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Study of Moisture Management Finish on Woven Fabrics

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ABSTRACT

An attempt has been made through this research work to analyze the moisture management behaviour of four types of woven fabrics such as Cotton, Polyester / Cotton blend, Microdenier polyester and Nylon. Also the effect of process parameters of moisture management finish on the comfort properties of woven fabrics was studied. The optimization of comfort level by varying the process parameters of moisture management finish in order to achieve suitability for making sportswear was also done. Based on the test results, Microdenier polyester fabrics and Cotton exhibits good in wicking, wetting and water absorbency characteristics than Polyester / Cotton blend and Nylon. Comparing the 3 different process parameters, it is found that the combination of ethoxylated alcohol blend (Wetting agent) and the recipe containing amino silicon polyether copolymer and hydrophilic polymer in the ratio of 1:2 with pH of 5.5 at 60^0 - 70^0C temperature is the optimum finishing process than the other two combinations so as to attain better comfort properties for sportswear.

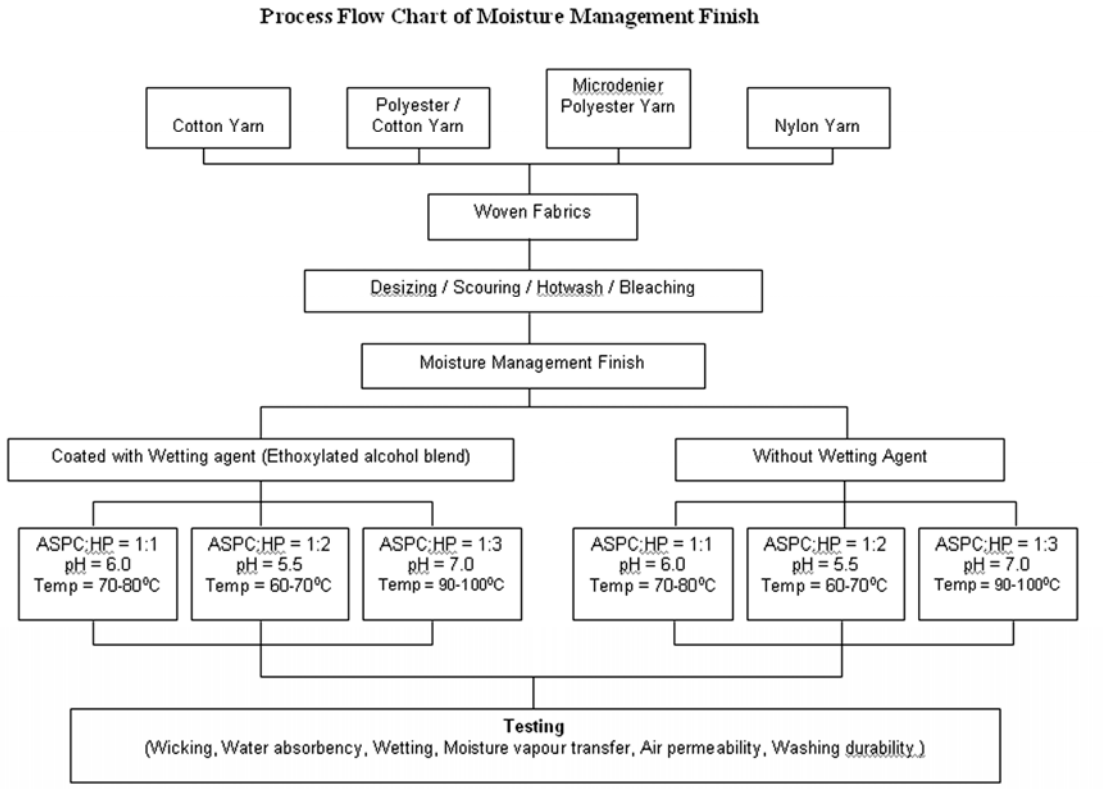
Key Words*: wetting, wicking, water absorbency, moisture vapour transfer, amino silicon polyether copolymer, hydrophilic polymer, ethoxylated alcohol, Microfibres.*

