Chapter

Functional Textile for Active Wear Clothing

Ramratan Guru, Anupam Kumar and Rohit Kumar

Abstract

Moisture management property is an important aspect of any fabric meant for active wear fabric, which decides the comfort level of that fabric specially used as active wear garments. Regular physical activity is important to maintain consistency in human health. To achieve comfort and functional support during various activities such as walking, stretching, jogging etc., athletes and sports persons use active wear clothing. A fabric's moisture management performance is also influenced by its air and water vapour permeability. The moisture management finish (MMF) and Antimicrobial finish (AMF) have been used to increase moisture absorbency; improves wetting, wicking action and antimicrobial performance. In this study, influence of MMF and AMF finishes on the moisture management property of different knitted active wear fabrics had been carried out. For the study two different knit fabrics of 100% Polyester and 100% Nylon with three different GSM levels (100, 130 and 160) has been selected. Further two varieties of commercially available functional fabric finishes have been also taken for the study. The result shows that in case of finished fabric at certain concentration level, as the fabric GSM increases the value of Accumulative one-way transport index (OWTI) %, water vapour permeability but same time drying rate increases. The result shows that in case of finished fabric at certain concentration level, as the fabric GSM increases the value of accumulative one-way transport index (OWTI) %, water vapour permeability decreases but same time drying rate increases. The knitted fabrics of 100% Polyester and 100% Nylon composition follow the similar trend. Further with the increase of fabric finish concentration level, OWTI %, and water vapour permeability (WVP) factor decreases while the drying rate increases.

Keywords: Active wear knit fabrics, moisture management, dry rate performance, water vapour permeability

1. Introduction

Moisture management properties of knit fabrics are important factors for deciding not only the comfort but also the performance of functional clothing like active wear, inner wear and sportswear. Comfort refers to the way clothing interacts with the body, with respect to dissipation of heat and moisture generated by the metabolic processes [1, 2]. During normal activity, human body loses heat by conduction, convection as well as radiation processes. Under normal condition, body cools itself by insensible perspiration where water vapour is lost from the body. When heat generation is excessive, the body breaks into a sweat or liquid moisture, also known as sensible perspiration [3]. Those properties such as smoothness of the fabric surface, air permeability, heat transmittance, hydrophilicity, knit structure, and the presence of a bio-finish influence the comfort characteristics of the knitted fabric. Active sportswear is mostly made of polyester knitted fabrics. Polyester with a modified cross section like hexachannel in coolmax gives more comfort due to its rapid liquid transmission and drying [4].

Moisture management properties of fabrics are influenced by various constructional parameters of the fabric which give knit fabric a porous structure. Total porosity of a knit fabric comprises two types of porosity, viz. micro porosity caused by void spaces among the fibres in the yarns and the macro porosity, which is a consequence of void spaces among the yarns. The air permeability, UV transmission and screen printing depend on the macro porosity; absorption of liquids and capillary phenomenon depend on micro porosity; and thermal resistance and water vapour permeability of fabric depends on both micro- and macro porosity [5, 6]. Interaction of liquids with textile materials involve several physical phenomenon such as wetting of fibre surface, transport of liquid into assembly of fibres, adsorption on the surface or diffusion of liquid into the interiors of fibres, Evaporation of sweat during wear has the potential to cool the body besides restricting the additional weight of sweat being absorbed by the fabric [7].

Moisture is transported in textiles through capillary action or wicking. In textiles, the spaces between the fibres effectively form tubes, which act as capillaries, and transport the liquid away from the surface. The liquid moisture management performance of fabrics results from complex properties including their absorbent capacity, absorption rate, and evaporation [8, 9]. This observed that the water and moisture transmission process is controlled by the water vapour pressure gradient across the inner and outer faces of the fabric. The resistance to diffusion was governed by the fabric construction, i.e. the size and concentration of inter yarn pores and the fabric thickness. The efficiency of yarn wicking depends on the surface tension, i.e., wet ability of the fibre surfaces and on the size, volume and number of capillary spaces was determined by the choice of yarn and fabric construction [10]. The length of time for a fabric to dry depends mainly upon the amount of initial liquid water retained by the fabric per unit area for evaporation. Also, the drying process seems to be related to capillary penetration and porosity of the fabrics. The most significant influence of fibre properties was believed to be the manner in which fibre shape and surface reflect increased or decreased capillarity of the fabric, which in turn causes and enhanced or diminished water uptake on wetting and water retention on drying [11]. The noted finish on a fabric is the most important consideration when developing a dynamic fabric system, as the initial uptake of water depends on the presence of a hydrophilic finish on the fabric surface. This initial uptake is the rate-determining step of the wicking action and a hydrophilic surface finish enhances the moisture management capabilities of fabrics [12, 13].

Antimicrobial finish is manly important role play for the active or sportswear fabrics. The present time is more demand all textile products in better antimicrobial performances. Antimicrobial treatment apply on fabric surface are basically more reduces cross infection, microbial bacteria and skin infections like fungi and increases the performance of sports person infections [14].

Duration the sports activity is more generated sweat and temperature for this condition get for more growth bacteria. This bacteria and fungi cause loss for sports activity performance, ageing, staining, unpleasant odours and potential skin infections.

The basically is during the sports activity generated sweat and increases temperature. In this condition are increase bacteria. This bacteria and fungi cause loss for sports activity performance, ageing, staining, unpleasant odours and potential skin.

2. Fibre use for active or sportswear cloths

Recently some year now, in active sportswear clothing are used for basically fashionable with more comfort performance. Active sportswears are one of the most lucrative segments within knits apparel. Performance of the clothing helps to remain cool, comfort and dry through the moisture management, thermal performance and other techniques. Polyester based knit has come up as a favourite for the performance of the apparel and also it can be engineered to wick transport moistures away from the body for the users' comforts.

The polyester is most common fibre used in active or sportswear cloths. Other fibres are used for active wear cloth like cotton, cotton-polyester, nylon-spandex, polyester- spandex, polypropylene and wool blend. Fibre crossection mainly used in active or sportswear cloth like irregular cross section and hollow structures fibre used [15]. Now it is more use blend with natural fibre in case for active wear cloths because improved thermo physiological performances. The basically fibre use sportswear clothing are mention in following (**Table 1**).

Polyester	**Nylon (Polyamide)**	**Polypropylene**	**Lycra/Elastane**	**Cotton**
Strong	Strong	Strong	Medium strength	Strong
Non absorbent	Non absorbent	Non absorbent	Not very absorbent	absorbent
Crease resistant	Crease resistant	Crease resistant	Crease resistant	Crease easily
Durable hard wearing	Durable hard wearing	Durable hard wearing	Durable so hard wearing	Durable
Elastic so stretches	Elastic so stretches	Elastic so stretches	Very elastic So stretches well	Not Very elastic so does not stretch
Not very warm to wear	Not very warm to wear	Not very warm to wear	To make a stretchy & fitting fabric	Cool to wear

Table 1.
Basically fibre used in active sportswear cloths.

