INFLUENCE OF REPEATED WASHINGS ON THE MOISTURE VAPOUR PERMEABILITY OF WOVEN COTTON FABRIC

Dr. Devanand Uttam, Department of Textile Engineering, Giani Zail Singh Campus College of Engineering & Technology, Bathinda, Punjab, India

Rahul Sethi, Department of Textile Engineering, Rajiv Gandhi Govt. Polytechnic Education Society Narwana, Haryana, India

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Abstract: *Moisture vapor transfer is the ability of a fabric to transfer the perspiration in form of moisture vapor through it. A fabric with low moisture vapor transfer is unable to transfer sufficient moisture, leading to sweat accumulation and hence discomfort. Any fabric, in its useful life goes a number of washing cycles which may alter the fabric physical factors hence it may change moisture vapour transport property of the fabric. In this paper, the effect of repeated washings on moisture vapour permeability of woven fabric has been evaluated. The result reveals that moisture vapour permeability decreases after repeated washing.*

Key words: *Cover factor, fabric thickness moisture vapour permeability, shrinkage, fabric weight*

1. INTRODUCTION

Textile products are essential material that we use every day to obtain physiological and psychological comfort and, more fundamentally, to insure physical conditions around our body suitable for survival [1]. The thermo-physiological wear comfort is concerns the heat and moisture transport properties of clothing and the way that clothing helps to maintain the heat balance of the body during various levels of activity [1,2]. The impact of the repeated washings on dimensional stability, air permeability, insulation and water vapour permeability of a cotton woven fabric were studies in our previous work [3-5].

The water vapour permeability of fabric is a critical property for clothing systems that must maintain thermal equilibrium for the wearer. It is an important property for those used in clothing systems intended to be worn during vigorous activity. The human body cools itself by sweat production and evaporation during periods of high activity. The clothing must be able to remove this moisture in order to maintain comfort and reduce the degradation of thermal insulation caused by moisture build-up. This is an important factor in cold environments. A fabric of low moisture vapour permeability is unable to pass sufficient perspiration and this leads to sweat accumulation in the clothing and hence discomfort [3, 6].

Washing is required for many fabrics, but it alter the fabric dimensions; hence its fabric properties and performance. Depending upon the number of washing cycle, the change in fabric structure such as fabric shrinkage, thickness, cover factor and fabric weight change which result in the change in intensity of water vapour permeability of the fabric.

In this paper the effect of repeated washing on moisture vapour permeability of the plain woven cotton fabric has been accessed. This study provide useful information to consumer and they can choose better fabric. The findings are also useful to garment manufactures to produce desired product quality.

2. MATERIAL & METHOD

To study the impact of repeated washing, five fabric samples were prepared using 100% cotton yarn [Table 1]. They are processed for repeated wash at various stages such as 0 - wash, 4-wash, 8-wash, 12-wash and 16-wash cycles.

2.1 Material

For this study the J-34 type of cotton used for making the ring spun yarn. The parameter of yarn has given Table 1.

Table 1: Yarn parameters

Fibre type	Cotton
Varity of cotton	J-34 variety
Warp count (Ne)	$2/40^s$
Weft count (Ne)	20^s
Twist/ inch	Warp single = 26, Weft single = 18

As in practice, for making the fabric in small scale industry, the yarn in the hanks form firstly scoured, bleached, anti-chlorine and optical brightened. This yarn is used for production of woven fabric for sale in domestic market. This is cost effective process. The details recipes of scouring, bleaching, anti-chlorine and optical brightening treatments are given in the Table 2, Table 3, Table 4 and Table 5 respectively.

Table 2: Recipe & condition for scouring

HCL	5 cc/l
Material to liquor	1:20
Temp	27˚±1°C
Time	15 min

Table 3: Recipe & condition for bleaching

Bleaching powder ($CaOCl_2$)	7 g/l
pH (by caustic soda drops)	10.8 - 11
Wetting agent (Turkey red oil)	1g/l
Material to liquor	1:20
Temperature	27˚±1°C
Time	90 min

Table 4: Recipe & condition for anti-chlorite

Sodium hydro-sulphite	1g/l
Material to liquor	1:20
Temp	27˚± °C
Time	15 min

Table 5: Recipe & condition for **o**ptical brightening

Tinopol	0.50%
Material to liquor	1:20
Temp	27˚±°C
Time	5 min

Making Fabric

The plain woven fabric has been prepared in Cimco Over Pick Power Loom for shirting fabrics using processed yarn (scoured, bleached, anti-chlorine and optical brightened). The loom width is 44”. In this loom, the weft is inserted through shuttle at the rate of 140 picks per minute. Fabric constructional particular are given in Table 6.