1. Introduction

Moisture management property is an important aspect of any fabric, which decides the comfort level of that fabric. Every human being sweats during different kinds of activities. An important feature of any fabric is how it transports this water out of the body surface and makes the feel comfortable. So moisture management can be defined as the controlled movement of water vapour and liquid water (perspiration) from the surface of the skin to the atmosphere through the fabric. Wetting, Wicking and Moisture Vapour Transmission properties are critical aspects of performance of products with moisture management finishes.

2. Methodology

Four types of yarns were taken as the raw materials which are made of Cotton, Microdenier polyester, Polyester/Cotton blend & Nylon. All the yarns were of the same count and twist. The four types of yarns were woven on power looms to produce fabrics with similar construction parameters.



Cotton & Polyester/Cotton blend fabrics were desized, scoured and bleached while Microdenier polyester & Nylon fabrics were hot washed and bleached. After the preparatory processes for four types of fabrics, the following two different techniques were adopted for the development of moisture management finish:

i) Moisture management finish with wetting agent (Newly developed using a synergetic blend of ethoxylated alcohol consisting of fatty alcohol, ethylene oxide and propylene oxide).
ii) Moisture management finish without wetting agent.

i) Moisture Management Finish with Wetting Agent:

The four fabric samples were first prewashed and coated with a wetting agent consisting of a synergetic blend of ethoxylated alcohol. (fatty alcohol, ethylene oxide and propylene oxide) at 2% concentration for half an hour at 60^0-70^0C temperature. Ethoxylated alcohol is a medium foaming, wetting and scouring agent, designed for the preparation of cotton, synthetic and blended fabrics.

After this wetting process the four variety of fabrics were cut to make three sets of samples. Each set of samples were treated for moisture management finish with different recipes. The first set of samples were treated with a chemical combination of Amino Silicon Polyether Copolymer (ASPC) and Hydrophilic Polymer (HP) in the ratio of 1 : 1 with a pH value of 6.0 at 70^0 - 80^0C temperature. The second set of samples were treated with a chemical combination of ASPC and HP in the ratio of 1: 2 with pH value of 5.5 at 60^0- 70^0 C temperature. The third set of samples were treated with a chemical combination of ASPC and HP in the ratio of 1 : 3 with pH value of 7.0 at 90^0 - 100^0 C temperature. Each set of samples were treated in the finishing bath for

20 minutes and padded using a padding mangle. The fabric samples were then dried in a hot air chamber.

Amino Silicon Polyether Copolymer (ASPC) is selected for its excellent water absorbency properties. It is normally added directly into the finishing bath and can be applied either by exhaustion or by padding. Similarly, Hydrophilic Polymer (HP) is added for its durability characteristics. When applied on polyester it forms a durable polymer film that interacts readily with water imparting a hydrophilic finish. This durable treatment inhibits formation of static charge, enhances wearer comfort drastically and improves wetting action of polyester.

ii) Moisture management finish without wetting agent:

In the second part of this research work of moisture management finish without wetting agent, the fabrics were taken and made into three sets of samples. These samples were directly treated for moisture management finish with the three different recipes as mentioned in the previous work.

4. Results & Discussion

4.1 Wicking - Vertical Wicking Test (BS 3424)

This property was measured by cutting 10 X 2 cm size of sample and dipped in water with the length of only 2 cm. After dipping that 2 cm in water, the time taken to raise the water spreading by the water capillary action was measured. In this method wick up action was observed by determining the rate of time at which the water moved upward on a strip of fabric suspended vertically with its lower ends dipping in to water solution.