3. Design requirement for the active or sportswear cloths

The textile materials are basically used in all sports as active or sportswear, games like for athletic clothing, football-cricket clothing, jackets, pants, shirts, shorts, socks, sweatshirts, swimwear and tennis clothing.

Plan prerequisites of dynamic and execution athletic apparel have delivered architects with abilities and information in illustrations, materials and style to imagine tastefully satisfying and ergonomically practical reaches which exploit the most recent advances in utilitarian and 'shrewd' materials [16]. Driving style fashioners have rushed to understand that the presentation has really become the feel in athletic apparel. It is the fabrics and innovation that set the precedent. Fuse of microfibres, breathable boundary fabrics, inventive stretch materials, shrewd materials, intelligent materials, for example, stage change materials and shape-memory polymers, and wearable innovation as a piece of the useful plan framework in active apparel, will get standard in the item improvement measure.

The development of new materials and designs for active or sportswears cloths has produced an exceptionally aggressive market for sports cloths design. The desires of customers for active wear sport and sportswear are concert, protection and comfort associated. The basically are all activewear cloths need for light weight, more durable, fast absorbing performance, heat- liquid regulating materials mainly used for functional design sportswear (**Tables 2**–**7**).

Knitted fabric is commonly used as base layer for functionally active wear due to greater elasticity and stretch ability compared to woven cloth, which is very imperative for freedom of body movement in sports. The tactile sensations by clothing

Single jersey	Rib	Interlock
High extensible in length & width	Excellent width elasticity	Width wise stretch
The fabric has tendency to curl.	No tendency to curl	No tendency to curl
Use for sportswear & undergarment	Use for sportswear & collar, cuffs, socks	Shorts, tops & sports, technical textile

Table 2.
Commercially use knitted structure for active sportswear.

Requirements	Mechanisms	Role of material designing
• External climate • Thermo physiological requirement • Physical and mechanical requirements • Protection and maintenance	• Mechanism of thermo physiological comfort • Stretch ability and comfort • Functional finishes protection and maintenance	Designing of sportswear based on the knowledge of textile properties and construction, along with the characteristics of other materials (E.g. membrane, coatings etc.), in combination.

Table 3.
Designing process for active sportswear cloths.

Functional properties	Aesthetic properties	Other properties
Light weight, high tenacity, more stretch ability, thermal preservation, Antimicrobial- UV resistance, more cooling capacity, more sweat absorption, quickly drying performance, liquid-vapour permeability and moisture management performances basically are requirement.	Feeling of softness, surface texture, handle, shine, colour discrepancy, transparency and comfort in sports wear are essential factors.	**Protection:** From wind water and undesirable climate **Insulation:** Safety from cold **Vapour permeability:** To make certain that body vapour passes outward through all layers of the clothing system. **Stretch ability:** To offer the freedom of movement essential in sports.

Table 4.
Basic requirement for active sportswear cloths.

Properties	Yarn 1	Yarn 2
Type	Polyester filament yarn	Nylon filament yarn
Blend	100%	100%
Yarn fineness (Denier)	120 D	120 D
No. of filaments in cross-section	75	75

Table 5.
Characteristics of yarn polyester and nylon.

Parameters	Polyester	Nylon
Breaking force (gf)	623.2	646.3
Tenacity (g/tex)	23.14	24.36
Elongation (%)	13.85	14.70
Unevenness (%)	14.92	13.86

Table 6.
Yarn quality parameters.

Sample & blend ratio	Polyester (100%)			Nylon (100%)		
GSM (g/m^2)	**100**	**130**	**160**	**100**	**130**	**160**
Wales Per cm	22.04	17.32	22.04	22.44	22.04	21.25
Courses Per cm	16.53	20.47	16.53	17.32	16.92	16.53
Stitch density (Loop/cm^2)	364.32	354.54	364.32	388.66	372.91	351.26
Loop length (mm)	2.3	2.2	1.9	2.4	2.2	1.9
Count (Tex)	10	15	21	9	14	21

Table 7.
Fabric geometrical characteristics.

in direct contact with the wearer skin makes wearer more relaxed due to uneven surfaces provided by the knitted fabrics in comparison to smooth-surfaced woven cloth. In addition, the lesser number of contact points of fabric with skin results in reduced clinging sensation during sweat-wetted skin [17].

4. Basic mechanism in thermal and moisture transmission though active wear clothing

The basic process implicated in heat and vapour transport is essential aspect which effects dynamic comfort of active wear garments. The basic phenomena heat can be transferred within active wear in the shape of conduction, convection, radiation and concealed heat transfer by vapour - liquid transport. Conduction, convection and radiation are overwhelmed by the temperature distinction between skin surface and climate and are thusly assembled as dry heat transfer. Then again, dormant heat transfer is accomplished by moisture transmission identified with water vapour pressure between the skin surface and the climate [18–20].

4.1 Essentials of heat transfer through garments system

The active wear fabric layers can by heat transfer from conduction, convection, radiation and wind penetration mechanisms as shown in **Figure 1**.

4.2 Essentials of moisture transfer through garments system

The basic phenomena moisture form garment may be transfer in liquid- vapour form. In vapour structure extraordinary framework like diffusion, sorption, absorption, convection and condensation are included while if there should arise an occurrence of liquid structure wetting and wicking are two components which are for the most part happen as shown in **Figure 2**.

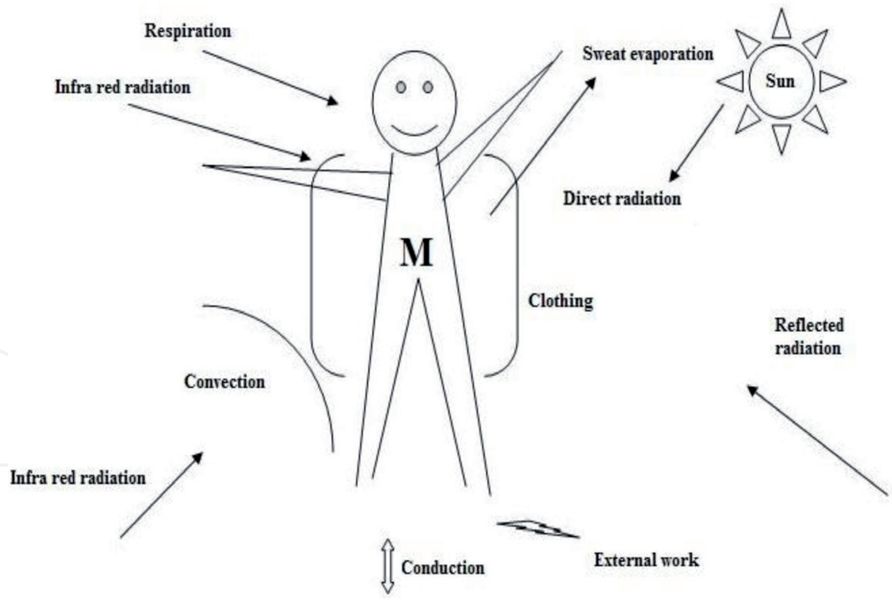

Figure 1.
The pathways for heat loss from the activities with human body.

