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Investigation the air permeability of single jersey fabrics obtained from ring yarns produced by different twist coefficients under constant and rasing pressure difference

Farklı büküm katsayılarıyla üretilen ring ipliklerden elde edilen süprem kumaşların sabit ve artan basınç farkında hava geçirgenliğinin araştırılması

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Abstract

Twist is applied to the fibers to keep them together and to raise their strength. Twist per unit length changes the mechanical and performance properties of the yarn and the fabric structure. In this study, ring yarns were produced from polyester, viscose and polyester-viscose fibers in undyed and dyed forms and Ne 10, Ne 25 and Ne 40 counts and with 3, 3,5 and 4 twist coefficients. In the first part of the study, quality tests were performed on these yarns and the results were analyzed. Then, Ne 25 and Ne 40 yarns were transformed into single jersey fabric via a single bed SDL circular knitting machine. The fineness of the labaratory type knitting mill is not suitable for Ne 10 yarns therefore these yarns were not transformed into knitted samples. The obtained knitted fabrics were subjected to air permeability test in SDL Atlas air permeability tester. In the last part of the study, air permeability test was applied to the samples obtained from undyed yarns with Ne 25 from the produced fabrics at increasing pressure ranges. As a result of this study, the effect of twist coefficient on the air permeability of fabrics was tried to be determined. The results were analyzed through graphs and statistical programs.

Keywords:*Twist coefficient, Air permeability, Single jersey fabric*

Öz

Lifleri bir arada tutmak ve mukavemetlerini arttırmak için büküm uygulanır. Birim uzunluk başına büküm, ipliğin ve kumaş yapısının mekanik ve performans özelliklerini değiştirir. Bu çalışmada polyester, viskon ve polyester-viskon elyaflardan boyanmamış ve boyalı formlarda Ne 10, Ne 25 ve Ne 40 numaralarında ve 3, 3,5 ve 4 büküm katsayılı ring iplikler üretilmiştir. Çalışmanın ilk bölümünde bu iplikler üzerinde kalite testleri yapılmış ve sonuçlar analiz edilmiştir. Daha sonra Ne 25 ve Ne 40 iplikler tek yataklı SDL yuvarlak örgü makinesinde süprem kumaşa dönüştürüldü. Kullanılan laboratuvar tipi örgü makinesinin inceliği Ne 10 ipliğe uygun olmadığından bu numaradaki iplik numuneleri kumaş numunelerine dönüştürülememiştir. Elde edilen örme kumaşlar, SDL Atlas hava geçirgenlik test cihazında hava geçirgenlik testine tabi tutuldu. Çalışmanın son bölümünde, üretilen kumaşlardan Ne 25'li gri ipliklerden artan basınç aralıklarında elde edilen numunelere hava geçirgenlik testi uygulanmıştır. Bu çalışma sonucunda, büküm katsayısının kumaşların hava geçirgenliğine etkisi belirlenmeye çalışılmıştır. Sonuçlar grafikler ve istatistiksel programlar aracılığıyla analiz edildi.

Anahtar Kelimeler: *Büküm katsayısı, Hava geçirgenliği, Süprem kumaş*

1. Introduction

Twist is an adhesive force that holds the bundles of fibers that make up the yarn together so that they have a certain strength value. According to the yarn formation method, it is called real twist, false twist and self twist. Real twist is obtained by keeping one end of the thread fixed and by turning the other end. While spinning the yarn with ring, rotor and friction yarn spinning, real twist is given. The strength raises to a certain level as the twist raises; however, when the maximum strength value is exceeded, the yarn handle hardens, breakage begins and the strength decreases. Therefore, it is very important to give an optimum twist during yarn production.

In the false twist method, an apparatus placed between the fiber bundles held at both ends gives the fibers a twist from its mid-point. When the apparatus is lifted, the fiber ends turning in opposite directions tend to slip on top of each other. This is the production in air-jet, vortex and some friction methods. Apart from these, there is also repco spinning, called self-twisting, used only for long staple yarns [1].

In this study, since the samples were obtained with ring spinning, the real twist will be discussed in detail. The twist is expressed as the number of turns in one meter (100 cm) or one inch (2.54 cm).

