fig 1. Water Absorbency



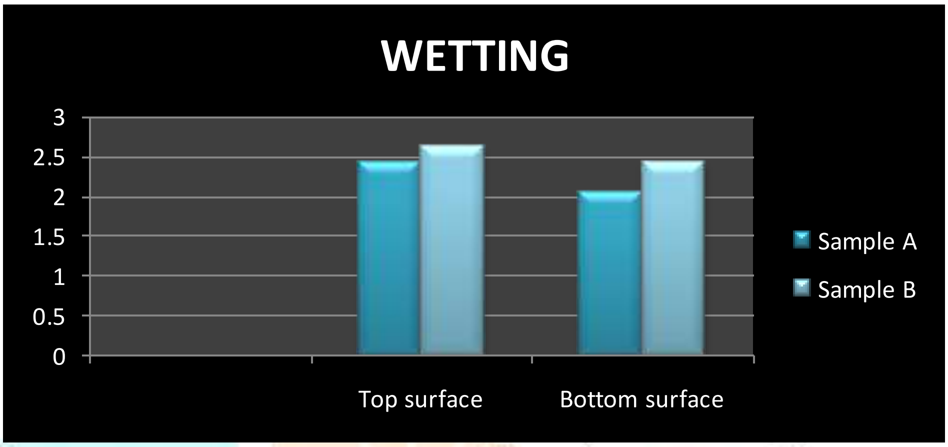
3.2 WETTING (BS 4554 1974)

Wet ability is defined as the time in seconds for a drop of water or 50 per cent sugar solution to sink into fabric. Fabrics that give times exceeding 200S are considered unset. Wet ability of the fabric samples was tested by using Electronic Tester developed by the authors as per British Standard (BS 4554 1974).

Table 2. Wetting

Test	Sample A	Sample B
	Wetting time in seconds	
Top surface	2.434	2.621
Bottom surface	2.059	2.434

Fig 2. Wetting

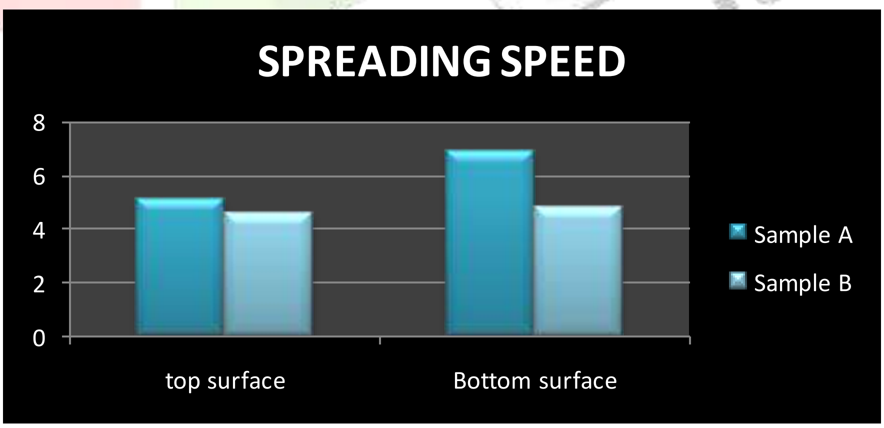


3.3 SPREADING SPEED (mm/sec)

Table 3. Spreading Speed

Test	Sample A	Sample B
	mm/sec	
Top surface	5.0879	4.5998
Bottom surface	6.8828	4.7991

Fig 3. Spreading Speed



3.4 WICKING TEST (*AATCC 79:2014*)

In this test, a strip of fabric is suspended vertically with its lower edge in a reservoir of distilled water. The rate of rise of the leading edge of the water is then monitored. The measured height of rise in a given time is taken as a direct indication of the wick ability of the test fabric. Five specimens were tested for each sample.

