

# **RESPONSE OF THERMOPHYSIOLOGICAL COMFORT PROPERTIES OF POLYESTER – MODAL BLENDED FABRIC TO CHEMICAL FINISHING**

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## **Abstract**

The present study has been undertaken to identify and analyze the response of air and moisture transmission properties of fabric woven with air-jet spun polyester – modal blended yarn (as weft) to chemical finishing. In this study, the fabrics of three different blends are treated with different concentration of anti-crease resin (DMDHEU) and softening agent (modified silicon). The concentration of anti-crease finishing agent and softener used for chemical treatment are decided based on Box and Behnken design of experiment. Mathematical models (in the form of regression equations) have been developed to predict the thermophysiological comfort parameters using SYSTAT 13 statistical package. It was observed that under all experimental conditions, the moisture transmission, absorbency and air permeability of grey fabric reduces after finishing at all blend levels. Moisture transmission properties and air permeability of finished fabric is negatively influenced by the concentration of silicon softener. The concentration of resin does not influence the air permeability of the fabric, but it improves the moisture vapour permeability marginally, though it is not statistically significant. The wicking power is increased with increase in polyester component and resin concentration; however the latter does not have, unlike softener, any significant influence of total absorbency of fabric.

## **Introduction**

Moisture transmission through textile, which is carried out through perspiration both in vapour and liquid form, has a great influence on the thermophysiological comfort of the human body. The clothing to be worn should allow this perspiration to be transferred to the atmosphere otherwise it will result in discomfort to the wearer. If moisture transfer rate through clothing is slow during sweating, relative and absolute humidity level of the clothing microclimate will increase, suppressing the evaporation of sweat. Further, it is also important to reduce degradation of thermal insulation caused by the moisture built up. Thus both in hot and cold weather and during normal and high activity levels, moisture transmission through fabrics both in sensible (liquid) and insensible (vapour) form play a major role in ensuring thermophysiological comfort of the wearer. Besides moisture transmission properties, air permeability also affects the comfort properties of clothing. Too high air permeability per unit area of a fabric gives lowers the protection against winds especially for outer wear garments, while too low air permeability affects body perspiration. Apart from transmission properties of air and moisture, absorbency of fabric is also significant. The ability of liquid water absorbency of the material determines how much liquid water can be absorbed by the clothing material from the skin. The perception of dampness will be higher when the moisture is held as free liquid, rather than an internally absorbed [1]. Hence, a low absorbent fabric will feel damper than the higher one at same percentage of excess moisture. Therefore, for a particular end-use it is necessary to select fabrics with appropriate air and moisture transmission and water absorbency characteristics. In the course of time, considerable efforts have been made

in identifying the key factors and their effects on thermophysiological comfort of fabric. It is obvious that the composition of textile materials in combination with several other factors like yarn structure or fabric constructional parameters greatly influence thermophysiological comfort of the fabric. The subject is further complicated by the type of the finish applied. The application of the finish, both mechanical and chemical, is quite common for imparting desirable characteristics, including look, feel and tailorability to the fabric. The finish applied to the fabric modifies the surface as well as morphological structure of the textile and hence is expected to affect the transmission properties of the fabric. Though a number of studies have been carried out to investigate the effect of fibre profile, yarn structure and fabric constructional parameters on the transmission properties of fabric, very few systematic studies have been carried out on the effect of chemical finish usually applied to the fabric. Furthermore, whatever studies carried out in this direction mostly focus on polyester, cotton, viscose and their blends. The availability of literature on blends of high wet modulus regenerated cellulose fibre is limited. Hence, the present study has been undertaken to identify and analyze the response of air and moisture transmission properties of fabric woven with polyester – modal blended yarn in varying proportions to chemical finishing.

## 1 Material and Method

### 1.1 Materials

Murata Jet Spun (MJS) yarn and ring yarn spun from blends of polyester and modal fibres. The specification of polyester and modal fibres used in the study is given in Table 1.

**Tab. 1:** *Specifications polyester and modal fibre*

<b>Fibre Characteristics</b>	<b>Polyester</b>	<b>Modal</b>
<b>Staple Length (mm)</b>	44	44
<b>Fineness (Denier )</b>	1.4	1.2

*Source: Own*

### 1.2 Preparation of samples

#### 1.2.1 Preparation of yarn sample

A predetermined quantity (depending on the required blend percentage mentioned in Table 2 of hand opened polyester and modal fibre were mixed (stack blending ) and opened again in the blender. The opened material is hand fed to carding. Two draw frame passage including one with auto leveler as finisher (RSB-851 drawframe) is given to prepare drawn sliver which is used for spinning two ply warp yarn (ring spun) and the same sliver is given additional passage to adjust the hank for Murata Jet Spun (MJS) yarn which is used as weft.

**Tab. 2:** Experimental plan for preparation of fabric sample to study the effect of finishing on polyester modal fabric of different blend percentage

Sample code	Details of fabric sample preparation		
Sample Ref no	Polyester content (%)	Concentration of resin (gpl)	Concentration of softener (gpl)
F1	35	60	20
F2	35	100	20
F3	65	60	20
F4	65	100	20
F5	35	80	10
F6	35	80	30
F7	65	80	10
F8	65	80	30
F9	50	60	10
F10	50	60	30
F11	50	100	10
F12	50	100	30
F13	50	80	20
F14	50	80	20
F15	50	80	20

Source: Own

### 1.3 Fabric sample preparation

The fabric samples for this project are woven in a non-automatic sample loom. The warp and weft used in all the fabric samples are 2/40s Ne. and 30sNe respectively. For all the fabric samples the blend composition of warp and weft are kept identical. The other constructional parameters e.g. weave, ends and picks per cm) are given below.