Wicking property: Rate of Water Spreading Capillary Action (cm^2)
With Wetting Agent

Sample Name	**ASPC: HP 1:1/6.0/70.80**	**ASPC: HP 1:2/5.5/60-70**	**ASPC: HP 1:3/7.0/90-100**
Cotton	5.3	7.1	4.8
Polyester/Cotton	4.85	6.3	4.3
Microdenier Polyester	7.1	9.8	6.7
Nylon	0.1	0.3	0.1

Without Wetting Agent

Sample Name	**1:1/6.0/70-80**	**1:2/5.5/60-70**	**1:3/7.0/90-100**
Cotton	4.2	4.5	4.1
Polyester/Cotton	3.9	4.1	3.9
Microdenier Polyester	6.0	6.2	5.9
Nylon	nil	nil	nil

The general observation of Wicking results is that Microdenier polyester shows 30% higher wicking rate (ie) water drop spreading area is more than Cotton and Polyester/Cotton blend. Nylon fabric exhibits poor wicking. The same trend is shown by the samples of moisture management finish without the wetting agent. As for as the three recipes are concerned, ASPC and HP 1:2 gives 30% higher wicking rate than the other recipe samples. In both with and without wetting agent samples the same trend is observed. The fabrics coated with wetting agent gives 15% higher wicking results than the fabrics without wetting agent.

4.2 Water Absorbency (AATCC 79: 2000)

To measure the ability of the fabric to absorb water by spreading action, a 20 x 20 cm fabric was taken. A drop of water was allowed to fall on flat fabric surface. 60 sec time is kept constant for finding out water spreading area. The height of drop of water is controlled by a syringe, which contains 1ml of water. The absorption and spreading of water on any material increases when the resistances to water flow is low.

Water Absorbency: Area covered by water drop spreading (cm^2)

With Wetting Agent

Sample Name	**ASPC: HP 1:1/6.0/70.80**	**ASPC: HP 1:2/5.5/60-70**	**ASPC: HP 1:3/7.0/90-100**
Cotton	8sec	6sec	9sec
Polyester/Cotton	16sec	14sec	18sec
Microdenier Polyester	5sec	5sec	5sec
Nylon	8sec	6sec	9sec

Without Wetting Agent

Sample Name	1:1/6.0/70-80	1:2/5.5/60-70	1:3/7.0/90-100
Cotton	12sec	12sec	12sec
Polyester/Cotton	19sec	20sec	19sec
Microdenier Polyester	5sec	5sec	5sec
Nylon	Above 60sec	Above 60sec	Above 60sec

Water absorbency results show that Microdenier polyester exhibits 20 % faster water absorbency than Cotton. Polyester/Cotton blend takes three times higher than Microdenier polyester. As like wicking behavior, Microdenier polyester shows same results. Nylon showed very poor absorbency. In both with and without wetting agent samples the same trend is shown. Comparing the three recipes it can be seen that ASPC and HP 1:2 gives a 30% more absorbency followed by ASPC and HP 1:1 and ASPC and HP 1:3 respectively. In the samples without wetting agent there is no appreciable difference between the three recipes. In the fabrics coated with wetting agent, the absorbency is 60% more than the fabrics without wetting agent.

4.3 Wetting (Sinking Test)

This property was measured by cutting a sample of 3 X 3 cm and placing it on the surface layer of water. The time taken for the sample to wet completely is measured. The samples were dropped on the surface of distilled water from a standard height and the time taken to sink the specimen in water was noted.

Wetting Property (Sinking Test)
With Wetting Agent

Sample Name	ASPC: HP 1:1/6.0/70.80	ASPC: HP 1:2/5.5/60-70	ASPC: HP 1:3/7.0/90-100
Cotton	9 sec 46 ms	7 sec 2 ms	8 sec 77 ms
Polyester/Cotton	7 sec 35 ms	7 sec 4 ms	7 sec 45 ms
Microdenier Polyester	2sec71ms	2sec78ms	3sec20ms
Nylon	Above 120 sec	Above 120 sec	Above 120 Sec

