The Comfort Properties of the Terry Towels Made of Cotton and Polypropylene Yarns

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ABSTRACT

Studies of woven fabric comfort properties have aroused the interest of researchers in recent years. Although studies on the structures of woven terry fabrics are rather limited, the study of the comfort properties these fabrics will reveal new approaches regarding the subject. The terry-structured fabrics, used in bathroom, pool, sea, sauna and Turkish bath, hold an important place in people's personal lives as end-products.

The methods of identifying and improving the comfort properties of the terry-woven fabric structure are discussed in this study. In the process of sample production, the towels were made on a loom and standard finishing techniques were applied.

Cotton and polypropylene yarns were used in this study, and the properties of woven towel fabrics with alternative weaving constructions were measured and analyzed.

The comfort parameters of the gray and finished fabrics such as air-permeability, velocity of water absorption, and vapor permeability were measured under standard laboratory conditions and the obtained data were evaluated statistically.

At the end of the experimental studies, the data from the terry fabrics which were made of different yarns and different structures were evaluated in order to identify the fabric and yarn parameters which will lead to the best comfort. The experimental results show that the use of the polypropylene fibers for the yarns in high-pile fabrics and the use of the cotton yarn in ground yarns have tend to provide the best comfort.

Keywords: Terry towel, comfort, cotton, polypropylene, moisture sensation.

INTRODUCTION

Towels are the most used textile structures in water-related usage of terry-woven fabrics. The users prefer that ready-made bathrobes and towels be comfortable and fresh, made of a light and soft structure, remain dry as they quickly transfer the water and sweat accumulated on the body, and be hygienic and naturally formed. Therefore comfort, an important property for the textile products, is also an important need for terry fabrics in water-related usage. However, the comfort properties of terry fabrics such as towels should be specific. The comfort parameters of air permeability, water vapor permeability, liquid transfer velocity, drying time, and water absorption will stand out in such products.

In terms of up to date theoretical studies, the most convenient fiber type and fabric construction are identified in this paper, and the experimental study with, certain changes, will provide a guide for the piled-products group.

Cotton (CO) and polypropylene (PP) fibers were chosen in this study. And in that choice, the previous studies have been the guide. Cotton is the most important of the natural cellulosic fibers. It still accounts for about 50% of the total fiber production of the world. Cotton is almost pure cellulose. As many as 10,000 repeating an-hydro glucose units are found in the polymeric cellulosic chains of cotton [4]. The high crystallinity and associative forces between chains in cotton result in a moderately strong fiber having a tenacity of 2-5 g/d (18-45 g/tex) [1]. The hydroxyl groups of cotton possess great affinity for water, and the moisture regain of cotton is 7-9% under standard conditions. At 100% relative humidity, cotton has 25-30% moisture absorbency [1]. The average fiber fineness is 1.8 dtex, the dry breaking strength is 24-28 cN/tex, the dry breaking elongation is 7-9%, the wet breaking resistance is 25-30 cN/tex, the wet breaking elongation is 12-14%, the polymerization degree is 2000-3000 and the water retention value is 45-55% of the weight of the cotton fibers [2]. Cotton has excellent hand, and the drapability of cotton fabrics is quite acceptable. Fabrics of cotton are of sat is factory appearance and have a low luster unless mercerized or resin finished [1]. The cotton fibers are selected in this study because of their superior characteristics of water absorption, higher wet breaking strength, dyeing affinity, washability and post-weaving softness.

The properties of the PP fibers for use in products such as towel, bathrobe, and waist cloth in terms of comfort are their hydrophobic structures and ability of fast moisture transfer [3]. These properties are considered as convenient for use for pile warp in the terry fabric. The PP fibers have ~65 cN/tex resistance, 17-20% breaking elongation, and research has revealed that these figures remain the same in both wet and dry conditions [4]. PP fibers have elastic recovery and continual elongation properties under load; when elongated 2% for 30 seconds they have a 91% elastic recovery; and when elongated 2% for 3 minutes an elastic recovery of 82% [5]. They have the lowest density within the textile fibers (0.90-0.92 g/cm^3) [4]. Their abrasion resistance is good; because of a lesser pilling property. Since PP is synthetic, it does not have the allergic impact that natural fibers cause to some people. Its water absorption rate is less than 0.05% but its capacity of liquid transfer is high; it has the property of water transfer for the capillarity effect via easy movement of water within the fibers [6]. Its thermal heat absorption capability is high. Nonetheless, its thermal conductivity is better than cotton and other natural fibers [7]. Its softening point is 155ºC and its melting point is 165ºC [8]. PP fiber water vapor permeability is considerably high compared to the other fibers [9]. It is rather affordable and is easy to be processed [5]. Polypropylene has found a number of applications particularly in home furnishings and industrial fabrics; uses include indoor-outdoor carpeting, carpet backing, upholstery fabrics, seat covers, webbing for chairs, nonwovens, laundry bags, hosiery and knitwear (particularly as a blended fiber), fishnet, rope, filters, and industrial fabrics [16].