Ends /cm: 32      Picks/cm: 28      Construction: 3/1 twill

#### 1.3.1 Finishing of fabric

In order to study the effect of finishing on moisture transport properties, the fabrics of three different blends are treated with different concentration of anti-crease finishing agents and softener. The concentration of anti-crease finishing agent and softener used for chemical treatment for different blends are decided based on Box and Behnken design of experiments. The actual values of three variable (e.g. blends and concentration of softener and anti-crease resin used in the study corresponding to the coded levels are given in the Table I. The process flowchart for chemical finishing is shown below.

### 1.3.1.1. Process sequence of finishing

Grey fabric → washing with non ionic detergent → drying → heat setting in stenter (at 2000c ) → finishing with softener and anti-crease finishing agent (varying concentration of anti-crease resin and softener) in stenter, following pad – dry – cure method as suggested by the supplier of the chemicals.

### 1.3.1.2. Application of finish to the fabrics

The fabric is padded with required amount as mentioned in the experimental plan (given in Table 2) of Cresotex – ULFC (low formaldehyde content DMDHEU resin) along with Ceraperm K M (modified silicone softener) at pH of 4 at 65% wet pick up. The treated fabric is dried and subsequently cured at 1600 C in a stenter at a speed of 20m/min.

## 1.4 Test methods

Fabric properties

### 1.4.1 Air permeability

Air permeability of fabric was measured in SDL Air Permeability Tester in accordance with IS 11056-1984 standard. Ten specimens with area 508 mm<sup>2</sup> (25.4 mm diameter) were tested for each sample to determine the mean value.

### 1.4.2 Moisture Vapour Permeability

Moisture vapour transmission rate of fabric was measured in SDL Moisture vapour permeability tester in accordance with ASTM: E-96-05 standard. Ten specimens were tested for each sample to determine the mean value in gm/m<sup>2</sup>/24 hrs.

### 1.4.3 Vertical Wicking

Vertical wicking test is carried out in accordance with the standard BS 3424 method 21 (1973). In this test a strip of fabric (25 cm x 2 cm) was suspended vertically with its lower edge in a reservoir of distilled water. The rate of rise of the leading edge of the water was then measured. To detect the position of the water head blue ink was added to the water. The measured height of rise in 30 minutes is taken as a direct indication of the wickability of the test fabrics. Ten specimens from each sample were taken to determine the mean wicking height. The same procedure was repeated also for weft direction.

### 1.4.4 Total absorbency

Total absorbency of water was measured by a static immersion test as mentioned in BS 3449. In this method four specimens, each 80 mm x 80 mm, were conditioned, weighed and then they were immersed in distilled water for 20 minutes to a depth of 10cm using a wire stick. The samples were taken out and the excess water was removed. Then they were transferred directly to pre-weighed airtight containers and weighed again. The absorbency of fabric was calculated and the weight of water absorbed expressed as a percentage of the dry weight of the fabric.

$$\text{Water absorbency in \%} = (B - A) / A \times 100 \quad (1)$$

Where, A = specimen weight before immersion (g) and B = specimen weight after immersion (g)

## **1.5 Analysis of the test results**

Response of moisture transport properties of polyester- modal blended fabrics at different blend levels to finishing treatment (combination of anti-crease resin and softener at varying levels) is analyzed by employing Design of Experiment as proposed by Box-Behnken. Mathematical models (in form of regression equations) have been developed to predict the value of dependent variables using SYSTAT 13 statistical package. The corresponding significant tests of model equations were carried out on the basis of correlation coefficient (R), coefficient of determination (R<sup>2</sup>), standard error. For visualization of the interaction effect, response surface graph were plotted taking two independent variables at a time (keeping the third variable at centre level). For Response surface Plot statistical software package SIGMAPLOT version 12 was employed.

## **2 Results and discussions**

Results of the experiments and their statistical analysis for test significance to assess the effect of various independent variables (e.g. polyester content in the blend, concentration of resin and softener) in isolation and their interactions on the response variable are presented in Table 3, 4, and Table 5 respectively. Response surface equations for the dependent variables are given in the Table 6.

**Tab. 3:** Thermophysiological comfort properties of polyester modal blended fabrics after chemical finishing

Code No.	Air Permeability (cc/sec/cm <sup>2</sup> )	Moisture Vapor Permeability (gm/m <sup>2</sup> /day)	Wicking height (mm)		Total Absorbency (%)
			Warp Way	Weft Way	
F1	24.85 (33.67)*	1,535.00 (1610)	49 (99)	46 (71)	168.6 (247.2)
F2	25.56	1,556.00	62	57	166.87
F3	27.87 (36.76)	1,410.00 (1496)	54 (107)	51 (87)	147.6 (214.8)
F4	26.78	1,435.00	65	60	142.7
F5	32.45	1,562.00	66	62	189.5
F6	23.21	1,512.00	42	37	136.8
F7	33.76	1,410.00	64	58	157.5
F8	23.55	1,395.00	44	40	133.7
F9	31.22 (34.23)	1,485.00 (1554)	59 (104)	53 (79)	167.4 (233.1)
F10	24.61	1,457.00	44	41	138.6
F11	32.89	1,479.00	67	59	185.6
F12	22.65	1,430.00	58	56	137.8
F13	26.54	1,443.00	62	57	146.0
F14	25.97	1,446.00	64	62	147.5
F15	26.15	1,449.00	61	58	149.5

\*Values within the parenthesis indicate the value of that particular parameter of the corresponding heat set blended fabric before application of the chemical finish.