(Tur/inch=$\alpha_e\sqrt{Ne}$) …………Eq.[1]

In this equation, α_e is the twist coefficient and Ne is the yarn number. As the α_e value raises for a yarn in the same yarn count, the twist amount in unit length raises. This study focuses on the effect of twist coefficient on air permeability properties of single jersey knitted fabrics. Yarn construction is an important attribute in knitting and end use performance of knitwear. Holistically, yarn construction affects fabric thickness and weight, and thereby influences air permeability of fabrics. The amount of twist is a decisive parameter for finished consumers' good which determines appearance, durability and serviceability of fabric. For this study 100% viscose fiber, 100% polyester fiber and 50-50% polyester-viscose fiber are processed into Ne 10/1, Ne 25/1 and Ne 40/1 (English count) count by ring spinning technique. Three twist coefficients (α_e) of 3.0, 3.5, and 4.0 are used. Half of the yarns are dyed other half of them stays as undyed and than all of the yarns were knitted. Dyeing process was applied to detect the effect of dyeing on yarn qualites and the air permeability values of knitted samples. During the study, at first strength, elongation and hairiness of the yarns are measured and than they are knitted. Finally, structural properties and air permeability of the samples are tested. Since the amount of twist affect the rigidity and the strength of the yarns there are many studies about the twist effects on the performance of fabrics. The effect of single-yarn twist and ply to single-yarn twist ratio on the evenness, hairiness and abrasion resistance of two-ply cotton yarn has been studied. The hairiness of two-ply yarn decreases as either the single-yarn or ply twist raises. Single-yarn twist and ply twist have a more influential effect on the yarn-to-yarn and yarn-to-surface abrasion resistances respectively of cotton two-ply yarns[2]. As the single yarn twist raises the tensile strength of the ply yarns with different levels of ply to single yarn twist ratio raises and at 130–140 % of normal single yarn twist level, the ply yarns attain almost the same strength[3]. Single jersey fabrics knitted from two-ply yarn with 1/2 of single yarn twist do not show spirality, whereas the fabrics produced using two-ply yarn with 1/3 and 3/4 of single yarn twist show spirality in Z and S directions respectively[4]. Mechanical property tests demonstrated that the initial modulus of a yarn produced by high performance polymer monotonically decreases with increasing twist. The experimental results show that the strength of these yarns can be improved by a slight twist. A high degree of twist damages the fibers and reduces the tensile strength of the yarn. The elongation to break of the yarns monotonically raises with the degree of twist[5]. In accordance with a study; the modified low-twisted yarn possesses a bulky feature which creates a porous fabric structure for more ultraviolet radiation (UVR) transmission. The extra-long staple yarn offers uniform fabric appearance for higher UVR reflection. However, the regularity of yarn also restricts the fabric shrinkage in laundering and thus improvement in UV protection by shrinkage is not as obvious as that provided by the conventional short-staple yarn[6]. In another study, it is reported that there was a linear relationship between the spirality degree and ratio of twist coefficient. Spirality degree will reduce with increasing of ratio of twist coefficient[7]. According to the results of a research; actual insulation and thermal resistance property decreased with an raise in twists/meter of the weft yarn. However, thermal conductivity does not significantly change while fabric compression reduced with an raise in twist as the surface roughness raised[8]. Air permeability is described as the rate of air flow passing perpendicularly through a known area, under a prescribed air pressure differential between the two surfaces of a material. Air permeability has a vital affect on thermal behavior of the fabrics and characteristic of the yarn has a vital role on the air permeability of the fabrics. Fabrics knitted with yarns of high linear density seem unsuitable in warm conditions owing to higher value of thermal resistance and lower values of air permeability and moisture vapor transmission rate[9]. The lower thickness and low mass per unit area exhibit better thermal conductivity, air permeability, water vapour permeability, wicking, moisture absorbency, drying rate and moisture management properties[10]. In woven fabrics, permeability raised with the twist level allowing more air circulation improving sensorial comfort while wicking ability reduced[11]. While the yarn twist and yarn count raise thermal resistance values decrease and water vapour permeability values raise[12].

Hasani reported that yarn twist affects the friction coefficient at the loops intersections. Results of an investigation show a slightly raise in shear rigidity, tensile linearity and tensile resilience as the yarn twist raise [13]. Karimian et al reserched that in higher yarn twist, the yarn tends to behave like a spring and shows more resistance against deformation[14]. Özdil et al studied on cotton yarns, produced in different yarn counts (Ne 20, Ne 30, Ne 40) and different twist values (αe=3.2, 3.6, 4.0) were knitted as single jersey structure in the same production conditions. The moisture management properties of the fabrics were measured in "SDL-ATLAS Moisture Management Tester". According to maximum wetted results, it can be seen that the value raises for the fabrics made from finer yarns and yarns having lower twist values. However the differences for the fabrics produced with the yarns in αe= 3.2 and αe= 3.6 is not apparent [15]. Stankovic et al obtained indicated that yarn twist to a great extent influenced the UV protection properties of the knitted fabrics through the influence on yarn compactness and surface properties, which in turn influenced the open porosity of the fabric[16].

In addition to the studies in the literature; in this article, the authors aimed to produce sample fabrics by making changes in yarn count, raw material and dyeing along with yarn twisting and to test the air permeability of these samples at constant and increasing pressure differences. The results are explained in relation to the twist coefficient.