3.4.1 MODAL(Outer layer)

Table 4.1 Wicking

Test	Sample A		Sample B	
	Lengthwise A	Widthwise A1	Lengthwise B	Widthwise B2
After 5 min	1.0	2.5	1.0	2.2
After 30 min	3.3	5.0	3.2	4.8

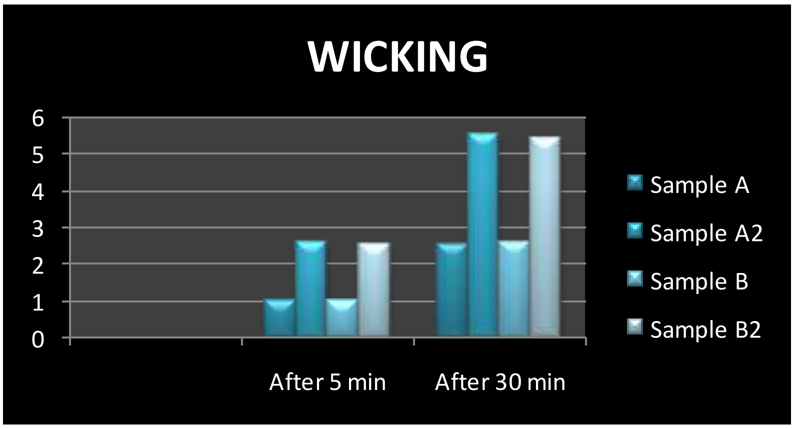
Fig 4.1. Wicking Test

3.4.2 POLYESTER (Inner layer)

Table 4.2. Wicking Test

Test	Sample A		Sample B	
	Lengthwise A	Widthwise A2	Lengthwise B	Widthwise B2
After 5 min	1.0	2.6	1.0	2.5
After 30 min	2.5	5.5	2.6	5.4

Figure 4.2 Wicking Test



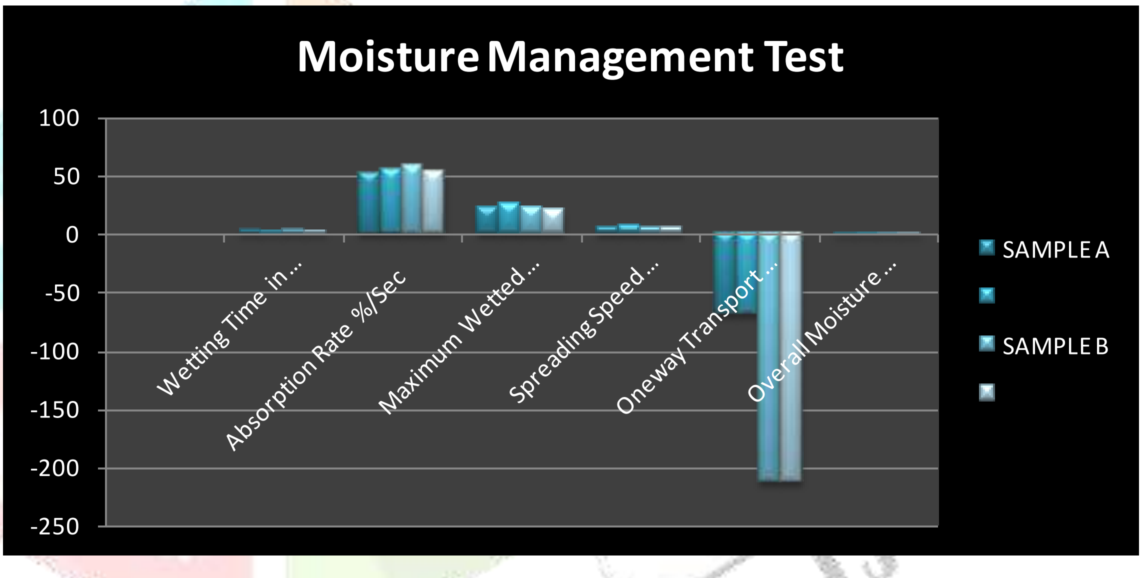
3.5 MOISTURE MANAGEMENT (*ASTM E96 – 95 Option B*)

The moisture vapour transfer rate is the difference between the initial height of the water and the actual height of the water in the cups. Unit of water vapour transfer is measured in percentage. It is understood that moisture vapour transfer differs with face and back side of fabric.