Source: Own

**Tab. 4:** Thermophysiological comfort properties of polyester modal blended fabrics after chemical finishing

Code No.	Thermal Conductivity (W/m/K)	Thermal Resistance (m <sup>2</sup> K/W)	Thermal Absorptivity (Ws <sup>1/2</sup> m <sup>2</sup> K <sup>-1</sup> )
F1	40.3 (43.2)	28.4 (25.8)	0.127 (0.148)
F2	40.6	28.3	0.129
F3	41.7 (43.4)	27.6 (26.7)	0.138 (0.146)
F4	40.2	28.7	0.128
F5	41.4	27.5	0.136
F6	41.3	27.1	0.140
F7	41.3	27.9	0.139
F8	40.7	27.7	0.126
F9	39.8 (43.7)	29,3 (25.9)	0.125 (0.148)
F10	40.9	28.2	0.127
F11	42.2	26.8	0.143
F12	41.8	27.0	0.139
F13	40.8	28.8	0.128
F14	39.4	28.9	0.126
F15	39.8	28.6	0.128

\* Values within the parenthesis indicate the value of that particular parameter of the corresponding heat set blended fabric before application of the chemical finish.

Source: Own

**Tab. 5:** ANOVA test results for significance testing

<b>Factor</b> <b>Properties</b>	<b>Air permeability</b>	<b>Moisture vapour Permeability</b>	<b>Wicking height (warp)</b>	<b>Wicking height (weft)</b>	<b>Total absorbency</b>
Polyester% (A)	s	s	s	S	s
Conc. of Resin (B)	ns	s	s	s	ns
Conc. of softener (C)	s	s	s	s	s
A*A	ns	ns	ns	ns	ns
B*B	ns	ns	s	s	ns
C*C	s	ns	s	s	s
A*B	S	ns	s	s	ns
B*C	ns	ns	ns	ns	ns
A*C	ns	ns	ns	ns	ns

*s* – Significant at 95% confidence level; *ns* – Not significant at 95% confidence level

Source: Own



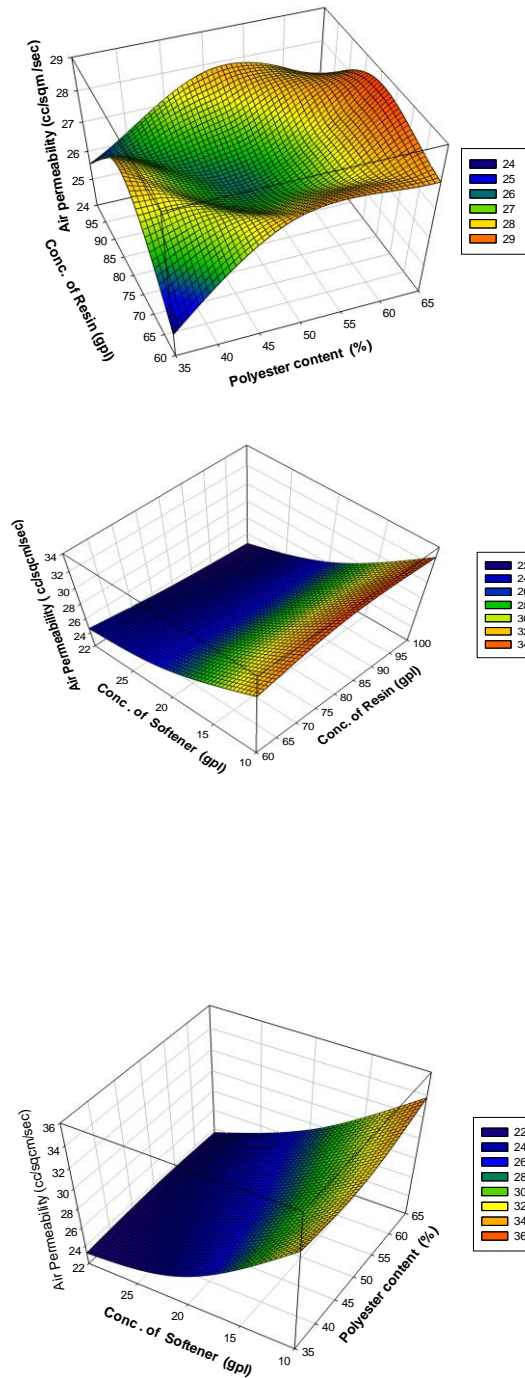
**Tab. 6:** Response surface equation for thermophysiological comfort properties of polyester-modal fabric to blend composition, *R* and *S* concentration