2. Material and Method

In this study, using ring spinning technique, yarns from polyester, viscose and 50-50% polyester viscose fibers were obtained. The yarns are produced in Ne 10, Ne 25 and Ne 40 numbers. During production, 3 α_e, 3,5 α_e and 4 α_e were chosen as the twist coefficient. Half of the produced yarns are dyed. Thus, 54 different ring yarn samples were obtained. Of the 54 yarns produced, Ne 25 and Ne 40 were converted into single jersey knitted fabric in the SDL ATLAS laboratory single feed circular knitting machine. The machine has 28 fineness , 3,2 inch diameter and 241 needles. (The fineness of the labaratory type knitting mill is not suitable for Ne 10 yarns therefore these yarns were not transformed into knitted samples). Since the tightness setting is fixed at 15 and the speed setting at 40 rpm during production, the loop lengths of fabrics produced with Ne 25 yarn are kept as 3.2 mm and the loop loop lengths of fabrics produced with Ne 40 yarn are kept as 2.5 mm. Since the feature to be determined is air permeability, the tightness is desired to be kept constant.

Quality tests of the yarns obtained were made by USTER tester and presented in the tables. Thickness, unit weight, loop density, loop shape factor of the produced samples were tested according to international standards and porosity was calculated by an equation below.

$$\text{Porosity}(\%)=(1-/\rho h)*100 \text{……………………Eq.[2]}$$

In this equation P is the porosity, m is the fabric weight, ρ is the density and h is the fabric thickness. In the SDL ATLAS Air Permeability Tester, 100 Pa pressure diffrence and by 20 cm^2 head; air permeability test was carried out from 10 different places of the fabric and the average of the result was obtained. The results obtained were analyzed with the help of graphics. Then, in order to determine the relationship of pressure difference with air permeability, air permeability test was applied to fabrics produced from Ne 25/1 dyed yarns by increasing the pressure difference between 50 and 500 Pa air pressure by 50 Pa. (Fabrics produced by the Ne 25/1 yarns were selected because they give the optimum permeability test results). The results are plotted in the form of pressure difference-air permeability.

Whether the effects of each independent variable (Raw material, yarn count, twist coefficient and dyeing) on the dependent variable (air permeability) and is statistically significant, the results tested by One -way ANOVA method and are presented in the form of a table. During the test, 95% confidence interval and α: 0.05 were chosen. Accordingly, values less than 0.05 indicate that the independent variable has a significant effect on the dependent variable, while values greater than 0.05 indicate that it is insignificant[17].

3. Results and Discussion

3.1. Yarn Quality Test Results

The quality of the yarns varies depending on the technical characteristics of the fiber used, the yarn's production principle, yarn count, twist and all the processes it has seen during / after production. For the yarn quality, the most important feature is yarn unevenness. Unevenness is expressed as a mass variation in unit length. This value, which is measured with the help of USTER is tried to be made statistically significant. Another important feature is yarn strength. The specific strength given independently from the yarn count is the appropriate method to express the change in strength due to all other factors. In order to estimate the flexibility and durability of the fabric produced, the percent of yarn elongation should be measured. Hairiness can be measured to estimate the fabric's knittability and susceptibility to pilling. The measurement results performed on the Uster tester are presented in Tables 1, 2 and 3.

Table 1. Quality test results of Ne 10/1 yarns

Twist coeficient, α_e	Raw material	Dyeing	Um	CVm	Thin -50	Thick +50	Neps +140	H	cN/tex	Elg, (%)
3	Polyester/Viscose	Undyed	6	8	0	2	6	9	26	14
	Polyester	Undyed	6	8	0	0	3	9	37	13
	Viscose	Undyed	6	8	0	0	4	8	20	16
	Polyester/Viscose	Dyed	6	8	0	5	5	4	19	19
	Polyester	Dyed	7	9	0	10	8	2	25	23
	Viscose	Dyed	7	9	10	10	40	7	19	16
3,5	Polyester/Viscose	Undyed	6	8	0	3	2	8	26	14
	Polyester	Undyed	6	7	0	1	1	8	35	14
	Viscose	Undyed	6	8	0	0	2	8	19	16
	Polyester/Viscose	Dyed	6	8	0	0	0	3	18	19
	Polyester	Dyed	7	9	0	10	10	2	26	23
	Viscose	Dyed	7	9	3	8	18	6	19	17
4	Polyester/Viscose	Undyed	6	8	0	2	4	7	27	15
	Polyester	Undyed	6	8	11	3	6	7	36	15
	Viscose	Undyed	6	8	0	0	2	7	19	16
	Polyester/Viscose	Dyed	7	8	0	0	0	3	19	19
	Polyester	Dyed	7	8	0	5	5	1	17	17
	Viscose	Dyed	7	8	0	8	10	5	18	16