Table 6: Fabric constructional particulars

Fabric	100% Cotton
Weave	Plain
Ends/inch	52
Picks/inch	48

Preparation of washed samples

For the study, five fabric samples were prepared by processing the fabric samples at various number of washing cycles: 0-wash (Sample–A), 4-wash (Sample–B), 8-wash (Sample–C), 12-

wash(Sample–D) & 16-wash (Table-E). The fabrics were washed at 27°C in Semi Automatic Washing Machine using 0.75 g/l solution of non-ionic detergent (96% concentration) and material to liquor ratio was kept as 1:40. One washing cycle completes in 12 minutes. Fabrics were washed, rinsed in clean water. Water is extracted by drier and samples were dried in sun light.

2.2 Test Method

These 5-fabric samples are fist conditioned in standard atmospheric condition and tested for following fabric parameters and properties:

EPI and PPI of the samples were assessed visually by using a pick glass according to the (IS: 1963-81) standard test method [7]. Fabric cover factor was evaluated by Peirce formula [8] expressed as: $Fabric\ cover\ factor(K_c) = K_1 + K_2 - \frac{K_1 \times K_2}{28}$

Where, K_1 = Warp cover factor,

K_2 = Weft cover factor

The Kawabata Evaluation System was used for fabric thickness determination [9] at 0.5 g-f/cm^2 pressure. Fabric weight was measured by Kawabata Evaluation System [10] and expressed as mg/cm^2.

Dimension stability was measured according to the BS 4931 Standard Test Method for preparation, marking and measuring of textile fabrics, garments and fabric assemblies in tests for assessing dimensional change [11].

The Moisture vapor transmission was measured using water dish method (ASTM E 96/E 96M-05) [12]. It is denoted in metric units as grams of weight change per day per square meter of fabric (g/m^2/day). The fabric was sealed over a cylindrical cup containing distilled water and the rate of evaporation was measured under an ambient temperature and relative humidity at 50 ± 2 %. Moisture wapour permeability was calculated using the following formula:

$$WVP = \frac{24\ x\ M}{A\ x\ t}\ g/m^2/day$$

Where, M - loss in mass(g)

A -Internal area of dish (m^2)

T = time (h)

STASTICA-6 software was used for analyzing the data.

3. RESULTS AND DISCUSSION

The effect of repeated washing on water vapour permeability of woven fabric was analyzed of 5 samples, A (0 wash), B (4 wash), C (8 wash), D (12 wash) and E (16 wash). The water vapor permeability was measured using ASTM E 96/E 96M-05 Standard Test Methods. It was denoted in metric units as grams of weight change per day per square meter of fabric ($g/m^2/day$). The fabric was sealed over a cylindrical cup containing distilled water and the rate of evaporation was measured under an ambient temperature and relative humidity at 50 ± 2 %. The result of moisture vapour transmission and fabric factors are given in the Table 8.

Table 8: Moisture vapour transmission in relation to number. of wash cycle and fabric factors

Sample code	No of wash cycle	Fabric Factors				Moisture Vapour Transmission [$g/m^2/day$]
		Fabric Cover Factor	Fabric Thickness at pressure 0.5 g-f/cm² in [mm]	Fabric Weight [mg/cm²]	Fabric Shrinkage [cm²]	
A	0 wash	17.90	0.857	12.168	0.00	1522.50
B	4 wash	18.29	0.921	13.74	23.28	1466.27
C	8 wash	18.29	0.924	13.80	25.28	1444.32
D	12 wash	18.57	0.926	13.88	27.52	1386.74
E	16 wash	18.95	0.928	14.05	28.37	1371.02