Comfort is a complex concept that involves many physical, psychological and physiological factors [10]. It can be defined as the feeling of pleasure deriving from the physical, psychological and physiological harmony between the body and the environment [11]. It is a neutral situation independent from pain and discomfort [12].

It is the so-called micro-climate air layer in-between the human skin and the cloth that determines the person's feeling of comfort. Micro-climate is affected by environmental factors, a person's activity level, and fabric properties [13].

The improvement of the comfort can only be provided by changing the fabric properties, because the micro-climate, the environmental conditions, and the person's physical, psychological and physiological moods cannot be intervened. Normally the fabric is in the form of layers. The inner layer which touches the skin is for comfort and support; and the outer layer is for warmth and protection against negative conditions.

For better comfort, it is necessary for the fabric system to have some comfort parameters. The basic parameters include heat and moisture transfer, air permeability, heat retention capability, and electrification tendency [14].

Besides these parameters; the comfort parameters change in accordance with the usage, purpose, and environment of the towels and bathrobes. These include water, vapor, and air permeability; moisture permeability; and water absorption; no feeling of wetness; drying period; liquid transfer velocity; and being non-allergic, soft handling.

In environments like bath and Turkish bath, where comfort probably is most sought, the lightness of towels and particularly bathrobes, their providing of a dryness feeling via quick absorption and transfer of water, breathing so as to not leave the body without air, and not causing allergic results are rather important. In this context, identifying a construction that meets these measures will also serve as a guide to new approaches.

MATERIALS AND METHOD

The comfort parameters of the terry-woven structures in accordance with their usage fields have been identified and in consideration of researched literature the weaving constructions have been arranged and the comfort properties have been examined.

Yarns

All towels were made from Ne 24/2 carded cotton yarn in the ground warp; Ne 16/1 carded cotton yarn in the ground weft; and cotton and Ne 20/2 PP yarns that produced from staple fibers in the pile. The properties of materials are given in *Table I*. All of the towels were produced with a pile /ground ratio 46 and 60 (low pile-high pile), 17 picks/cm weft density and 12 ends/cm warp density. Pile/ground ratio is practically described as the length of pile warp per a 10 cm length of fabric in the warp direction.

TABLE I. Specification of samples used in the experiments.

Parameters	CO Ground Warp	CO Ground Weft	CO Pile	PP Pile
Fiber Fineness (mic)	4.75	4.69	4.81	17.11
Fiber Length (mm)	28.5	28.1	28.6	29.1
Yarn Count (Ne)	24/2	16/1	20/2	20/2
Yarn Twist Coeff. (α_e)	4.27	4.22	3.91	3.95

Towel Weaving

While the yarn counts, ground yarns, warp, weft and pile yarn densities were kept constant for the samples being produced for this work, the factors such as the pile/ ground rate (pile length), fiber types, blending rates (installation position of the yarns) and the final shape of the fabric (gray or finished) were modified. The samples were prepared by considering their variable properties and were classified and evaluated by their characteristics.

All of the fabrics were woven with the same weaving design. The design used in the fabrics is shown in *Figure 2.1*.