Table 2. Quality test results of Ne 25/1 yarns

Twist coeficient, α_e	Raw material	Dyeing	Um	CVm	Thin -50	Thick +50	Neps +140	H	cN/tex	Elg, (%)
3	Polyester/Viscose	Undyed	9	12	0	8	35	6	22	11
	Polyester	Undyed	10	12	2	15	38	6	32	12
	Viscose	Undyed	9	12	0	14	54	7	17	13
	Polyester/Viscose	Dyed	10	12	0	14	55	2	17	16
	Polyester	Dyed	11	13	2	40	37	1	22	20
	Viscose	Dyed	9	12	0	13	37	4	18	15
3,5	Polyester/Viscose	Undyed	9	11	0	7	21	5	25	12
	Polyester	Undyed	10	13	0	30	39	5	31	11
	Viscose	Undyed	9	12	1	12	45	5	18	14
	Polyester/Viscose	Dyed	10	12	3	13	37	2	18	17
	Polyester	Dyed	11	14	8	35	28	1	18	17
	Viscose	Dyed	9	12	1	9	30	4	19	16
4	Polyester/Viscose	Undyed	10	12	0	8	23	5	22	13
	Polyester	Undyed	10	12	0	21	36	5	29	12
	Viscose	Undyed	10	12	0	10	38	5	17	13
	Polyester/Viscose	Dyed	10	12	1	12	38	2	17	16
	Polyester	Dyed	10	13	7	37	42	1	20	19
	Viscose	Dyed	9	12	1	7	30	3	17	14

Table 3. Quality test results of Ne 40/1 yarns

Twist coeficient, α_e	Raw material	Dyeing	Um	CVm	Thin -50	Thick +50	Neps +140	H	cN/tex	Elg, (%)
3	Polyester/Viscose	Undyed	13	16	74	106	221	5	18	11
	Polyester	Undyed	13	17	123	161	101	5	27	10
	Viscose	Undyed	12	15	41	110	317	5	17	12
	Polyester/Viscose	Dyed	13	16	100	126	132	2	14	14
	Polyester	Dyed	15	19	437	344	169	1	18	17
	Viscose	Dyed	13	16	61	107	277	3	16	13
3,5	Polyester/Viscose	Undyed	12	16	58	83	218	5	20	11
	Polyester	Undyed	13	16	75	155	213	5	26	10
	Viscose	Undyed	13	16	53	136	293	4	15	10
	Polyester/Viscose	Dyed	13	17	120	103	153	2	15	14
	Polyester	Dyed	15	19	395	276	146	1	19	17
	Viscose	Dyed	13	16	74	96	239	3	16	12
4	Polyester/Viscose	Undyed	13	16	85	88	178	4	20	11
	Polyester	Undyed	13	16	67	162	252	4	26	10
	Viscose	Undyed	12	15	33	101	335	4	12	7
	Polyester/Viscose	Dyed	13	17	103	132	335	2	14	12
	Polyester	Dyed	15	19	390	252	120	1	15	14
	Viscose	Dyed	13	17	131	153	364	3	15	11

In the tables above strength variations depending on the number, raw material, dyeing situation and twist coefficient are shown. It is clear that the strength decreases when the yarn fineness raises. Although the results were evaluated as specific strength, there was an expected decrease in strength as a result of the decrease in the number of fibers per unit area. Polyester yarn within samples is the most durable one regardless of twist. Dyeing has reduced the strength of the polyester yarn. Twist coefficient and dyeing process did not affect the strength of viscose yarns. While the twist coefficient did not have a significant effect on the strength of polyester viscose yarns, the dyeing process reduced the strength. However, in general, the twist coefficient reaching 4 α_e and dyeing process caused a significant decrease in strength. Because viscose yarns are cellulosic regenerated fibers, they could not resist as much as polyester and polyester blended yarns. Moreover, neither the twist coefficient nor the dyeing process had a significant effect on strength. Among the tests carried out, after the strength and elongation, it is thought that hairiness changes by twisting; hairiness is also important on air permeability. The dyeing process and twist raise significantly reduces hairiness. Twist variatio

ns due to raw materials could not be detected in undyed fabrics. Polyester-viscose dyed yarns have the lowest hairiness in all samples regardless of twist. Therefore, it is concluded that dyeing process results loss of strength for viscose yarns.

Correlation was made with SPSS 11.0 package program to statistically analyze the effects of raw material, number and twist on the structural properties of yarns. Correlation results show that the yarn count has a strong relationship with all structural features. Raw material causes a significant change on hairiness, strength and elongation. No relation was found between the change in twist coefficient and the structural properties of the yarns.

3.2. Structural Analysis Test Results of Sample Fabrics

The structure of knitted fabrics varies depending on the raw material, yarn count, pattern and finishing processes. In this study, the pattern was kept constant. However, structural features have also changed depending on other variables. Structural properties must be analyzed since the thickness, unit weights, stitch density and porosity of the fabrics also affect the performance of the fabrics. Structural test results of sample fabrics applied according to international standards are given in Tables 4 and 5.