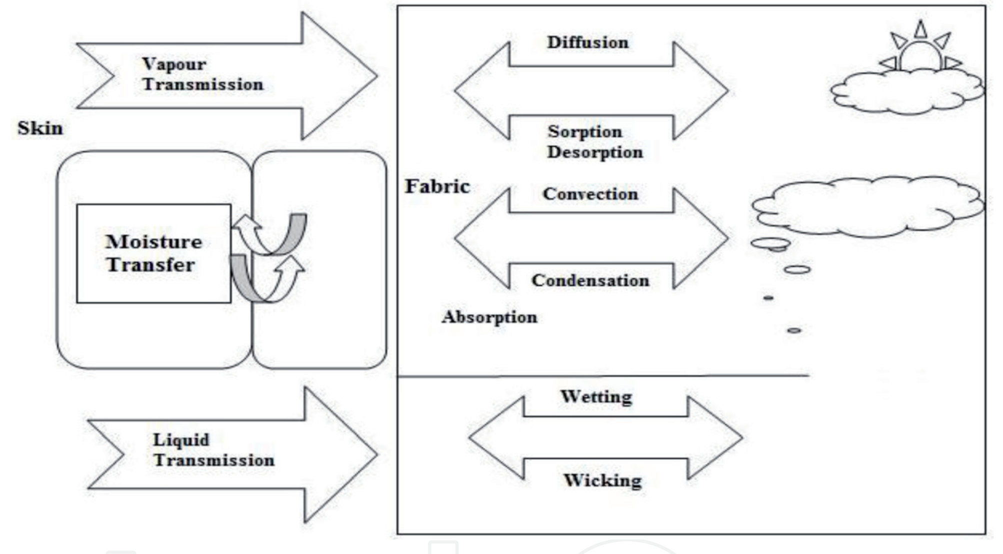

Figure 2.
The pathways for moisture loss from the activities with human body.

There are various finishes which are being applied nowadays on fabrics to improve its moisture management behaviour. So here in this research work various combinations of knit activewear fabrics (Polyester and Nylon) with varying moisture management finish and antimicrobial finish have been studied for its improvement in moisture management behaviours and antimicrobial activities for the activewear garments.

5. Material for active wear cloths

In this study work, polyester and nylon yarn count range has kept constant 120 denier, The mesh interlock knit activewear fabrics has prepared on circular knitting machine. Two different knitted fabrics of 100% Polyester and 100% Nylon were used for the study with three different GSM (100, 130 and 160). The fabrics used are scoured, bleached and ready for dyeing (RFD) fabrics (**Figures 3**–**5**).

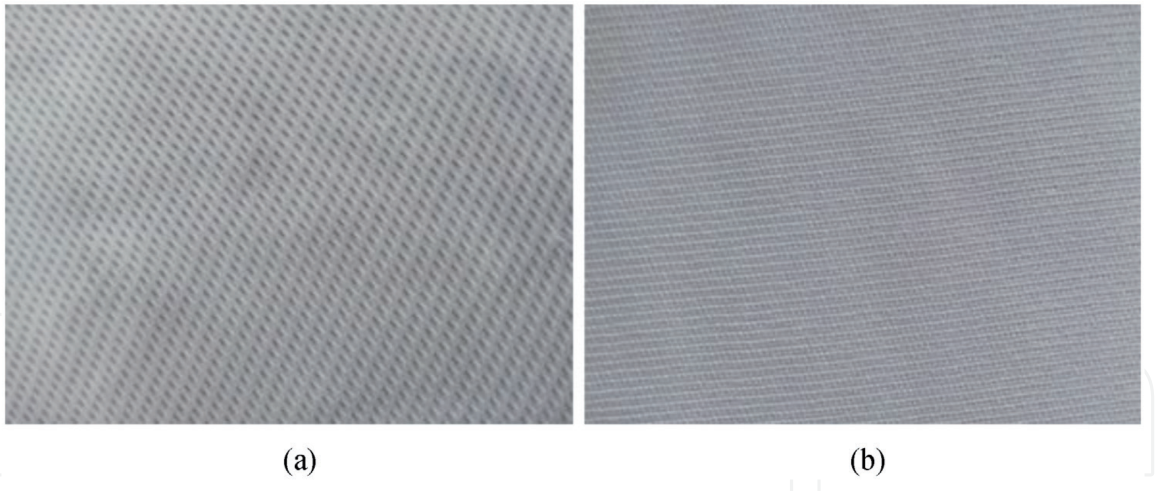

Figure 3.
(a) Polyester fabric. (b) Nylon fabric.

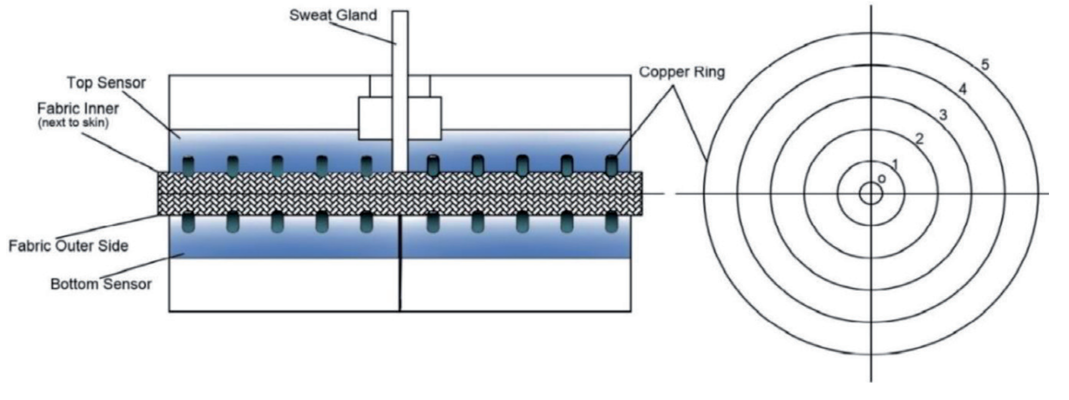

Figure 4.
Schematic diagram of MMT apparatus testing.