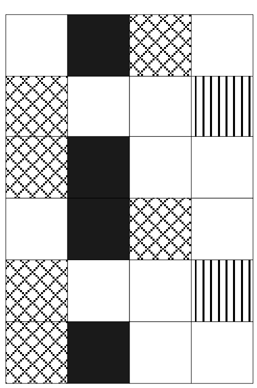


FIGURE 2.1. The weaving design used in the samples.
G: Ground warp; F: Face pile warp; B: Back pile warp

In this study, the number of woven samples was 24 and contained 5 basic and 2 special constructions. In the basic constructions, 20 samples were produced with low/high pile length and gray/dyed. The pile formation in the basic construction is shown in *Figure 2.2*. However, as shown in *Figure 2.3 and 2.4,* in special constructions 4 samples were produced in one group with high pile yarns and the other with low pile yarns in both gray and dyed forms. A dyed form means that finishing processes were applied to the samples. The sample properties used in the trials are shown in *Table II*.

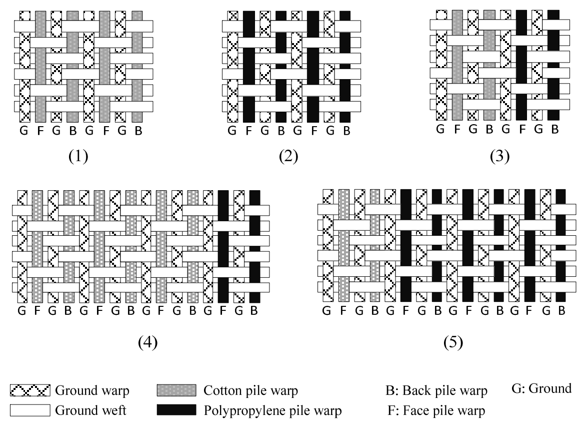


FIGURE 2.2. The pile warp formation in the basic construction.

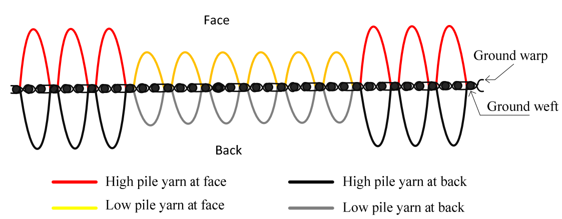


FIGURE 2.3. The pile warp formation in the special constructions (side view).

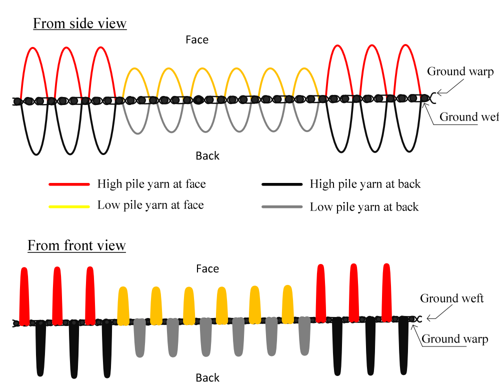


FIGURE 2.4. The pile warp formation in the special constructions.

Loom and Finishing Process

The samples were woven in Pignone TPS 600 dobby type towel weaving machines. The machine width was 360 cm with 4 pile frames having 8 weft insertion, 8 ground frames and 2 leno weaving frames with 16 frames.

The bleaching process applied to cotton towels was used in towel samples in order to have repetitive towels like those selling in the market. No finishing process was applied for the PP yarns. The fabrics were treated with optical bleaching in the overflow machines.

Test Method

Air permeability tests were made with TEXTTEST FX 3300 air permeability test equipment. According to ISO 9237 test standards, the test pressure for the normal fabrics is 100 Pa, the applied 20 cm2 test area and the measuring unit is mm/s.

Water vapor permeability test was made with M261 Shirley water vapor permeability test equipment. The test was made in accordance with ISO 15496 test standards. The measuring unit is $g/m^2/24h$.

The measuring of the velocity of soaking of textile fabrics in respect of water –also called the increasing level or liquid transfer velocity- was made in accordance with DIN 53924 standards under laboratory conditions which are 20±2 ^{0}C and 65% relative humidity. The measurements were reported within in 60 seconds measurement time in both warp and weft directions.

Statistical Analysis

During the statistical evaluating of the experimental results, SPSS (Statistical Package for the Social Sciences) for Windows statistical analysis program was used. In order to determine how any parameter change affects the results and whether this change was important or not, One-Way ANOVA (Analysis of Variance) and correlation evaluations were made.