Properties	Response surface equation	R	R <sup>2</sup>	R <sup>2</sup> <sub>adj</sub>	S.E.
Air permeability (cc/sec/cm <sup>2</sup> )	$25.131 - 0.103 P - 0.233 R - 730S + 0.001 P * P + 0.001 R * R + 0.018 S * S - 0.001 P * R - 0.005 R * \text{SOFTENER} - 0.002 P * S$	0.995	0.990	0.972	55.672
Moisture vapour permeability (gm/m <sup>2</sup> /day)	$2222.250 - 15.725 P - 5.760 R - 3.092 S + 0.100 P * P + 0.039 R * R + 0.012 S * S - 0.003 P * R - 0.026 R * S + 0.058 P * S$	0.989	0.978	0.938	13.283
Vertical wicking height (mm) (warp way)	$-10.852 + 1.807 P - 0.587 R - 0.017 S - 0.017 P * P - 0.002 R * R - 0.044 S * S - 0.002 P * R + 0.007 R * S + 0.007 P * S$	0.969	0.940	0.831	3.554
Vertical wicking height (mm) (weft way)	$-16.139 + 1.847 P + 0.615 R - 0.008 S - 0.019 P * P - 0.003 R * R - 0.055 S * S - 0.002 P * R + 0.011 R * S + 0.012 P * S$	0.934	0.873	0.643	4.945
Total absorbency (%)	$355.068 - 2.710 P + 0.015 R - 0.038 S + 0.013 P * P - 0.015 R * R - 0.038 S * S - 0.003 P * R - 0.024 R * S + 0.048 P * S$	0.989	0.979	0.941	4.267
Thermal Conductivity	No correlation could be observed among the dependent and independent variables				
Thermal Resistance					
Thermal Absorptivity					

Source: Own

## 2.1 Air permeability

The response of air permeability of finished fabric to the polyester content, resin and softener concentration is shown in the Figure 1 to Figure 4. High value of  $R^2_{\text{adjusted}}$  shows that the regression model for air permeability correlates well with the variable. ANOVA results for the regression model (Table 5) shows that the significant factors that affect the air permeability are concentration of the softener and polyester content. It can be seen from the response surface plot that air permeability is negatively influenced by softener concentration. This may be because of the fact that the softener molecules develop a smooth micro film over the (macro emulsion) yarn surface [2] which reduces the permeability of the fabric. Further, it can be seen that for given concentration of softener air permeability increases with increase in polyester content. This might be because of the fact that polyester fibres due to circular cross section and low intrinsic flexural rigidity can pack closely in the yarn leading to reduction in diameter [3]. Thus inter-yarn space increases which causes more air to pass. However, this effect is offset at higher concentration of softener due to more deposition of micro layer over the fabric.



Source: Own

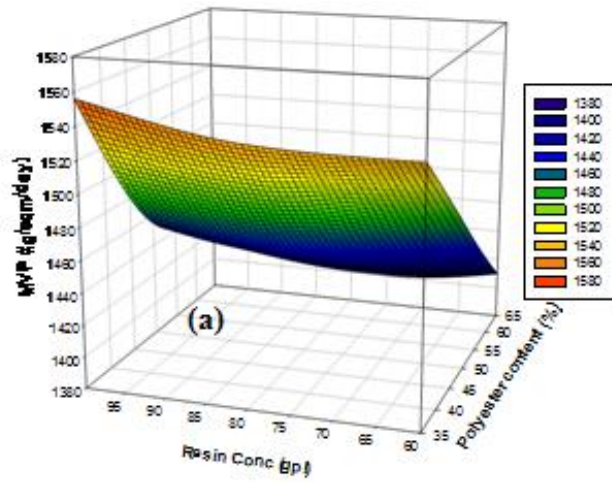
**Fig. 1:** Effect of Polyester content, concentration of softener and resin on air permeability of finished polyester- modal blended fabric

## 2.2 Moisture vapour permeability

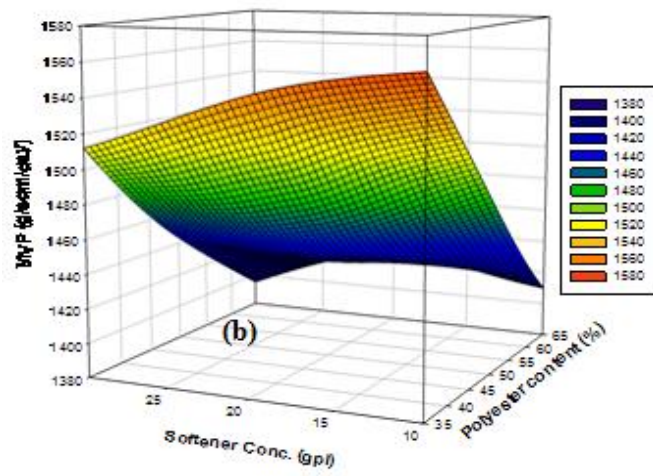
The response moisture vapour permeability (MVP) of finished fabric to the polyester content, resin and softener concentration is shown in the figure. High value of  $R^2$  and  $R^2_{\text{adjusted}}$  and the negligible difference between them confirms that the good correlation between the dependent and independent variables and the proposed regression model is significant at 95% confidence level. It is evident that moisture vapour permeability of finished fabric reduces with the increase in polyester content and concentration of softener. This behavior can be explained by

the moisture vapour transmission mechanism which takes place by diffusion and sorption-desorption [4]. Water vapour diffuses through a textile structure in two ways, simple diffusion through the air spaces between the fibers and yarns and along the fiber itself [4]. For a given construction of fabric the diffusion rate along the textile material depends on the water vapour diffusivity of the fiber, which increases with the increase in moisture regain [5]. So as the modal fibre proportion in the blended fabric increases (i.e. polyester portion reduces), moisture regain of the material increases causing higher diffusivity. With the increase in the modal component in the fabrics, more amount of moisture is absorbed in the fibrous structure and then distributed for evaporation over a wider area rather than liquefying locally in one region [6]. In the same way moisture transfer through sorption-desorption process will increase with the hygroscopicity of the material. A hygroscopic fabric has a better ability to absorb water vapour from the humid microclimate and release it in dry air. This enhances the flow of water vapour from the microclimate to the environment in comparison with a fabric which absorbs less water vapour and reduces the moisture built up in the microclimate.