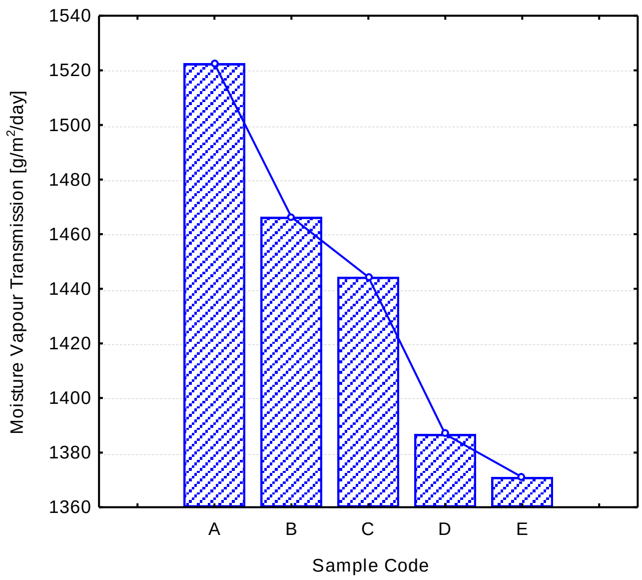

Fig 1 Change in Moisture vapour transmission after repeated washing

Table 8 & Fig 1 show moisture vapour transmission decrease with the number of repeated washing. A significant difference existed in moisture vapor transmission among without washed and washed samples. Further in subsequent washing stages significant difference was found in the washed samples C, D and E washed after 8 cycles, 12 cycles, and 16 cycles. The moisture vapor transmission values of test specimens were abruptly decreased.

Table 9: Correlation(R) of water vapour permeability with fabric factors

Factors	Correlation(R) of Water vapour permeability with fabric factor
Cover Factor	-0.96
Fabric Thickness	-0.82
Fabric Weight	-0.85
Fabric Shrinkage	-0.86

3.1 Effect of fabric cover factor on moisture vapour transmission

A graph has been plotted showing the relationship between moisture vapour transmission & fabric cover factor (Fig 2).

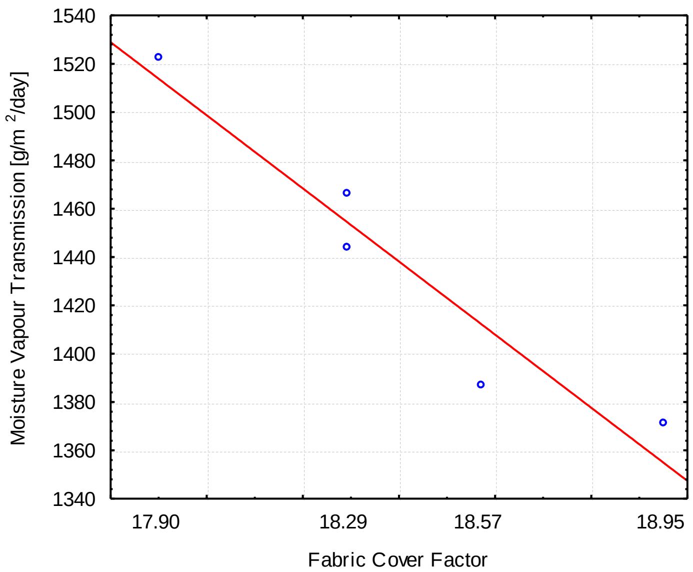

Fig 2 Contour plot of Fabric Cover Factor Vs Moisture Vapour Transmission

It is clear from Fig 2 that water vapour permeability reduces as fabric cover factor increases. This is ascribed to the fact that as fabric cover factor increases open spaces in fabric reduce which diminish diffusivity of the fabric samples.

The water vapour permeability of the fabrics has very good correlation (R= -0.96) with fabric cover factor which was showing in Table 9.

3.2 Effect of fabric thickness on moisture vapour transmission

A contour plot has been drawn showing the relation of moisture vapour transmission with fabric thickness (Fig 3).

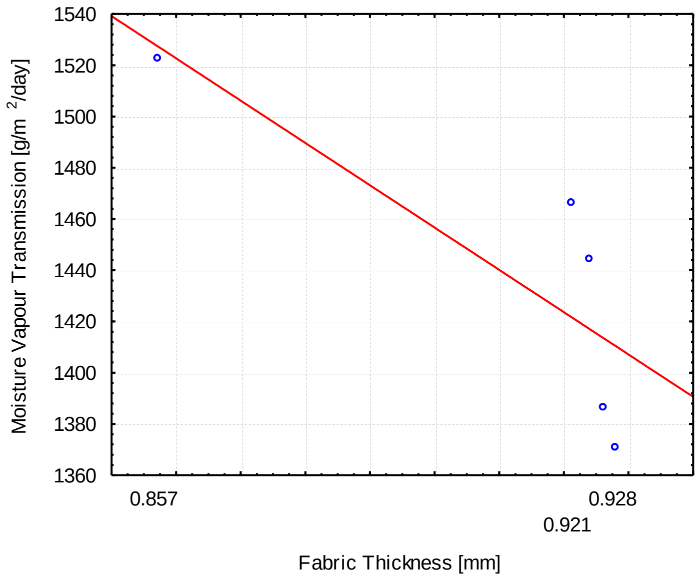

Fig 3 Contour plot of Fabric Thickness Vs Moisture Vapour Transmission

It has been found [Fig 3] that with increase of fabric thickness, moisture vapour permeability value to be decrease. This is due to increase in the length of the water vapour permeability path as the thickness increases.