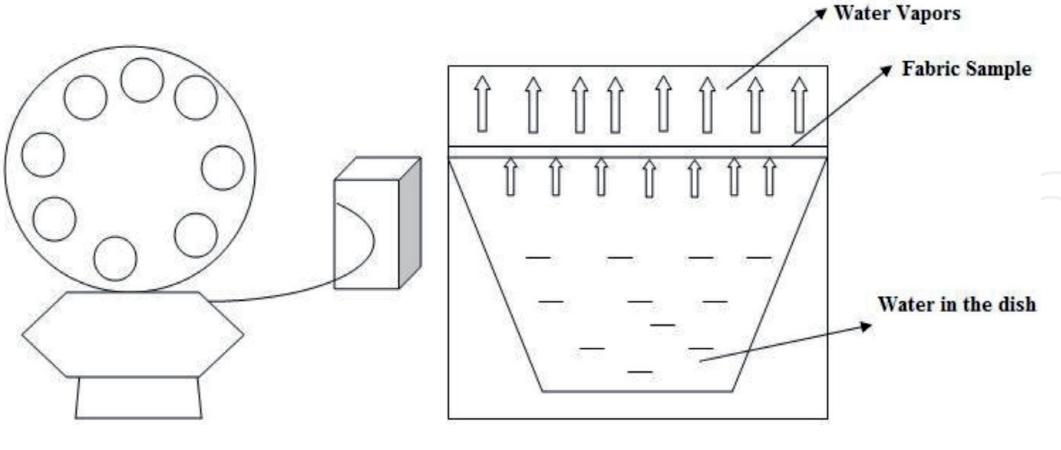

Figure 5.
Schematic diagram of water vapour permeability tester equipment (left) and testing procedure (right).

6. Moisture management (MMF) and antimicrobial finish (AMF)

The fabrics of different type and different GSM are finished with (i) Evo soft MMF finish, (ii) Evo AMF finish. In Evo soft MMF finish Silicone micro emulsion is done which increases the hydrophilic and moisture management characteristics of the fabric. Similarly AMF finish, antimicrobial cloth is used especially for activewear and leisure activities to feel clean and safe or to control malodour.

Anti-microbial finished textile lowers down the psychological discomfort associated with foul odour arising out of microbial growth and by fungi causing skin infections which is an important aspect as human body sweats during various sports activities and the temperature of human body also increases, favouring microbial growth. They also create a powerful barrier against the spread of antibiotic resistant bacteria, which are responsible for medical infections in hospitals other activities.

7. Application of finishes

Various finishes are applied on ready for dyeing fabrics, as per the following methodology. For treating the samples with MMF (i.e. to give moisture management finishing) solutions of 10 gpl and 20 gpl concentrations were prepared. For 10 gpl concentration, 10 gram of MMF was added to 1 gpl of acetic acid and 1 litter of water. Whereas, for 20 gpl concentration of finishing, 10 gram of MMF was added to 1 gpl of acetic acid and 1 litter of water. The same procedure was followed for preparing solution for other two finishes. Samples of dimension (25x 25) cm were prepared and treated with 100 ml of prepared solution by immersing it in

Fabric mass (g/m^2)	Material	Fabric thickness (mm)	Air Permeability (Cm^3/Cm^2/Sec)	WVP (g/m2/day)	Rate of drying (mg/min*inch^2)	Accumulative one-way transport index (%)
100	Polyester	0.41	56.22	321.52	0.0963	321.52
	Nylon	0.40	55.26	396.90	0.0863	396.90
130	Polyester	0.55	47.21	244.94	0.0757	244.94
	Nylon	0.47	45.87	293.41	0.0657	293.41
160	Polyester	0.56	43.65	199.01	0.0635	199.01
	Nylon	0.49	41.25	189.32	0.0535	189.32

Table 8.
Vapour and liquid moisture management properties of standard samples without finish.

Fabric mass (g/m^2)	Fabric	MMF finish conc.	Fabric thickness (mm)	Air Permeability (Cm3/Cm2/Sec)	WVP (g/m2/day)	Rate of drying (mg/min*inch2)	Accumulative one-way transport index (%)
100	Polyester	10	0.43	57.65	1663.18	0.2381	241.094
		20	0.40	57.12	1108.79	0.2536	196.201
	Nylon	10	0.42	56.23	2217.58	0.2181	283.41
		20	0.41	56.10	1563.38	0.2526	196.13
130	Polyester	10	0.56	49.26	1663.18	0.292	181.094
		20	0.51	48.25	1523.12	0.363	162.667
	Nylon	10	0.48	47.25	1663.18	0.272	187.09
		20	0.46	46.45	1423.32	0.323	154.35
160	Polyester	10	0.57	44.56	1663.18	0.231	137.73
		20	0.53	43.89	1109.16	0.323	106.52
	Nylon	10	0.51	43.58	1563.18	0.241	132.73
		20	0.50	42.87	1109.16	0.321	97.52

Table 9.
Influence of variation in (MMF) finish on moisture management properties of fabrics.

Fabric mass (g/m^2)	Fabric	AMF finish conc.	Fabric thickness (mm)	Air Permeability ($Cm^3/Cm^2/Sec$)	WVP (g/m2/ day)	Rate of drying (mg/ $min*inch^2$)	Accumulative one-way transport index (%)
100	Polyester	10	0.42	57.15	2217.50	0.1794	176.39
		20	0.41	55.12	2014.50	0.1802	156.29
	Nylon	10	0.44	55.13	2117.38	0.2182	298.41
		20	0.41	53.10	1663.28	0.2226	186.23
130	Polyester	10	0.56	50.23	2217.58	0.1612	135.49
		20	0.52	48.15	1663.18	0.1708	98.87
	Nylon	10	0.48	49.35	1663.18	0.262	188.09
		20	0.47	46.45	1213.10	0.341	122.15
160	Polyester	10	0.55	44.56	2017.28	0.1371	96.29
		20	0.52	43.89	1562.12	0.1402	61.82
	Nylon	10	0.53	42.58	1663.18	0.243	132.73
		20	0.51	41.87	1215.20	0.308	96.52

Table 10.
Influence of variation in antimicrobial (AMF) finish on moisture management properties of fabrics.

the solution contained in a beaker for 10 minutes. Then the sample was taken out & sand with between two transparent sheets & was passed through the padding mangle to squeeze out the solution. The squeezed samples were dried at 150 ^{0}c for 1 minute in oven dryer. The same procedure was repeated for 2 samples for each level. The whole experimental work was carried out for 100, 130, 160 GSM 100% polyester and 100% Nylon knit fabrics. The variation in fabric geometrical characteristics after applying various finishes and their concentration (level) of finish is tabulated in the (**Tables 8–10**). Same processes applying antimicrobial finishes.