Without Wetting Agent

Sample Name	**1:1/6.0/70-80**	**1:2/5.5/60-70**	**1:3/7.0/90-100**
Cotton	10sec17ms	4sec77ms	14sec23ms
Polyester/Cotton	13sec62ms	11sec22ms	13sec45ms
Microdenier Polyester	5sec	5sec	5sec
Nylon	Above 60sec	Above 60sec	Above 60sec

In the Wetting results it is observed that Microdenier polyester takes the least time to sink in water. The time taken to sink the samples specimen is two and five times more in case of Cotton & Polyester/Cotton blend respectively when compared to Microdenier polyester. Nylon takes an unduly long time to sink. A similar trend is seen in the fabrics without wetting agent also. Between the three recipes samples ASPC and HP 1:2 takes only half the time to sink than ASPC and HP 1:1 and ASPC and HP 1:3. The fabrics with wetting agent takes lesser time to sink than fabrics with out wetting agent.

4.4 Moisture Vapour Transfer (MVT) – Cup Method (ASTM E 96)

Reduction in the height of water in the cup

Water was poured into a cup upto 6cms from base level. The cups were marked for every half cm. The fabric samples were tied on top of the cup and kept in room temperature for 48 hrs. After 48 hrs the reduction n height of water was noted down. The moisture vapour transfer rate is the difference between the initial height of water and the actual height of water in the cup which is given as a percentage.

Moisture Vapour Transport – The Height of Water Reduction in Cup in percentage
With Wetting Agent

Sample Name	ASPC: HP 1:1/6.0/70.80	ASPC: HP 1:2/5.5/60-70	ASPC: HP 1:3/7.0/90-100
Cotton	3.33 %	4.16 %	3.33 %
Polyester/Cotton	3.33%	4.99%	3.33%
Microdenier Polyester	3.33%	4.99%	3.33%
Nylon	2.49%	3.33%	2.49%

Without Wetting Agent

Sample Name	1:1/6.0/70-80	1:2/5.5/60-70	1:3/7.0/90-100
Cotton	1.66%	2.49%	1.66%
Polyester/Cotton	2.49%	3.33%	2.49%
Microdenier Polyester	2.49%	3.33%	2.49%
Nylon	1.66%	1.66%	1.66%

As far as the height reduction is concerned Polyester/Cotton blend & Microdenier polyester shows same MVT rate and it is followed by Cotton & Nylon respectively. Among the three recipes, ASPC and HP 1:2 give 50% increase in height reduction than other recipes samples. ASPC and HP 1:1 and ASPC and HP 1:3 show similar readings. In the height reduction, both the fabrics with and without wetting agent, show more or less the same trend.

4.5 Air Permeability

The air permeability of a fabric is very sensitive indicator of the fabric construction and type of fibers and yarn used. There are several factors, which influence the air permeability among which are type of fabric, construction, bulk density, thickness, air porosity in the yarn etc.

Air Permeability Test (Cm^3 / S/ Cm^2)
With Wetting Agent

Sample Name	ASPC: HP 1:1/6.0/70.80	ASPC: HP 1:2/5.5/60-70	ASPC: HP 1:3/7.0/90-100
Cotton	20.25	20.15	20.10
Polyester/Cotton	21.15	21.20	21.25
Microdenier Polyester	20.75	20.80	20.75
Nylon	19.50	19.55	19.65

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Without Wetting Agent

Sample Name	1:1/6.0/70-80	1:2/5.5/60-70	1:3/7.0/90-100
Cotton	20.75	20.65	20.20
Polyester/Cotton	21.65	21.40	21.25
Microdenier Polyester	20.85	21.00	20.65
Nylon	19.60	19.65	19.45

The Air permeability results show that Polyester/Cotton blend is more air permeable. When compared to the other three fabrics Microdenier polyester show 2% marginal increase in air permeability than Cotton & Nylon. But the result is not significant. Comparing the three recipes samples, there is no appreciable difference in the readings between them. Both the fabrics, with and without wetting agent, has shown the same results.