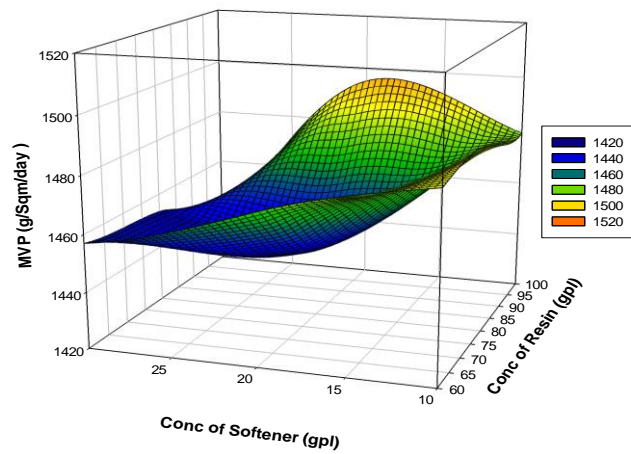
It can be seen from the response surface plot that presences of softener significantly reduce the moisture vapour permeability in all cases irrespective of level of other variables. The methyl groups of the  $\text{OSi}(\text{CH}_3)_2$ - structure shield the oxygen atoms from outside contact. Therefore, the surface of fibres finished with polydimethylsiloxane is mostly non-polar and hydrophobic [2]. In the case of cellulosic fibres, there are strong hydrogen bonds between the hydroxyl group present in the fibres and modified di-methyl silicone. These bonds act as an anchor for the silicone, which forms an evenly distributed film on the fibre surface and hence results in hydrophobic surface [2]. This prevents building up of moisture concentration and reduces moisture vapour permeability. Moisture vapour permeability is lowest at high polyester content and softener concentration which is quite evident from the above discussions. The response surface plot reveals that there is marginal though significant increase in moisture vapour permeability with increase in concentration of resin. This may be attributed to the fact that the application of resin (durable press finishes) increases the pore volume in the fibrous strand [7] leading to more diffusion of water vapour through the interfibre spaces within the yarn. However, in all the cases the moisture vapour permeability of the fabric is lower as against the grey stage irrespective of concentration of softener and resin used in the study. This is attributed to surface deposition of softener on the yarn surface suppress the effect of other variables.



(a)



(b)



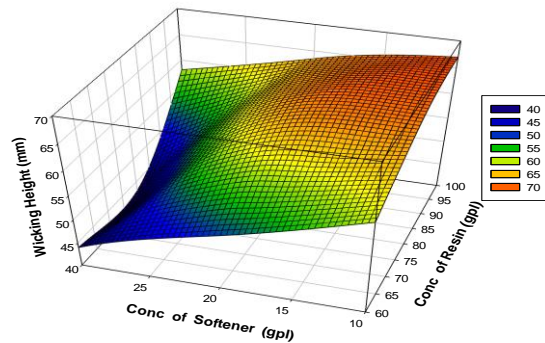
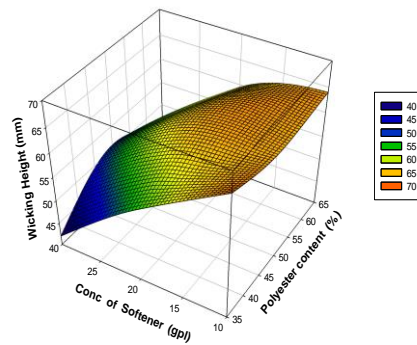
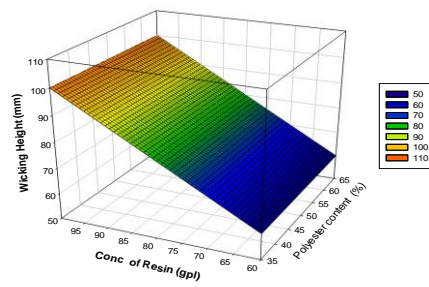
(c)

Source: Own

**Fig. 2:** Effect of Polyester content, conc. of softener and resin on moisture vapour permeability of finished polyester – modal blended fabrics

### 2.3 Wicking height

The response of warp and weft way wicking height of finished fabric to the polyester content, resin and softener concentration is shown in the figure. The wicking of the fabric in warp and weft behaves in the similar way except the fact that wicking height of the former is always higher. This is undoubtedly because of two ply and coarse yarn used in warp which favours wicking. High value of  $R^2$  and  $R^2_{\text{adjusted}}$  and the negligible difference between them confirms that the good correlation between the dependent and independent variables and the proposed regression model is significant at 95% confidence level. It can be seen that wicking height reduces with increase in softener concentration. This is expected as the softener form a hydrophobic layer on to the surface of yarn which increases the time of wetting and causes delayed wicking. The increase in concentration of resin results in the increase in pore volume. Further, the hydroxyls groups of cellulose present in modal component reacts with the resin and are thus unavailable to interact with water when water moves up along the capillary. This might be the reason for increased wicking height at higher concentration. Presence of increased amount of hydrophobic fibre component favours wicking as it does not form bonds with water molecules [8], though the effect is much less pronounced after finishing. This might be because of the fact that after finishing the hydroxyl groups in modal fibres already form cross link with resin molecules. The water molecule after wetting the fabric dragged very smoothly and enhances the wicking phenomena.