In order to deduce whether the parameters were significant, p values were examined. As known, if the ‘p’ value of a parameter is greater than 0.05 ($p>0.05$), the parameter will not be significant and should be ignored.

TABLE II. Specification of samples used in the experiments.

Code	The raw materials for pile yarn	Pile Warp Pattern	Pile Height (Ratio of pile/ground warp)	Finishing
1	% 100 CO	CO	LOW	NONE
2	% 100 CO	CO	HIGH	NONE
3	% 100 CO	CO	LOW	APPLIED
4	% 100 CO	CO	HIGH	APLLIED
5	% 75 CO % 25 PP	3 CO 1 PP	LOW	NONE
6	% 75 CO % 25 PP	3 CO 1 PP	HIGH	NONE
7	% 75 CO % 25 PP	3 CO 1 PP	LOW	APPLIED
8	% 75 CO % 25 PP	3 CO 1 PP	HIGH	APPLIED
9	% 50 CO % 50 PP	1 C0 1 PP	LOW	NONE
10	% 50 CO % 50 PP	1 C0 1 PP	HIGH	NONE
11	% 50 CO % 50 PP	1 C0 1 PP	LOW	APPLIED
12	% 50 CO % 50 PP	1 C0 1 PP	HIGH	APPLIED
13	% 25 CO % 75 PP	1 CO 3 PP	LOW	NONE
14	% 25 CO % 75 PP	1 CO 3 PP	HIGH	NONE
15	% 25 CO % 75 PP	1 CO 3 PP	LOW	APPLIED
16	% 25 CO % 75 PP	1 CO 3 PP	HIGH	APPLIED
17	% 100 PP	PP	LOW	NONE
18	% 100 PP	PP	HIGH	NONE
19	% 100 PP	PP	LOW	APPLIED
20	% 100 PP	PP	HIGH	APPLIED
21	% 50 CO % 50 PP	6 CO 6 PP	6 HIGH (PP) 6 LOW (CO)	NONE
22	% 50 CO % 50 PP	6 CO 6 PP	6 HIGH (PP) 6 LOW (CO)	APPLIED
23	% 50 CO % 50 PP	CO/PP	6 HIGH 6 LOW	NONE
24	% 50 CO % 50 PP	CO/PP	6 HIGH 6 LOW	APPLIED

(CO: Cotton fibers, PP: polypropylene fiber, Low pile height= 46cm, High pile height= 60 cm)

* Not specified percentages of pile warp yarn by weight, specified percentages of it by the number of pile warp yarns.

RESULTS

Air permeability, water vapor permeability and water soaking velocity tests were made on the samples and the results are shown in *Table III*. Each test result was analyzed in the basis of pile height, CO-PP rate, finishing treatments and the effects of pile weaving structure. The results of variance analysis are given in *Table IV*.

TABLE III. Results obtained from tests of air permeability, water vapor permeability and velocity of water absorption.

Code	Air Permeability (mm/s)	Water Vapor Permeability ($g/m^2/24h$)	Velocity of Water Absorption in Weft Direction (mm/60s)	Velocity of Water Absorption in Warp Direction (mm/60s)
1	716,6	618	5,3	4,7
2	627,2	555,9	6,3	5,3
3	232,8	541,1	46	50,0
4	214,6	541,1	47,3	50,0
5	760,6	819	5,7	34,3
6	687,2	1034,9	8,3	31,0
7	247,8	597,3	43,3	47,0
8	242,8	550	45	48,3
9	788,4	810,2	9,3	36,3
10	713,4	1073,3	13,7	31,3
11	255,2	600,2	44,3	49,3
12	244,4	567,7	48,7	50,7
13	767,4	1460,6	15,3	37,0
14	703,6	1555,3	21,	35,7
15	246,6	597,3	43,73	47,3
16	239,8	570,7	46,73	50,3
17	787,6	1620,3	25,7	37,7
18	718,4	1744,5	34	36,0
19	270,6	591,4	43,0	47,0
20	246,8	561,8	45,7	49,3
21	550,4	610,9	26,0	32,7
22	194,4	470,13	47,0	45,3
23	563,8	405,1	29,0	22,7
24	256	600,23	41,3	40,3

TABLE IV. The p values of the variance analysis.