4.6 Washing Durability (Reduction in wicking rate)

The Washing Durability was measured by the reduction in wicking rate for each set of samples twice (i.e.) after 5 washes & after 10 washes and the results are given as a percentage.

Washing Durability (Reduction in wicking rate given in percentage)
With Wetting Agent

	AFTER 5 WASH			AFTER 10 WASH		
	1:1/6.0/ 70- 80	1:2/5.5 /60-70	1:3/7.0/ 90-100	1:1/6.0/ 70- 80	1:2/5.5/ 60-70	1:3/7.0/ 90-100
Cotton	85%	87.4%	81%	79.25%	81.5%	76.90%
Polyester/ Cotton	55.7%	58. %	53.20%	45.37%	53.10%	44.30%
Microdenier Polyester	67%	70.30%	65.40%	59.16%	63.5%	57.90%
Nylon	--	--	--	--	- -	--

Without Wetting Agent

	AFTER 5 WASH			AFTER 10 WASH		
	1:1/6.0/ 70- 80	1:2/5.5/ 60-700	1:3/7.0/ 90-100	1:1/6.0/ 70- 80	1:2/5.5/ 60-700	1:3/7.0/ 90-100
Cotton	96.43%	95.10%	91.80%	92.86%	92.80%	91.70%
Polyester/ Cotton	56.50%	58.20%	54.60%	48.8%	52.10%	49.20%
Microdenier Polyester	66.70%	70.80%	63.20%	60%	61.20%	59.60%
Nylon	-	-	-	-	--	-

It is generally observed that, there is a reduction in wicking rate after 5 washes ranges from 12 -40% and this is significant. The reduction in wicking rate after 10 washes is between 5 – 7 % uniformly for all samples. The reduction in wicking rate is gradually increased after 5 & 10 washes consequently. This trend is same for all the samples. Among the three recipes, ASPC and HP 1:2 shows only 5 % higher durability followed by ASPC and HP 1:1 and ASPC and HP 1:3 respectively.

5. Conclusion

Based on the test results, Microdenier polyester fabric and Cotton fabric exhibits good in wicking, wetting and water absorbency characteristics than Polyester/Cotton blend and Nylon. Comparing the 3 different process parameters, it is found that the combination of ethoxylated alcohol blend (Wetting agent) and the recipe containing amino silicon polyether copolymer and hydrophilic polymer in the ratio of 1:2 with pH of 5.5 at 60^0 - 70^0C temperature is the optimum finishing process than the other two combinations so as to attain better comfort properties for sportswear.

6. References

1. G.R. Lomax, “The design of water proof, water vapour permeable fabrics” Journal of Coated Fabrics, Vol 15 – July 1985. Pg. 40-65.
2. Dr. Karl – Heinz Umbach, “Moisture Transport and wear comfort in microfibre fabrics”, Melliand English 2 / 1993. pg. E78-80.
3. Barbara pause, “Measuring the water vapour permeability of coated fabric and laminates “Journal of coated fabrics, Vol 25, April 1996. pg. 311-313.
4. Tzanro Tzanov, Rossitza Betchwa and Ivan Hardalov, “Thermophysiological comfort of silicone softeners – treated woven textile material”, International Journal of Clothing Science& Technology vol.11, No.4 Feb 1999, pg.189-190.
5. M. Hayakawa, “Engineering Comfort”, Asian Textile Journal, Nov 2001 pg. 38-39.
6. A.Patnaik, R.S. Rengasamy, V.K. Kothari and A. Ghosh, “Wetting and Wicking in Fibrous materials” Textile Progress, Vol. 38 No.1 2006. Pg.54 – 73.
7. A.Patnaik, R.S. Rengasamy, V.K. Kothari and A. Ghosh, “Wetting and Wicking in Fibrous materials” Textile Progress, Vol 38 No.1 2006. Pg.89-94.