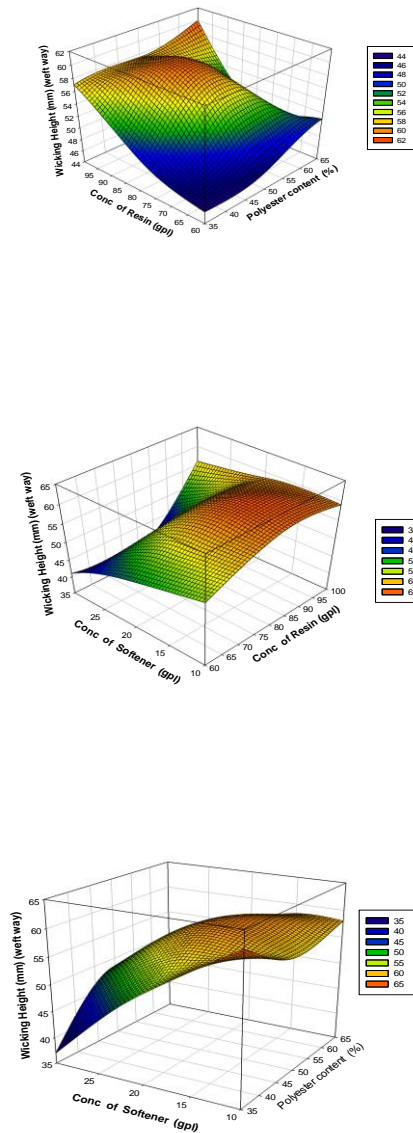
Source: Own

**Fig. 3:** Effect of polyester content , conc. of resin and softener on wicking height (warp way) of polyester – modal blended fabric

## 2.4 Total absorbency

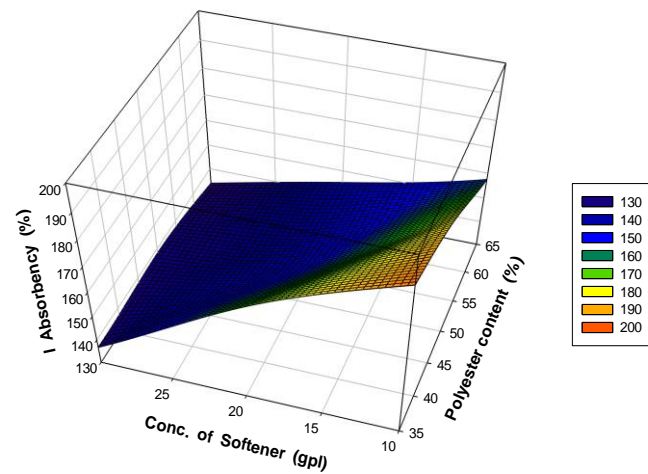
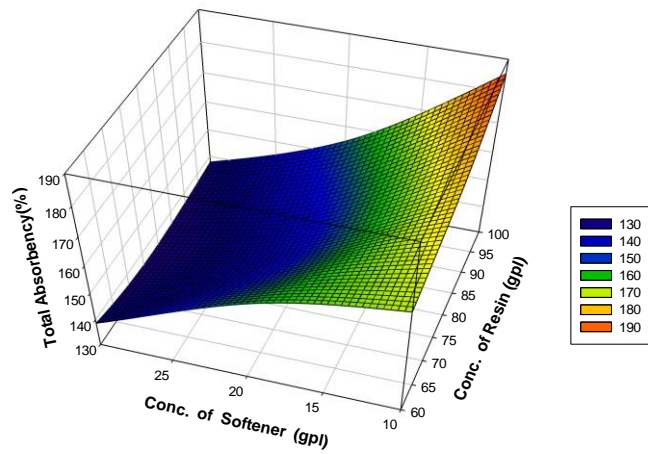
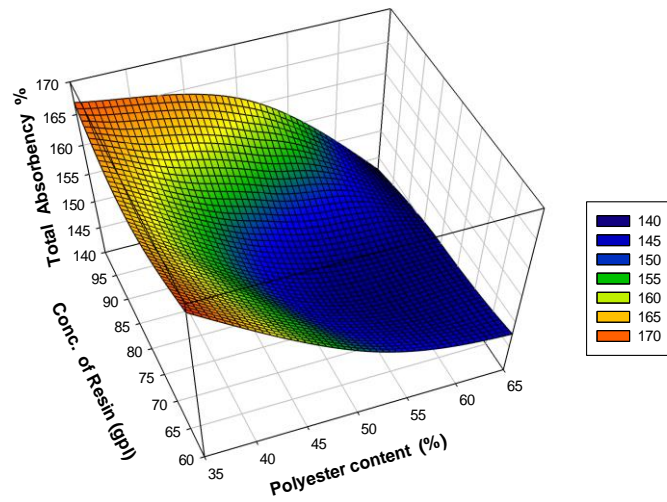
Regression analysis shows that the variables that influence the total absorbency of the fabric are polyester content in the fabric and softener concentration. Both of them negatively influence the total absorbency of the fabric. Absorbency as determined by the static method

indicates the water retaining capacity of the fabric which is in turns governed by the construction of fabric and the presence of hydrophilic group in the material. As the fabric constructional parameter remains the same in all cases, the increase in hydrophobic polyester content steadily decreases the absorbency of the fabric. Further, it can be seen that absorbency reduces with an increase in softener concentration. This is expected as the softener forms a hydrophobic layer on to the surface of yarn which increases the resistance of water takes up.