Table 4. Structural test results of sample fabrics produced by Ne 25/1 yarns

Twist coeficient, α_e	Raw material	Dyeing	Thickness, mm	Unit weight, g/m^2	Course /cm	Wale /cm	Stitch density	Loop shape factor	Porosity
3	Polyester/Viscose	Undyed	0,63	108,9	11	8	88	1,38	87
	Polyester	Undyed	0,50	88,2	10	7	70	1,43	88
	Viscose	Undyed	0,54	97,2	11	9	99	1,22	87
	Polyester/Viscose	Dyed	0,60	120	12	11	132	1,09	85
	Polyester	Dyed	0,52	109	13	11	143	1,18	86
	Viscose	Dyed	0,55	102,5	12	10	120	1,20	87
3,5	Polyester/Viscose	Undyed	0,63	111	11	9	99	1,22	87
	Polyester	Undyed	0,56	109	11	9	99	1,22	87
	Viscose	Undyed	0,55	111	11	8	88	1,38	86
	Polyester/Viscose	Dyed	0,59	122	13	11	143	1,18	85
	Polyester	Dyed	0,52	111	14	12	168	1,17	86
	Viscose	Dyed	0,61	120,5	11	9	99	1,22	86
4	Polyester/Viscose	Undyed	0,73	120	11	9	99	1,22	88
	Polyester	Undyed	0,64	111	11	9	99	1,22	88
	Viscose	Undyed	0,68	112	10	8	80	1,25	88
	Polyester/Viscose	Dyed	0,58	127	13	11	143	1,18	84
	Polyester	Dyed	0,57	117	13	12	156	1,08	86
	Viscose	Dyed	0,62	119	11	9	99	1,22	86

Table 5. Structural test results of sample fabrics produced by Ne 40/1 yarns

Twist coeficient, α_e	Raw material	Dyeing	Thickness, mm	Unit weight, g/m^2	cpc	Wpc	Stitch density	Loop shape factor	Porosity
3	Polyester/Viscose	Undyed	0,48	71	11	11	121	1,00	89
	Polyester	Undyed	0,43	74	12	8	96	1,50	89
	Viscose	Undyed	0,43	68	11	9	99	1,22	89
	Polyester/Viscose	Dyed	0,61	76	10	9	90	1,11	91
	Polyester	Dyed	0,45	76	12	10	120	1,20	89
	Viscose	Dyed	0,48	75	12	10	120	1,20	89
3,5	Polyester/Viscose	Undyed	0,58	74	11	10	110	1,10	90
	Polyester	Undyed	0,45	74	11	10	110	1,10	89
	Viscose	Undyed	0,57	75	11	9	99	1,22	91
	Polyester/Viscose	Dyed	0,62	90	11	9	99	1,22	89
	Polyester	Dyed	0,43	76	10	9	90	1,11	88
	Viscose	Dyed	0,54	73	14	12	168	1,17	90
4	Polyester/Viscose	Undyed	0,60	80	12	11	132	1,09	90
	Polyester	Undyed	0,51	78	11	9	99	1,22	91
	Viscose	Undyed	0,56	73	12	11	132	1,09	91
	Polyester/Viscose	Dyed	0,51	92	10	9	90	1,11	87
	Polyester	Dyed	0,48	80	11	9	99	1,22	89
	Viscose	Dyed	0,57	88	14	13	182	1,08	89

Tables 4 and 5 were examined and the following conclusions were drawn: The dyeing process raised the weight of the fabric but did not cause any significant change in thickness. The dyeing raised the loop frequency, but the same effect was not reflected in the loop shape factor. Polyester fabrics are heavier and thicker than viscose fabrics. Although their specific weight is different in terms of porosity, no difference was found. The reason for this is that the stich density is kept constant and accordingly thickness-weight changes. The change in yarn twist coefficient causes an raise in unit weight and thickness. The raises in weight and thickness occurred as the twist reduced the unit length and raised the yarn diameter. It is anticipated that this change will also consider the porosity of the fabric, but calculations have shown that this is not correct. The thinning of the yarn caused an raise in porosity while a decrease in weight, thickness and density[18].

3.3. Air Permeability Test Results of Sample Fabrics under Constant Pressure

It is thought that the thickness, weight and porosity of the fabric may affect the changes that may occur in the air permeability that passes under a certain pressure per unit time from the unit area. Within the scope of the study, the variables that cause these structural differences were investigated mainly by changing the yarn twist coefficient. Accordingly, the permeability results of the produced samples are presented graphically in Figure 1.