8. Moisture management tester

The knit fabric (Untreated and treated) samples were tested on SDL ATLAS M290 moisture management tester (MMT) according to AATCC test method 195–2009, 2011. The accumulative one-way transport index (OWTI) and the overall moisture management capacity (OMMC) measured by using the (Moisture management tester) MMT provide an insight about the liquid moisture transmission performance of fabrics. OWTC is the difference in the accumulative moisture content between the two surfaces of the fabric. OWTC reflects the one-way liquid transport capacity from the top (Inner next to the skin) to the bottom (Outer) surface of the fabric.

8.1 Drying rate testing

Dry rate testing was carried out using dry rate tester, which evaluates the weight of water evaporated in given time from the fabric. This device can be used independently to find a drying rate or in conjunction with the SDL Atlas Moisture Management Tester (MMT) in order to obtain a more complete understanding of the moisture management properties of a performance fabric. Sample size of 15 x 15 cm was used for the study, to which 2 ml water was added on its surface and allowed dry for required amount of time in the room conditions. The difference between initial and final weight gives the dry rate % of the fabric sample.

8.2 Water vapour permeability testing

Water vapour permeability testing is carried out to determine the resistance of textiles and textile composites (Particularly action wear fabrics) to water vapour penetration using testing standard BS 3424. It was carried out in the water vapour permeability tester which consists of 8 containers with water reservoirs, a standard permeable fabric cover, sample holder ring and precision drive system. The water vapour permeability (WVP) of the fabric was calculated in g/m^2/day is using the Equation (1).

$$WVP = \frac{24\,M}{A_t} \tag{1}$$

where, M- Loss of the assembly over the time period t (in g).

T- Time between successive weightings' of the assembly in hours.

A - Area of exposed test specimen (equal to the internal area of the test dish (in m^2) in this case. A = 0.0054113 m^2.

8.3 Scanning electron microscope

The surface of the coated fabrics was investigated using an SEM XL 30, Philips. According to SEM image confirm the impregnation of moisture management finish has used on the surface of the fabric. This can be also revealed from the SEM images of the moisture management finish shown as below **Figures 6** and **7**. I have used coating on the polyester fibre with a particle size ranging 10 nm. The similar trend has also found for the nylon fibre.

This can be also perceived from **Figures 8** and **9** in SEM images at the uniform coating of the antimicrobial finishes on the polyester fabrics surface with a particle size ranging 10 nm. The similar trend has also found for the nylon.

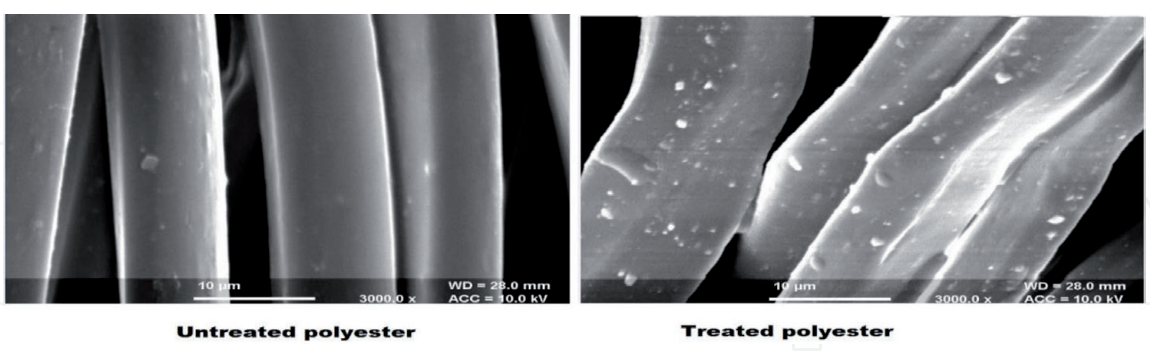

Figure 6.
SEM images of untreated and treated polyester fabric with moisture management finishes.

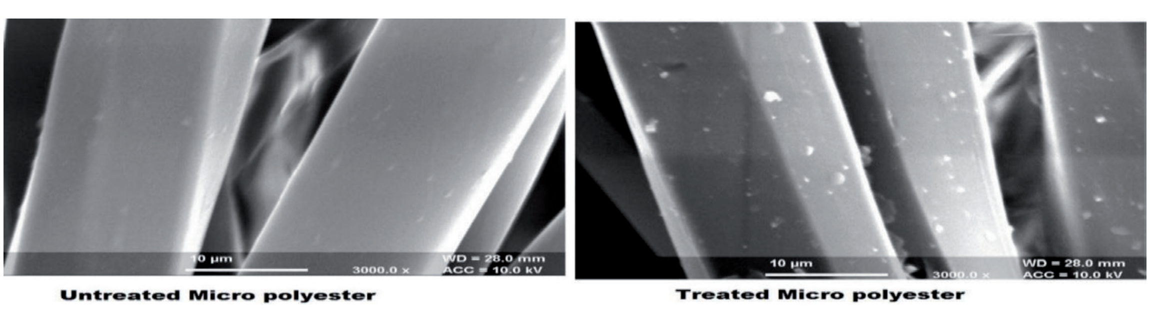

Figure 7.
SEM images of untreated and treated polyester fabric with moisture management finishes.

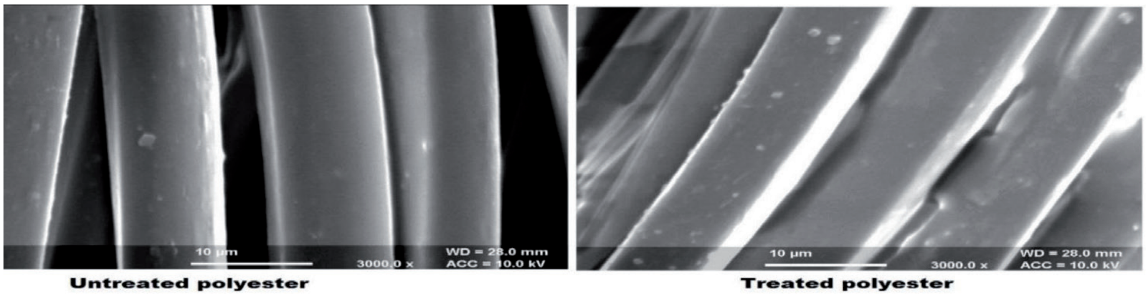

Figure 8.
SEM images of untreated and treated polyester with antimicrobial finish.