Source: Own

**Fig. 4:** Effect of polyester content, conc of resin and softener on wicking height (weft way) of finished polyester – modal blended fabric



Source: Own

**Fig. 5:** Effect of polyester content, concentration of resin and softener on absorbency of finished polyester modal blended fabric



## 2.5 Thermal properties of the finished fabrics

It can be seen that irrespective of blend and concentration of finishing ingredients (e.g. resin and softener) there is an increase in thermal conductivity and absorbency and increase in thermal resistance. However, no definite trend could be observed with respect to the concentration of resin and silicon softener. This may attributed to the fact that variation of the concentration of finishing agent does not bring about any major change in construction of the fabric. Decrease in thermal conductivity of the fabric after finishing may be explained considering the fact that there is resistance to transfer heat from the body to the surrounding air as the sum of three parameters, these being (i) the thermal resistance or conductivity to transfer of heat from the surface of the material (ii) the thermal resistance or conductivity of the clothing material and (iii) the thermal resistance of the air in the inner layer. After finishing, thermal conductivity of clothing material is found to be reduced as it becomes less permeable to air. Further, thermal resistance value as measured by Alambeta increases after finishing as the thickness measured by Alameta increases marginally.

Another parameter measured in the same instrument, is thermal absorptivity, a determinant of the ‘warm-cool feeling’ of textiles which measures the contact temperature of two bodies, found to decrease after finishing. Thermal absorptivity is a surface property and it is a measure of the heat flow  $q$  ( $W/m^2$ ) which passes between the human skin and the contacting textile fabric. It is directly proportional to conductivity; the lower the value of conductivity, the lower the value of thermal absorptivity. Thus the fabrics after chemical finishing become warmer to touch.

### Conclusion

All the moisture transmission properties (both in form of liquid water and vapour) and air permeability of finished fabric are negatively influenced by the concentration of silicon softener. Air permeability is reduced because of the formation of a film over the surface of the fibre and yarn which cause obstruction to the passage of air where moisture transmission and absorption properties are affected because of the hydrophobic character of softener and development film over the surface which reduces the rate of diffusion through the pores.

The concentration of resin does not influence the air permeability of the fabric, but it improves the moisture vapour permeability, the improvement, though marginal, is significant irrespective of blend percentages.

The water absorbing capacity of fabric is invariably reduced with the increase in both polyester and softener concentration. But the same remains unchanged with the increase in resin concentration.

The wicking power is increased with the increase in polyester component and resin concentration. The resin forms bond with the hydroxyl groups of modal fibre and prevents them from interfering at the time of the rise of water column through the capillary.

Under all experimental conditions the moisture transmission (both wicking and moisture vapour permeability), absorbency and air permeability of grey fabric reduces after finishing at all blends levels. Irrespective of blend and concentration of finishing ingredients (e.g. resin and softener) there is an increase in thermal conductivity and absorptivity and an increase in thermal resistance. However, no definite trend could be observed.

Unlike softener, resin does not have any significant influence on total absorbency of fabric.

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## ODEZVA VZDUCHU A PAROPROPUSTNOST TKANINY UTKANÉ ZE VZDUCHEM PŘEDENÉHO POLYESTERU

Přenos vlhkosti přes textil, který probíhá prostřednictvím potu, a to jak párou, tak v tekuté formě, má velký vliv na termofyziologický komfort lidského těla. Kromě samotných vlastností paropropustnosti také ovlivňuje komfort oděvů. Aplikace povrchové úpravy, a to jak mechanickou, tak chemickou cestou, běžně dodává textilnímu materiálu žádoucí vlastnosti, včetně jejího vzhledu, omaku a možnosti dalšího zpracování. Povrchová úprava aplikovaná na textilní materiál upravuje její povrch, stejně jako morfologickou strukturu textilie, a proto se očekává, že bude mít vliv na přenosové vlastnosti látky. Záměrem této studie bylo identifikovat a analyzovat odezvu vzduchu a paropropustnost tkaniny utkané ze vzduchem předeného polyesteru – modálních směsových přízí (v útku) s chemickými dokončovacími pracemi. V této studii je popsáno, jak jsou látky ze tří různých směsí ošetřovány různou koncentrací nemačkovací pryskyřice (DMDHEU) a změkčovadla (upravený křemík). Koncentrace prostředku proti mačkání a aviváže používaných pro účely chemického ošetření je určována na základě experimentálního designu Box a Behnken. Matematické modely (ve formě regresních rovnic) byly vyvinuty s cílem předvídat termofyziologický komfort pomocí parametrů statistického balíčku Systat 13. Bylo zjištěno, že za všech experimentálních podmínek přenosu vlhkosti se savost a prodyšnost šedé tkaniny snižuje po ukončení na všech úrovních prolnutí. Přenos vlhkosti a prodyšnost hotové textilie jsou negativně ovlivněny koncentrací křemičitého změkčovače. Koncentrace pryskyřice nemá vliv na prodyšnost tkaniny, ale částečně zlepšuje paropropustnost, i když statisticky nevýznamně. Odvod energie se zvyšuje s nárůstem polyesterové složky a koncentrace pryskyřice, ten však nemá na rozdíl od změkčovače žádný významný vliv na celkovou nasákavost tkaniny.