Parameter	Air Permeability	Water Vapor Permeability	Velocity of Water Absorption
Pile Height	0,006*	0,175	**0,062**
PP Rate	0,000*	0,001*	**0,000***
Finishing	0,012*	0,009*	**0,039***
Type of Weave	**0,023***	**0,014***	**0,846**

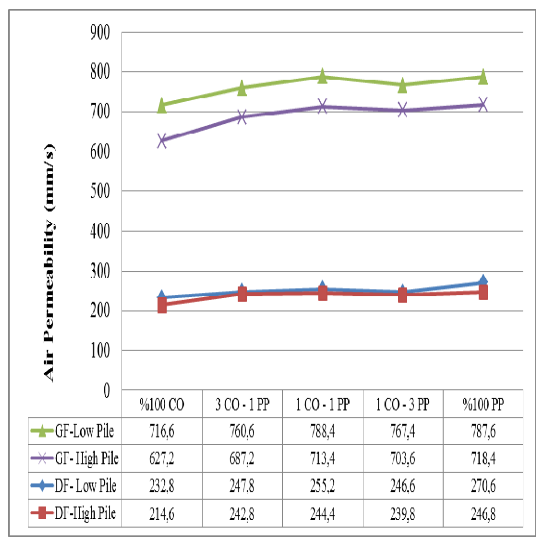
*statistically significant according to α= 0, 05.

Air Permeability

The movement of the air through the fabric thickness considerably influences of the final usage performance parameters such as the wind resistance of the product that will be made out of this fabric, water vapor permeability and filtering property.

The results in terms of the effect of pile height on air permeability show that an increase in pile height causes a decrease in air permeability rate and this decrease is important statistically. The reason of the decrease of air permeability derives from that the amount of the volume that the air can pass through in the high pile fabrics is less than low pile fabrics. Furthermore, the increase of the air with in the piles functions as a factor of isolation.

When the effect of PP rate on air permeability was studied, the results revealed that the increase of PP rate leads an increase in air permeability as seen *Figure 3.1*. This increase is considered to be important statistically.



* GF = **G**ray **F**abric, DF = **D**yed **F**abric

FIGURE 3.1. Values of air permeability of samples with different rates of PP.

This situation can be explained by the fact that the density of the PP fibers is less than the CO fiber density and thus PP fiber's causing more volume. Because the most important factor that affects air permeability is related with the fabric volume through which air passes.

Depending on the reverse proportion between the volume and the density, as the density of the fiber in the same bulk, the volume of it will decrease. Thus the PP fiber with low density will compose more volume than CO fiber and the air permeability will be higher.

When taking the effect of finishing on the air permeability into consideration, it is seen that the bleaching and optical bleaching of the cotton towels decreases the air permeability of the fabric. It is reported that this decrease is important statistically.

After this treatment, CO fibers release from lubricants, waxes and contamination. But the bleaching process provides a more compact structure to the fabric. With a more tight structure the volume that air can pass through decrease and the air permeability value decreases as well.

The effect of pile weaving structure on the air permeability were studied with "special construction 1" towels' air permeability values with 6 high pile PP yarn, 6 low CO pile yarn and "special construction 2" with 6 high pile, 6 low pile CO/PP blends, respectively.

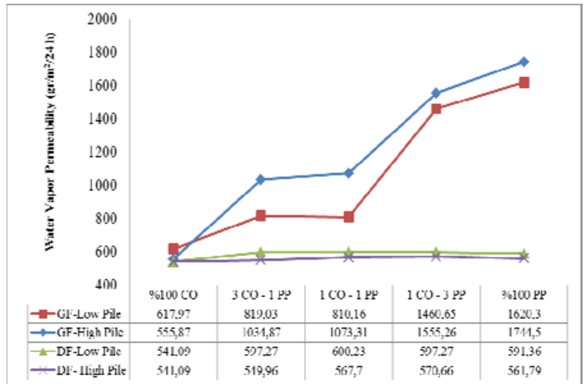
According to the results it is shown that gray form fabric samples, both of the special constructions' air permeability values are lower, and in the finished samples', particularly "special construction 1" fabrics' air permeability values are lower.