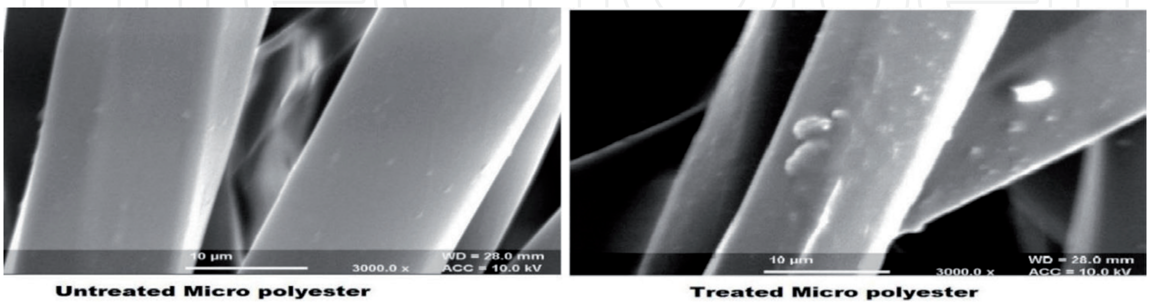

Figure 9.
SEM images of untreated and treated polyester fabric with antimicrobial finish.

9. Influence of moisture management finish (MMF) on fabric moisture management properties

In case of 100% polyester fabric it can be observed from the **Figure 10**. That as the fabric GSM increases from 100 to 160 grams, the value of accumulative one-way transport index (OWTI) % decreases. It is due to the increase in the thickness of the fabric with the increase in GSM as shown on the **Table 9**. The increased thickness

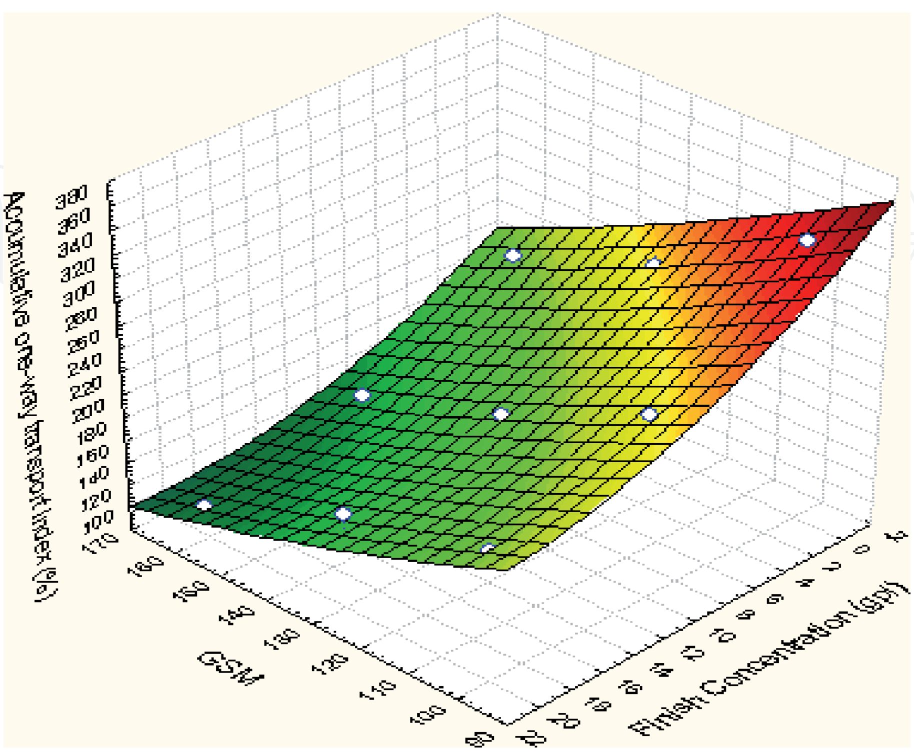

Figure 10.
Effect of MMF finish concentration and GSM on OWTI% in polyester fabric.

offers more restriction to the flow of moisture across the plane of fabric (reduced conductivity), which reduces the OWTI %. Also it was observed that the increased finishing concentration decreases the OWTI% of polyester fabric. It is due to the increased decreased pore size after finishing. HDS finish provides a surface finish on the fibre surface to increase its moisture management property. Since the finish is applied on the surface of the fibre, the fibre diameter increases and pore size decreases after finishing. The decreased pore size also decreases the air permeability of the fabric as shown in the **Table 9**. It can be seen that other fabric 100% Nylon also follows the similar trend but the rate of reduction in pore size and OWTI% was different for different fabrics. Basically the HDS softness to penetrate deeply into fibres with amorphous structure to create and increase core hydrophilicity and softness to the fabrics.

10. Influence of moisture management finish (MMF) on drying rate of different fabrics

In case of 100% polyester fabric it can be observed from the **Figure 11**. That as the fabric GSM increases from 100 to 160 grams, the value of drying rate increases. This is because of the increase in the thickness of the fabric with the increase in GSM. Increase in the thickness causes the water to spread in wider volume which causes the fabric to dry easily. Further with the increase of finish concentration level, drying rate increases. It is due to the blocking of pores of the fabric and so water remains on surface of the fabric not inside the pores and facilitating easy drying. It can be seen that other fabric 100% Nylon also follows the similar trend but the rate of increment is different due to its different physical properties than polyester.

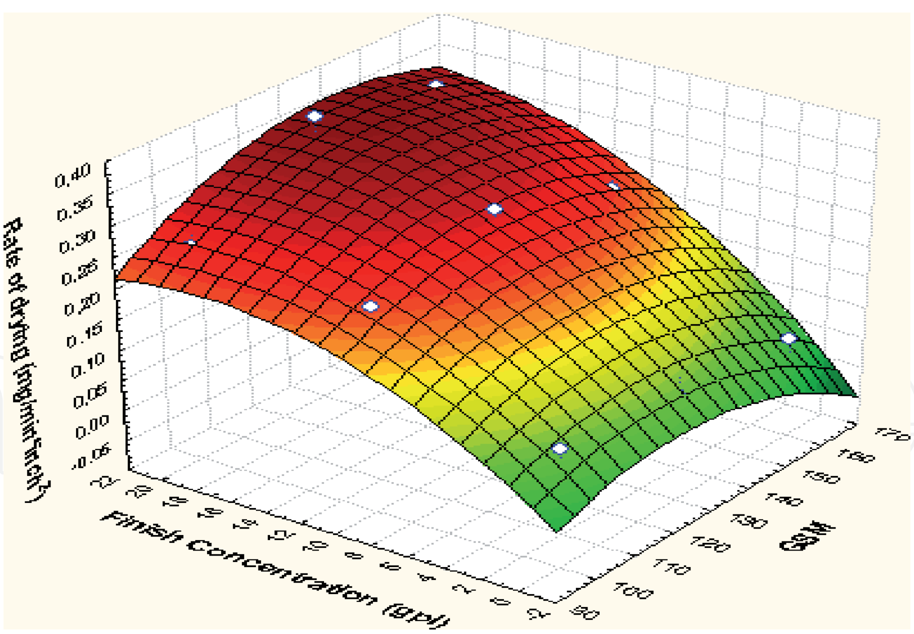

Figure 11.
Effect of MMF finishes concentration and GSM on rate of drying in polyester fabric.