The water vapour permeability of the fabrics has good correlation (R= -0.82) with fabric thickness [Table 9].

3.3 Effect of fabric weight on moisture vapour transmission

The relation between moisture vapour transmission and fabric weight is shown in the Fig 4.

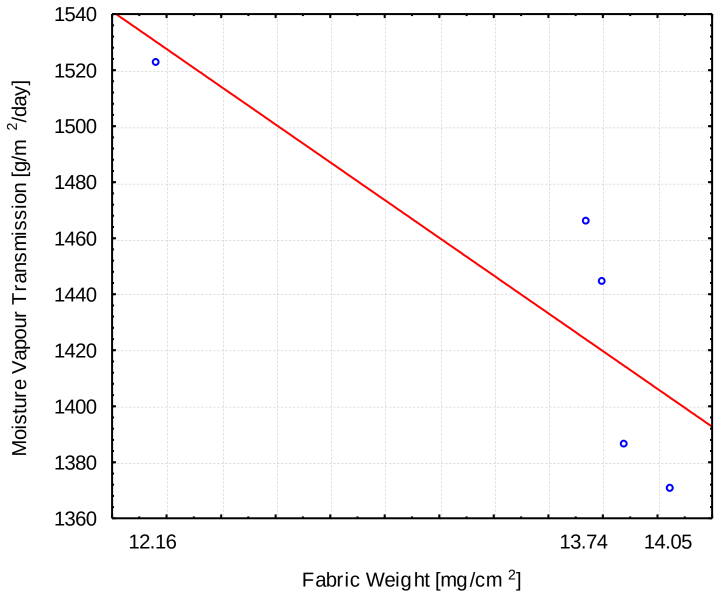

Fig 4 Contour plot of Fabric Weight Vs Moisture Vapour Transmission

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It has been observed from the above Fig 4 that with the increase of Fabric weight together with the lesser porosity of the fabric samples are thought to have contributed more strongly to the decreased water vapour transmission.

The water vapour permeability of the fabrics has very good correlation (R= -0.85) with fabric weight showing Table 9.

3.4 Effect of fabric shrinkage on moisture vapour transmission

A contour plot has been drawn showing the relation of moisture vapour transmission with fabric shrinkage (Fig 5).

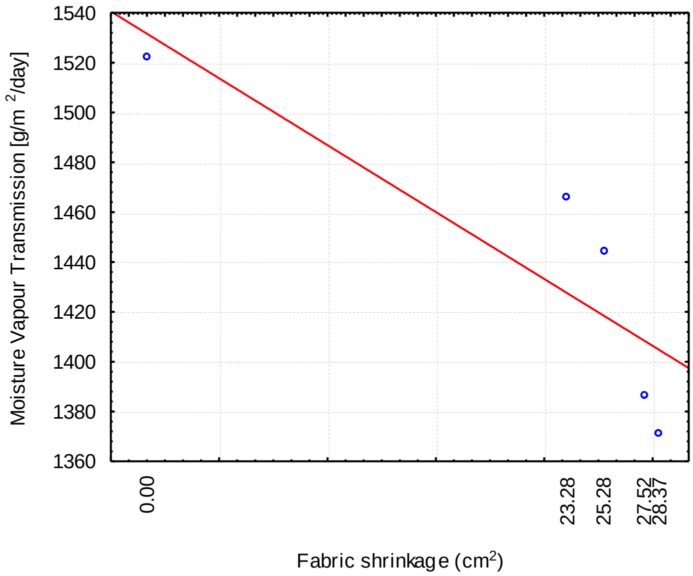

Fig 5 Contour plot of Fabric shrinkage Vs Moisture Vapour Transmission

It has been observed from the above Fig 5 that with the increase of Fabric shrinkage, water vapour permeability value gradually decrease which may be due to the increase of cover factor and reduction in inter-yarn porosity.

The water vapour permeability of the fabrics has very good correlation (R= -0.86) with fabric shrinkage [Table 9].

4. CONCLUSION

Results shows that the moisture vapour transmission values decreases after repeated washing which may be due less void spaces in the fabric after repeated washing. The fabric thickness was also the cause of less water vapour transmission. There are good correlation has been found between moisture vapour transmission and fabric cover factor (R= -96), fabric thickness (R= -82), fabric weight (R= -85) & fabric shrinkage (R= -86).

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