Water Vapor Permeability

When the results were studied in terms of the pile height water vapor permeability, the increase of the pile height in gray fabrics caused a limited increase in water vapor permeability and this increase seems to be unimportant statistically. As for the finished fabrics, an increase in pile height decreases the water vapor permeability and this decrease is important statistically.

An interesting result has come out as a result of the experiments. While the high-piled gray fabrics provide better water vapor permeability values than low-piled gray fabrics, the water vapor permeability values of the low-piled finished fabrics are considerably better than the high-piled finished fabrics. Due to their broad structures, low-piled fabrics have more pores and for that their water vapor permeability becomes much more. Though there is not a big difference between the gray fabrics, the result is just the reverse.

Tests carried out on the water vapor permeability of PP rate have shown that PP yarn has a positive effect on the water vapor permeability. In statistical analysis, it is seen that the usage of PP fiber has an important effect on water vapor permeability as seen *Figure 3.2.* Both in dyed and gray fabrics, the increase of PP fiber increases water vapor permeability.



* GF = **G**ray **F**abric, DF = **D**yed **F**abric

FIGURE 3.2. Values of water vapor permeability of samples with different rates of PP.

The first reason of this result is; since the PP fibers have a smooth surface, the PP fabrics used to have bigger pores. So the water vapor permeability which depends on the porosity of the fabric increases considerably.

The second reason is, due to its molecular structure, moisture ability of the PP fiber is being low. This property avoids the fibers keeping water vapor within them. Thus an important amount of the vapor is being transmitted around without being kept inside the fabric structure.

In the studies realized in terms of the effect of finishing process on the water vapor permeability, it is seen that the bleaching and optical bleaching treatments of cotton towels decrease the water vapor permeability of the fabric. And it is seen that this decrease is important statistically.

The most important parameter that determines the water vapor permeability is the number of pores on the fabric. Some part of the pores of the fabric during the finishing treatments is filled via bonding with chemical substances. The decrease of the pores affects the water vapor permeability in a negative way. After finishing process, the fabric weight and warp/weft in cm increases, this increase results to decrease of water vapor permeability.

The bleaching and optical bleaching processes are being applied in this work. That is; PP fibers were not treated with special finishing processes. But it is seen that finishing process affects both fiber types in a negative way.

For the purpose of searching the effect of pile weaving structure on the water vapor permeability, “special construction 1” towel with 6 high pile PP yarn, 6 low CO pile yarn and “special construction 2” towel with 6 high pile, 6 low pile CO/PP blends were used.

In the gray formed fabric samples, the water vapor permeability of both special constructions is more low, but within themselves, the water vapor permeability of “special construction 2” fabrics is lower than “special construction 1”. As for the finished fabric samples, particularly the air permeability values of the “special construction 1” fabrics were lower. The interesting point here is the decrease of the water vapor permeability of the “special construction 1” fabrics after finishing, while the water vapor permeability of “special construction 2” fabrics increase.

The high-pile gray fabrics provided the highest the water vapor permeability values. They are followed by the low-pile gray samples. The lowest the water vapor permeability values belong to the gray “special construction 2” fabrics.

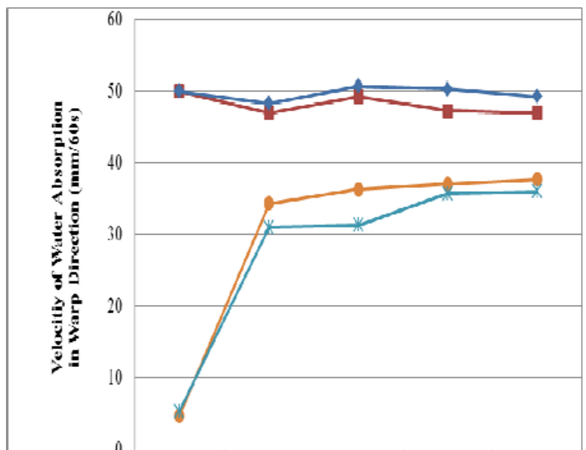
<u>Velocity of Water Absorption</u>

Often known as vertical absorbency, in this test method, at the sample whose bottom end dipped into the liquid, the saturated layer transfers the liquid to the upper layer. For this reason the PP fibers transmit the liquid quickly even though they have low liquid absorption property as seen in *Figure 3.3 and Figure 3.4.*

When the effect of pile height to the water absorption velocity is examined, the results show that the increase in pile height causes an increase in the sample fabrics’ water absorption velocity in the weft direction in general, and this increase is important statistically. In the meantime this increase is not important statistically in the warp direction samples.