In general, when the graphic is examined, it is seen that the air permeability raises as the yarn becomes fine. This is because the pores of the fabric raise. Samples obtained by Ne 25/1 show that when the twist raises for all three raw materials the air permeability raises at the same time. However, when the twist coefficient raises up to 4 in Ne 40/1 for fabrics, the air permeability decreases. It has been observed that the weight and thickness of these fabrics raise depending on the twist coefficient. This raise is related to the more fibers in the unit area of the fabrics. Air permeability of fabrics made of viscose is higher than polyester. However, this difference is not seen at a significant level. Therefore, it was concluded that no factor alone was fully effective on air permeability and all other factors should be evaluated together.

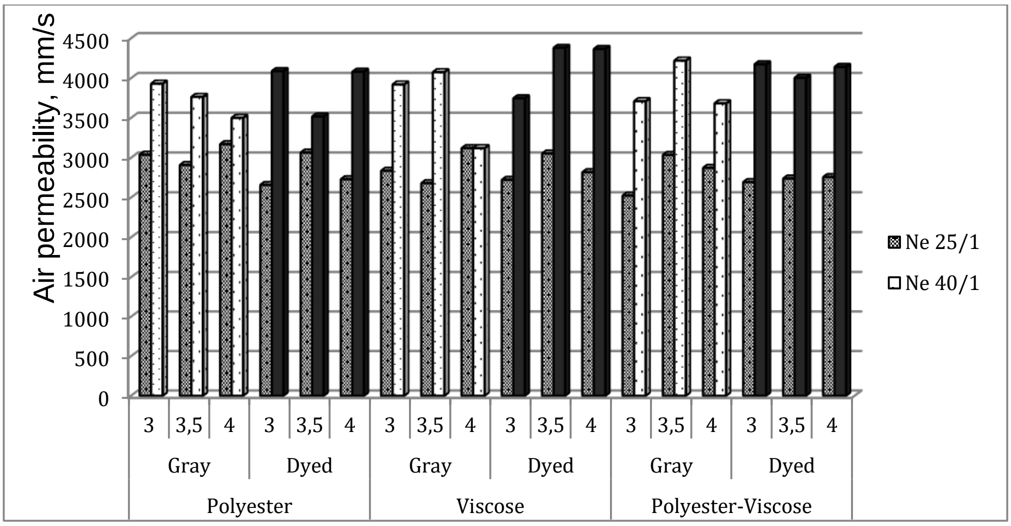

Figure 1. Air permeability test results of samples under constant pressure

3.4. Air Permeability Test Results of Sample Fabrics under Increasing Pressure

Within the scope of the study, knitted fabrics were obtained from yarns produced in different twist coefficient with 2 different yarn counts. Air permeability of the produced fabrics was measured under constant pressure. Analysis shows that yarn count is the most effective parameter on air permeability. As the basis of the study is the effect of twist difference on the air permeability, the pressure has been changed and the air resistance of the fabrics between 50 Pa and 500 Pa has also been determined. Since it is seen that the effect of the yarn count overrides other variables, this test was carried out only on 9 different fabrics knitted from Ne 25/1 yarns. The reason for choosing this number is that the permeability test results of them were moderate within the results. Air permeability of Viscose, Polyester-Viscose and Polyester fabrics are presented in Figures 2, 3 and 4 respectively.

When Figure 2 is analyzed, it is seen that as the pressure difference raises, the air permeability of viscose fabrics raises linearly. However, when it is examined in detail, it is seen that an raise in the twist coefficient, raises the air permeability and moreover, an raise in the twist coefficient causes a significant change on the air permeability as the pressure difference raises. An raise in the twist coefficient should decrease the air permeability as it basically raises the number of fibers in the unit area. This prediction was confirmed in the first part of the study performed with constant pressure difference. On the other hand, the short fiber ratio decreasing on the surface with the raise of twist causes the volume of the yarn to decrease and the formation of harder yarns. This reveals the importance of hairiness with raised pressure awareness. In other words, it can be said that low-twisted yarns for viscose raw material in windy weather are more insulating than high-twisted yarns [19].