11. Influence of moisture management finish (MMF) on water vapour permeability of different fabrics

In case of 100% polyester fabric it can be observed from the **Figure 12**. That as the fabric GSM increases from 100 to 160 grams, the value of water vapour permeability (WVP, $gm/m^2/day$) decreases. It may be due to the increase in the thickness of the fabric

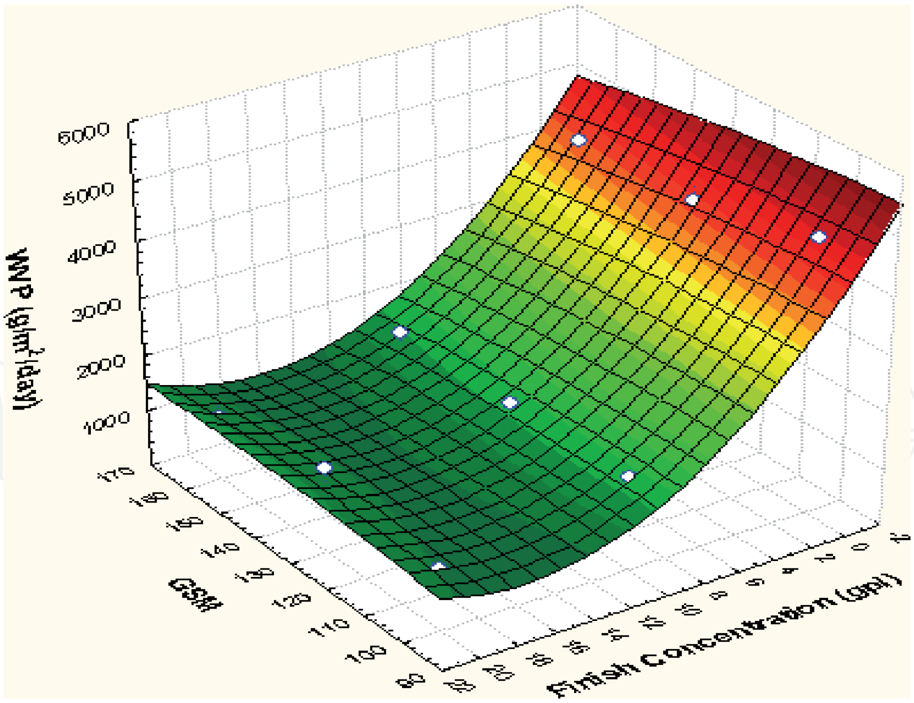

Figure 12.
Effect of MMF finish concentration, GSM on water vapour permeability in polyester fabric.

with the increase in GSM. Further with the increase of finish concentration level, WVP decreases. It is due to the increase in the fabric thickness after finishing, blinding of the fabric structural pores and reduction in fabric porosity with the increase of finish level. This may also be attributed that the reason of blocking of natural capillary action of the fibre/fabrics softener (HDS) [13]. It can be seen that other fabric 100% Nylon also follows the similar trend but the rate of reduction is different.

12. Influence antimicrobial (AMF) finish on fabric moisture management properties

In case of 100% polyester fabric it can be observed from the **Figure 13**. That as the fabric GSM increases from 100 to 160 grams, the value of accumulative one-way

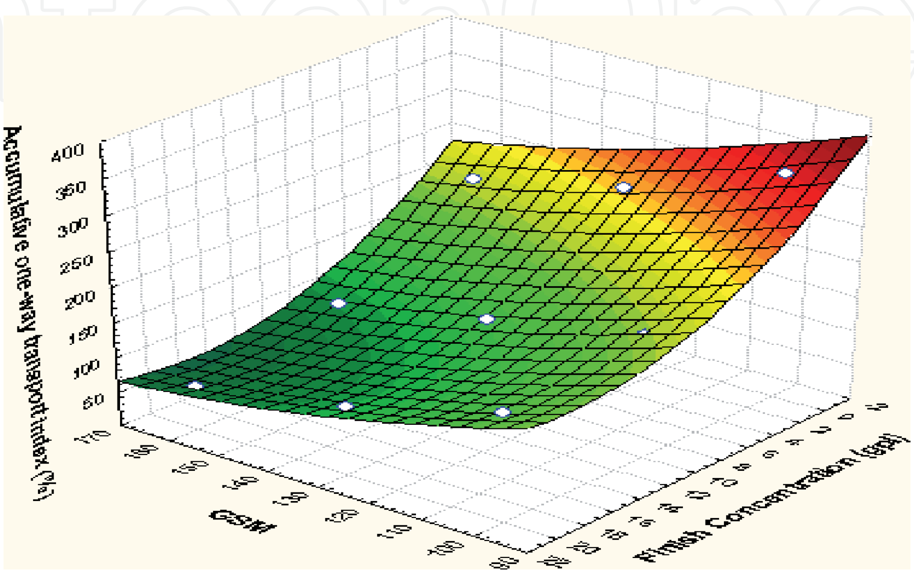

Figure 13.
Effect of AMF finish concentration and GSM on OWTI%% in polyester fabric.

transport index (OWTI) %decreases. It is due to the increase in the thickness of the fabric with the increase in GSM as shown on the **Table 10**. The increased thickness offers more restriction to the flow of moisture across the plane of fabric (reduced conductivity), which reduces the OWTI %. Also it was observed that the increased finishing concentration decreases the OWTI% of polyester fabric. It is due to the increased decreased pore size after finishing. PEH finish provides a surface finish on the fibre surface to increase its moisture management property. Since the finish is applied on the surface of the fibre, the fibre diameter increases and pore size decreases after finishing. The decreased pore size also decreases the air permeability of the fabric as shown in the **Table 10**. It can be seen that other fabric 100% Nylon also follows the similar trend but the rate of reduction in pore size and OWTI% was different for different fabrics.