The test carried out in terms of the effect of PP rate to the water absorption velocity shows that PP yarn has a positive effect to the water absorption velocity (liquid transmission ability), particularly for the samples in gray form. In statistical evaluation, it is seen that PP fiber usage in gray fabrics has an important effect on the water absorption velocity. Velocity of water absorption is high for 100% PP compared to 100% CO, because PP yarns do not absorb water, it only show capillarity effect whereas CO yarns absorb water and do not transmit.

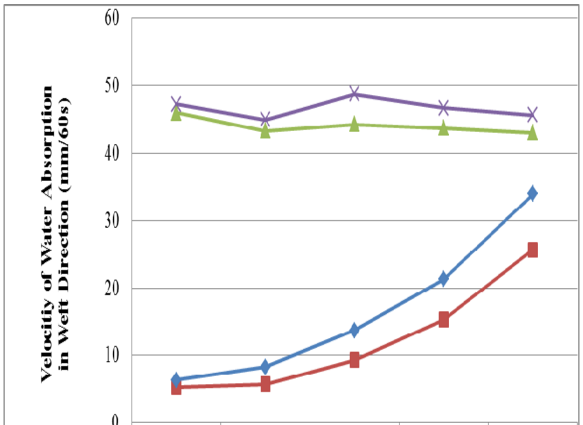
Another notable point is the liquid transmission ability of the PP fibers. For PP yarns do not take the water in, they quickly transmit the liquid to the other layer due to their slippery structure. So the PP fibers function as a carrier rather than an absorber.



	%100 CO	3 CO - 1 PP	1 CO - 1 PP	1 CO - 3 PP	%100 PP
GF-Low Pile	4,7	34,3	36,3	37	37,7
GF-High Pile	5,3	31	31,3	35,7	36
DF-Low Pile	50	47	49,3	47,3	47
DF-High Pile	50	48,3	50,7	50,3	49,3

* GF = **G**ray **F**abric, DF = **D**yed **F**abric

FIGURE 3.3. Values of velocity of water absorption in warp direction with different rates of PP.



	%100 CO	3 CO - 1 PP	1 CO - 1 PP	1 CO - 3 PP	%100 PP
GF-Low Pile	5,3	5,7	9,3	15,3	25,7
GF-High Pile	6,3	8,3	13,7	21,3	34
DF-Low Pile	46	43,3	44,3	43,73	43
DF-High Pile	47,3	45	48,7	46,7	45,7

* GF = **G**ray **F**abric, DF = **D**yed **F**abric

FIGURE 3.4. Values of velocity of water absorption in weft direction with different rates of PP.

Especially in the warp samples it is seen that the PP yarns raise the liquid like a transport channel; on the other hand, parts composing of cotton yarn can not raise the liquid. Since the highest level is taken into consideration, high values are being recorded in gray blended samples due to PP yarns.

In the context of the effect of finishing process to water absorption velocity, the remarkable point in the test results is the changing of the finished fabrics in comparison with their gray forms. Before the finishing process (when the fabric is in its gray form) the water absorption velocity (in other words, velocity of transmission to the upper layer) of CO fibers is rather low. On the contrary PP fibers have a high speed. As the amount of PP fibers in the gray fabric increases, the water absorption velocity increases as well.

After the finishing process, CO fibers absorb the liquid faster since they are released from lubricants, waxes and foreign substances. When the fabric is in its gray form, lubricants, wax and foreign substances etc. perform an obstacle against liquid passage and thus they decrease the liquid transmission. On the other hand PP fibers do not contain foreign substances because of they are synthetic.

In terms of the effect of pile weaving structure on the water absorption velocity, the water absorption velocity values of “special construction 1” and “special construction 2” towels are investigated.

In the gray fabric samples both of the special constructions provide close values of water absorption velocity in warp and weft directions and the water absorption velocities of the special constructions are better than other gray fabric samples. The finished fabric samples represent average water absorption velocity values.