## DIE REAKTION DER LUFT UND DIE VERDUNSTUNGSDURCHLÄSSIGKEIT VON GEWEBEN AUS MIT LUFT GESPONNENEM POLYESTER

Die Übertragung von Feuchtigkeit über Textilien, die sowohl als Ausdunstung als auch in flüssiger Form über den Schweiß verläuft, hat einen großen Einfluss den thermophysiologischen Komfort des menschlichen Körpers. Außer den eigentlichen Eigenschaften der Verdunstungsdurchlässigkeit beeinflusst er ebenso den Komfort der Kleidung. Die Anwendung der Oberflächenbearbeitung, und zwar sowohl der mechanischen als auch der chemischen, verleiht dem Textilmaterial in der Regel die erforderlichen Eigenschaften, inklusive des Aussehens, des Tastgefühls und der Möglichkeit weiterer Verarbeitung. Das Ziel dieser Studie bestand darin, die Reaktion der Luft und die Verdunstungsdurchlässigkeit des aus mit Luft gesponnenem Polyester gewobenen Stoffes zu identifizieren und zu analysieren. In dieser Studie wird beschrieben, wie Stoffe aus drei verschiedenen Mischungen mit einer unterschiedlichen Konzentration aus knitterfestem Harz (DMDHEU) und einem Weichmacher behandelt werden. Die Konzentration des Mittels gegen Knittern und die Avivage, die für Zwecke der chemischen Behandlung Verwendung finden, wird auf Grundlage des experimentellen Designs Box und Behnken bestimmt. Die mathematischen Modelle (in Form von Regressionsgleichungen) wurden mit dem Ziel entwickelt, den thermophysiologischen Komfort mit Hilfe der Parameter des statistischen Pakets Systat 13 vorherzubestimmen. Dabei wurde festgestellt, dass unter sämtlichen experimentellen Bedingungen der Feuchtigkeitsübertragung die Saugfähigkeit und die Luftdurchlässigkeit des grauen Gewebes auf allen Durchdringungsebenen gesenkt werden. Die Feuchtigkeitsübertragung und die Luftdurchlässigkeit fertiger Textilien werden durch die Konzentration eines quarzigen Enthärter in negativer Weise beeinflusst. Die

Harzkonzentration hat keinerlei Auswirkung auf die Luftdurchlässigkeit des Gewebes, verbessert aber teilweise die Verdunstungsdurchlässigkeit, wenn auch statistisch in unbedeutendem Maße. Die Ableitung von Energie erhöht sich mit dem Anstieg der Polyesteranteile und der Harzkonzentration. Dieser Anstieg hat jedoch im Unterschied zum Enthärter keinen bedeutenden Einfluss auf die Wasseraufnahmefähigkeit des Gewebes.

#### RUCH POWIETRZA A PAROPRZEPUSZCZALNOŚĆ TKANINY WYKONANEJ Z PRZĘDZY POLIESTROWEJ TEKSTUROWANEJ POWIETRZEM

Przepuszczanie wilgoci przez tkaninę, które zachodzi poprzez pot, zarówno w formie pary, jak i w postaci ciekłej, ma duży wpływ na termofizjologiczny komfort ciała człowieka. Pomijając właściwości jako takie, paroprzepuszczalność wpływa także na komfort ubrań. Zastosowanie odpowiedniego wykończenia, zarówno mechanicznego, jak i chemicznego, nadaje tkaninie pożądane właściwości, w tym wygląd, cechy odczuwane w dotyku oraz możliwości dalszego przetworzenia. Wykończenie warstwy wierzchniej tkaniny zmienia jej powierzchnię oraz strukturę morfologiczną i dlatego zakłada się, że będzie miało wpływ na przepuszczalne właściwości tkaniny. Celem przeprowadzonych badań było zidentyfikowanie oraz przeanalizowanie ruchu powietrza oraz paroprzepuszczalności tkaniny z przędzy poliestrowej teksturowanej powietrzem – modalnej przędzy mieszkankowej (w wątku) z chemicznym wykończeniem. W opracowaniu opisano, w jaki sposób tkaniny z trzech różnych mieszanek pielęgnowane są różnymi stężeniami niemnącej żywicy (DMDHEU) oraz zmiękczacza (wzbogacony krzem). Stężenie środka zapobiegającego gnieniu i płynu do płukania tkanin stosowanych do celów chemicznej pielęgnacji określane jest na podstawie eksperymentalnego planu Boxa-Behnkena. Modele matematyczne (w formie równań regresji) opracowano w celu prognozowania termofizjologicznego komfortu przy pomocy parametrów pakietu statystycznego Systat 13. Stwierdzono, że we wszystkich warunkach eksperymentalnych przenoszenia wilgoci chłonność i przewiewność szarej tkaniny zmniejsza się po zakończeniu na wszystkich poziomach przenikania. Na przenoszenie wilgoci i przewiewność gotowej tkaniny negatywnie wpływa stężenie krzemowego zmiękczacza. Stężenie żywicy nie ma wpływu na przewiewność tkaniny, ale częściowo poprawia paroprzepuszczalność, chociaż pod względem statystycznym w sposób nieistotny. Odprowadzanie energii zwiększa się wraz ze wzrostem składnika poliestrowego oraz stężenia żywicy, nie ma o jednak w odróżnieniu od zmiękczacza żadnego istotnego wpływu na ogólną wsiąkliwość tkaniny.