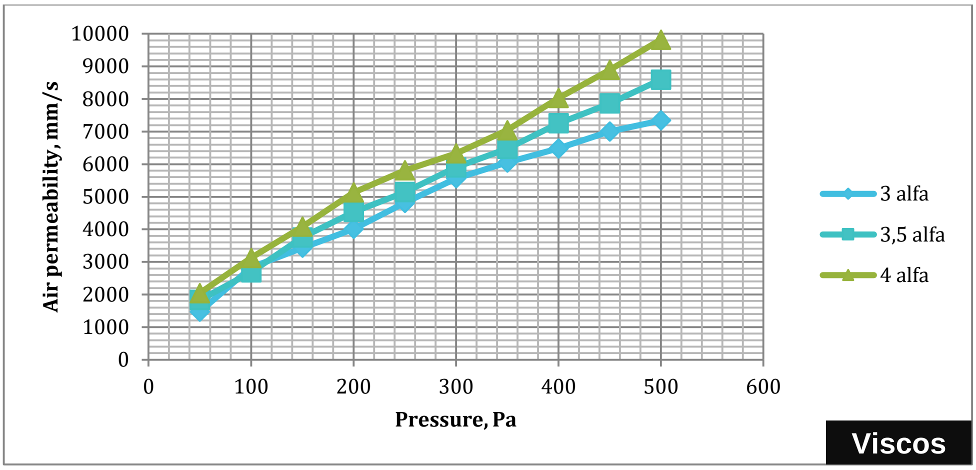

Figure 2. Air permeability test results of viscose samples under raised pressure

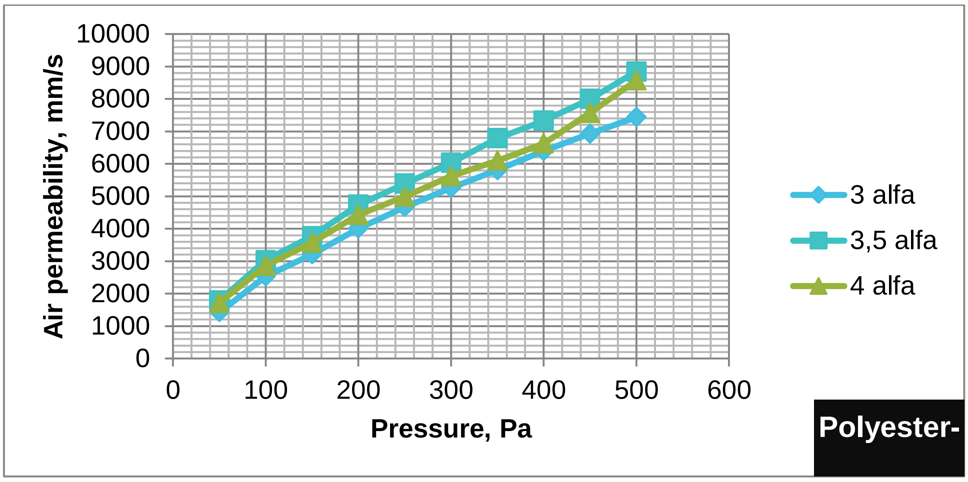

Figure 3. Air permeability test results of polyester-viscose samples under raised pressure

In Figure 3, the air permeability of the fabrics with polyester viscose blend and knitted from different twisted yarns is displayed with increasing pressure awareness. As the pressure raises according to the figure, the air permeability raised linearly. However, for polyester viscose fabrics, medium twisted yarns up to 400 Pa appear to be more breathable. When the pressure raised to 500 Pa, it was seen that medium and high twisted yarns pass the same amount of air. When the permeability of polyester-viscose and viscose raw materials are compared, it is seen that viscose fabrics show less resistance to air. When the density of both raw materials are compared, it can be said that viscose raw material has high density, that is, for materials with the same mass, viscose fiber is less voluminous, which may explain the reason for excess permeability.

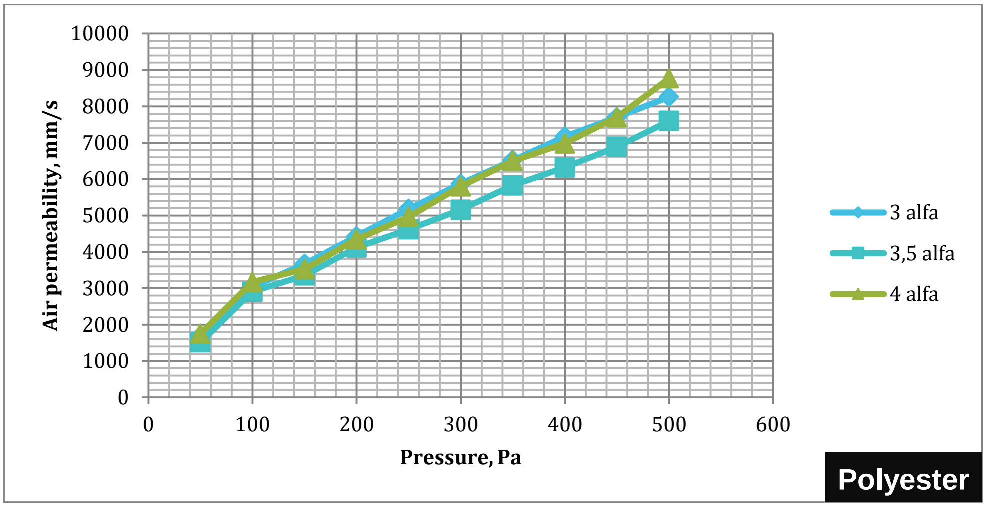

Figure 4. Air permeability test results of polyester samples under raised pressure

According to Figure 4, although the pressure raise on the air permeability of knitted fabrics obtained from yarns produced in different twists with polyester raw material causes a linear raise, the effect of the twist raise is not seen. In this case, it can be said that the resistance of polyester fabrics against the raised air pressure is higher than viscose fabrics regardless of the twist.