Table 5. Moisture Management

TEST	SAMPLE A		SAMPLE B	
LAYER	TOP LAYER	BOTTOM LAYER	TOP LAYER	BOTTOM LAYER
Wetting Time in Seconds	2.4898	2.1156	2.6584	2.415
Absorption Rate %/Sec	52.1103	54.4492	58.4466	52.5035
Maximum Wetted Radius in mm	23	25	23	20
Spreading Speed mm/Sec	5.5489	6.8754	4.7612	4.9881
Oneway Transport Index %	-69.0015	-69.0015	-212.9048	-212.9048
Overall Moisture Management Capability	0.3979	0.3979	0.3681	0.3681

Fig 5. Moisture Management



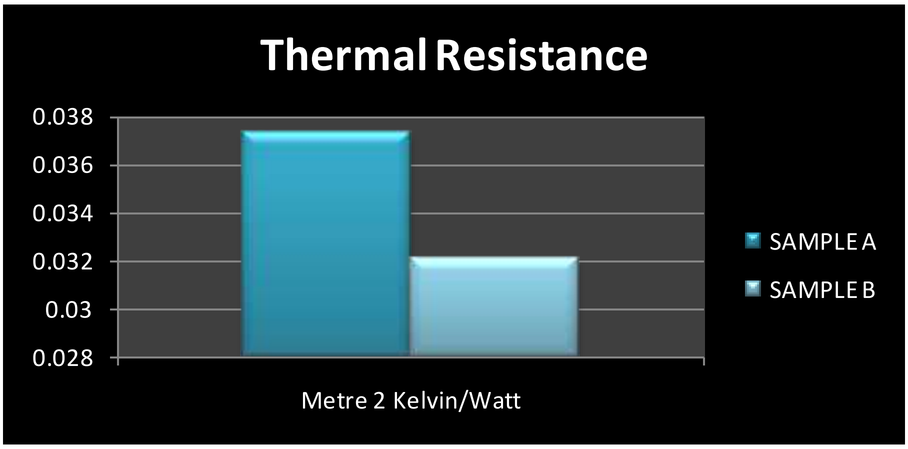
3.6 Thermal Resistance (*ISO 11092*)

Thermal resistance is the important factor for Sportswear. Due to heavy sweating of the body lot of moisture accumulated on the skin and when it get dried there may be chances that body temperature get decrease very rapidly which causes hypothermia to the wearer[5]. Hence the sportswear must also provide proper thermal resistance in cold condition also.

Table 6. Thermal Resistance

TEST	SAMPLE A	SAMPLE B
Metre 2 Kelvin/Watt	0.0373	0.0321

Fig 6. Thermal Resistance



3.7 AIR PERMEABILITY *(ASTM D 737:04) (2012)*

It is the rate of air flow through a material under differential pressure between two faces of a fabric. The fabric air resistance is expressed as Kpa/sec/m.

The fabric having high air permeability gives better comfort to the wearer by maintaining the proper body temperature up to 33.3^0 c. The active sportswear also required good air permeability.

Table 7. Air Permeability

TEST	Sample A	Sample B
Air permeability	232	187

Fig 7. Air Permeability

4. Results and Discussion

The properties of two different Bi-Layer structured weft knitted fabric (sample A and sample B) shows that it is suitable for sportswear and winter wear. The sample A (plaited jacquard) is good and better compared to sample B (Interlock jacquard) for sportswear. Moisture absorbency, Thermal resistance, spreading speed and wicking properties is very good and excellent in Sample A.

Sample A is fast absorbing and quick drying fabric compared to sample B. It is dimensional stable, wrinkle free with more comfort due to high wicking property of polyester layer and perspiration transfer by the modal layer in the fabric. By using various colour yarn in feeders of dial and cylinder needles we can produce innovative design at both the inner and outer layer of the fabric. Hence it is recommended to be used in the active sports for better comfort and better performance of the sports person.

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