DISCUSSION

In fabrics it is an interesting issue to study the comfort properties. In the literature search, was seen that in previous works research of comfort properties in such fabrics are lacking. However when the usage fields are taken into consideration, the first aim of the people using such fabrics is to relax and feel comfortable in the related places (pool, Turkish bath, sauna, bathroom.). The person who is comfortable and relaxed in where he/she is should also keep that comfort in the products he/she uses.

When the issue is taken from such a point of view, to determine the comfort parameters and to offer a suitable design will be very useful, given the usage areas of these products as well.

The properties expected from these fabrics become the comfort properties of water vapor permeability, air permeability, and velocity of water absorption. Thermal parameters seem less important.

The design that will be developed in accordance with these parameters are; the fabric must be light, feel dry, be soft, have a clean appearance, be non-allergenic, dry fast, and transmit heat. With these requirements taken into consideration, the idea of the combination of the PP fibers with the CO fibers has come into prominence,. because the PP fiber is rather light with its low density; has a high ability of liquid transmission, gives a dryness feeling; is bright and soft, and has no allergic effects like the natural fibers; and has good values of air permeability. In the previous studies it was seen that the drying capability of the PP fiber is better than CO, wool, acrylic and PES fibers [15], the heat transmission property is better than the natural fibers [7]. Despite all these positive characteristics, its water soaking ability is not well-developed which is important for the towel fabrics. To compensate this weakness it will be a rational way to use it together with the CO fibers within a combination.

When the air permeability values are studied; low piled, high PP rate; gray fabrics provided better air permeability values. PP fibers provided that high air permeability values due to their low density. Besides it is well known that both yarn properties such as hairiness, twist, smoothness etc. and fabric structural properties effect on air permeability of fabric. In the forthcoming studies it will be useful to measure fabrics' air permeability with different yarn and fabric properties.

When the water vapor permeability values are studied; it is seen that the pile height is not so much of a determinant, and the increase of PP rate is positive and the gray fabrics provide better results.

When the velocity of water absorption in both direction (weft and warp) values are studied; it is seen that the increase in pile height causes an increase in the fabric samples' velocity of water absorption value in the weft direction; PP yarn has a positive effect on velocity of water absorption (liquid transmission ability) particularly in gray fabrics, and the finishing treatment has a positive effect on CO fibers. Results show that CO fibers absorb the water and make feel wet, although PP fibers transmitted liquid through their surface by capillary effect.

The purpose of the special constructions is to identify the suggested construction and to see the difference better. And within these constructions, particularly "special construction 1" -6 high PP pile yarns, 6 low CO pile yarns- has shown that PP fibers transmit the liquid more rapidly in both gray and finished forms, and provide a good moisture transfer. Besides, the CO yarns also have good water absorption, and provide good air and water vapor permeability values.

It is known that PP fibers have a feel poorer than natural fibers. For this reason we used PP with CO with a different weave construction. But some subjective studies should be investigated in the future. Since a test environment cannot be composed for thermal resistance and thermal conductivity, a more comprehensive study of the effect of PP addition to the fabric structure to these parameters will be useful.

CONCLUSION

In this study we report the comfort properties of the fabrics produced with different weaving structures, different pile heights, yarns made of different fibers and some of the fabrics finished. The purpose is to obtain the most convenient comfort values of the pile structure alternatives used in products such as towels and bathrobes.

A structure of CO fibers inside and PP fibers outside (where the fabric touches the skin) was found to provide a positive result. This structure can be obtained through high pile PP fibers, low pile CO fibers and with the usage of CO yarns as ground. Thus the PP fibers will touch the skin and CO yarns will take place at the inside of the structure. Having moisture transfer property, PP fiber will be used on the surface that touches the skin, and CO fibers inside which have a high ability of moisture absorption. PP fibers transmit the liquid inside that has a high soaking ability through capillary effect. The absorptive inner surface (CO fibers) absorbs the liquid and vaporizes after a while without evoking. So the PP fibers that touch the skin will remain dry. As a result, a feeling of dryness and comfort will be obtained in the fabric.

It can be seen from this study that, in the towel weaving field, taking comfort into consideration and identifying the variation of the parameters that effect comfort, an understanding of the contribution that PP fibers can supply to these products and the effectiveness of the structures composed via pile heights, will pave the way for a better understanding in this field of application.

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