13. Influence of antimicrobial (AMF) finish on drying rate of different fabrics

In case of 100% polyester fabric it can be observed from the **Figure 14**. That as the fabric GSM increases from 100 to 160 grams, the value of drying rate increases. This is because of the increase in the thickness of the fabric with the increase in GSM. Increase in the thickness causes the water to spread in wider volume which causes the fabric to dry easily. Further with the increase of finish concentration level, drying rate increases. It is due to the blocking of pores of the fabric and so water remains on surface of the fabric not inside the pores and facilitating easy drying. It can be seen that other fabric 100% Nylon also follows the similar trend but the rate of increment is different due to its different physical properties than polyester.

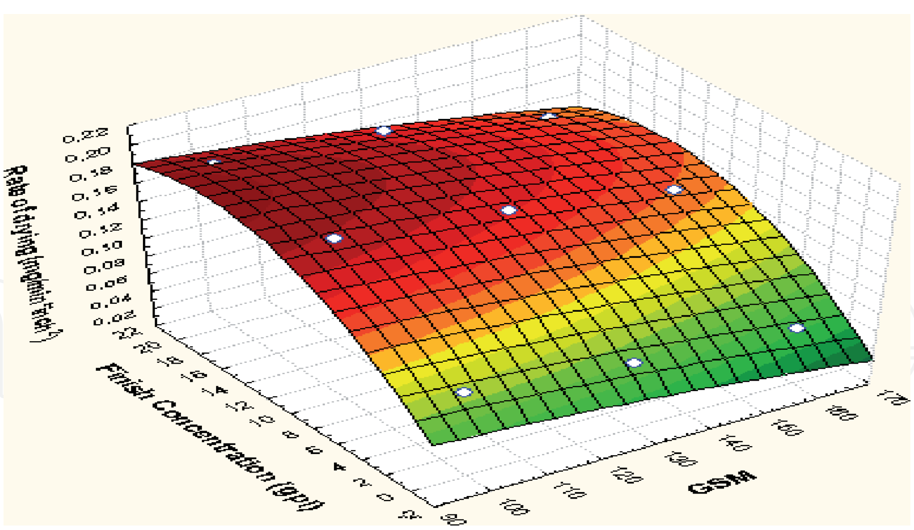

Figure 14.
Effect of AMF finish concentration and GSM on rate of drying in polyester fabric.

14. Influence of antimicrobial (AMF) finish on water vapour permeability of different fabrics

In case of 100% polyester fabric it can be observed from the **Figure 15**. That as the fabric GSM increases from 100 to 160 grams, the value of water vapour permeability ($g/m^2/day$) decreases. It may be due to the increase in the thickness of the fabric with the increase in GSM. Further with the increase of finish concentration

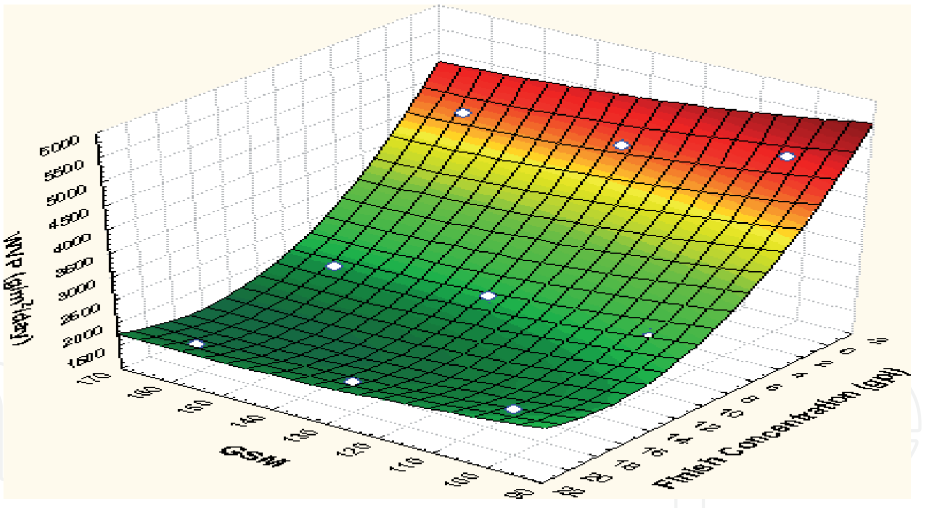

Figure 15.
Effect of AMF finish concentration, GSM on water vapour permeability in polyester fabric.

level, WVP decreases. It is due to the increase in the fabric thickness after finishing, blocking of pores of the fabric and reduction in fabric porosity with the increase of finish level [14]. It can be seen that other fabric 100% Nylon also follows the similar trend but the rate of reduction is different.

15. Conclusions

In this research an attempt has made to study the influence of MMF and AMF finishes on the moisture management behaviour, dry rate performance, water vapour permeability properties on different knit activewear fabrics. Therefore from the various combinations of fabrics, GSM, finishes and finish concentration level the following conclusions are drawn:

- The liquid and vaopur moisture management properties are much influenced by the GSM and finishing concentration. The moisture management property of the fabric was increased when the one way transport index (OWTI) %, dry rate performance and the rate of water vapour permeability (WVP) increases in the fabric. When the moisture management finishes (MMF) and antimicrobial finish are applied on the polyester and nylon fabrics, the OWTI% is much influenced by the GSM and finishing concentration. At higher GSM and finishing concentration, OWTI% reduced due to increased thickness and decreased pore size.

- The dry rate performance increases with increased GSM and finishing concentration which is due to more area for moisture spreading and evaporation from the fabrics. Water vapour permeability (WVP) performance of fabric reduces at increased GSM and finishing concentration; it is due to the smaller pores and reduced porosity at higher GSM and finishing concentration level. However in the different fibre type's fabrics, it was observed that to have less influence on the moisture management properties, it's because, these finishes applied were less penetrating into fibre and hence it's not reacting with fibre molecules of the yarns. Moisture transmission properties (Both vapour and liquid form) improve by moisture management, antimicrobial finish. Uniform coating of finishes is observed in polyester and then followed by the nylon fabrics, on the basis of SEM image.

- Active sportswear is a vast and challenging field in which required functionality can be designed by suitable choice of raw material, fabric structure, garment design and finishes. Due to suitable properties of fibres such as polyester, nylon and blends of fibres and filaments, their use in sportswear clothing is of paramount importance.

- Moisture management properties like sweat absorption sweat dissipation and faster drying are primary desirable functions of active sportswear, which affect the comfort sensation of players during sports, while ensuring the required thermal insulation. For performance apparel, the knowledge of fabric is useful for garment selection and design and development.

- To achieve required comfort level, the development of sportswear includes various modern approaches such as using special polymers, modifying the structure at fibre, yarn, and at fabric level techniques such as coating, laminating and finishing and other manufacturing technologies.

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