3.5. Statistical Analysis Test Results

In addition to the test results, statistical evaluations were examined with one-way ANOVA and correlation methods. The correlation of the relationship between independent variables and air permeability is presented in Table 6.

Table 6. The correlation between independent variables and air permeability

Correlation	Raw material	Twist coefficient	Yarn count	Air permeability
Air permeability	,006	,018	,884**	1

According to Table 6, only the yarn count has a high level of influence on air permeability. From this point of view, we can say that the fabric becomes more permeable as the yarn becomes thinner. One-way ANOVA test was applied to determine the significance of changes on air permeability depending on each variable and the results are given in Table 7.

Table 7. ANOVA Analysis of air permeability related with dependent variables

OneWAY ANOVA	Sum of squares	df	Avg of squares	F	Sig.
Raw material	69,167	108	,640	,895	,702
Twist coefficient	18,958	108	,176	1,129	,294
Yarn count	9468,750	108	87,674	9,485	,000
Dyeing	3041,667	108	28,164	1,371	,077

ANOVA analysis in Table 7 confirmed the correlation results. The only significant variable on air permeability was found as the yarn count. According to these results, changing the yarn twist, raw material or dyeing is not enough to change the air permeability alone. The effective parameter on air permeability is known to be thickness and weight changes, so the most effective parameter on these changes is yarn fineness, which is graphically and statistically verified. In the second part of the study, a graphical examination of the air permeability change against the raised pressure was given. The significance measurement results of these results are also given in Table 8.

Table 8. ANOVA Analysis of air permeability differentiation under increasing pressure related with dependent variables

OneWAY ANOVA	Sum of squares	dof	Avg of squares	F	Sig.
Raw material	22200,00	340	65,294	,912	,732
Twist coefficient	229,250	340	,674	1,04	,414
Raised air pressure	9187916,667	340	27023,284	31,559	,000

According to the analysis results made in Table 8, the pressure change caused a statistically significant effect on air permeability. Twist raise and raw material change have no significant effect on air permeability in different pressure ranges. According to the scientific expression of the statistical results, when the pressure of the applied air pressure raises, the air permeability raises regardless of the twist change and the raw material. Moreover on the air permeability of knitted fabrics only significant variable is found as raising air pressure (Sig. value is 0.00).

5. CONCLUSIONS

This study was carried out to determine the changes in different yarn twist coefficients primarily on the quality of the yarns and then on the air permeability of the fabrics knitted from these yarns. In order to raise the reliability of the study, the same tests were applied for yarns from 3 different numbers, 3 different raw materials, dyed and undyed. In the last part of the study, the air permeability of the knitted fabrics produced by Ne 25/1 yarns were measured under raising pressure difference. The results of the graphical and statistical analysis of the study are as follows:

When the quality of the produced sample yarns were examined, the strength decreased as the yarn count became fine. Undyed polyester yarn within samples was found to be the most resistant regardless of twist. In addition, when the twist coefficient reaches to 4 α_e and dyeing process apllied to samples; both strength and hairiness decreased significantly.

When the structures of the fabrics knitted from the obtained yarns are examined, it is determined that the dyeing process raises the weight of the fabric but does not cause a significant change in the thickness. The dyeing raised the loop density, but the same effect was not reflected in the loop shape factor. The change in the yarn twist coefficient caused an raise in unit weight and thickness. The fineness of the yarn caused an raise in porosity while a decrease in weight, thickness and tightness.

When the air permeability of the fabrics at constant pressure is examined, it is concluded that no factor alone is fully effective on the air permeability and all other factors must be evaluated together. But; the most effective factor was found to be the yarn count. It has been observed that the air permeability raises as the yarn count is examined. The results were also statistically confirmed.

In the second part of the study, it was focused on how the pressure raise changes the air permeability. The short fiber ratio decreasing on the surface with the raise of twist causes the volume of the yarn to decrease and the formation of harder yarns. This reveals the importance of hairiness with raised pressure awareness. In other words, it can be said that low twisted yarns for undyed viscose material in windy weather are more insulating than high-twisted yarns. When the permeability of polyester-viscose and undyed viscose materials are compared, it is seen that viscose fabrics show less resistance to air. When the densities of both yarns are compared, it can be said that the undyed viscose material is denser, that the viscose fiber is less bulky for materials with the same mass, which may explain the reason for the excess permeability. In this case, it can be said that the resistance of polyester fabrics against the raised air pressure is higher than viscose fabrics regardless of the twist. As a result; when the pressure of the air raises, the resistance of the fabrics decreases regardless of the twist change and the raw material.

When the study started, it was predicted that the twist change in the yarn would change the air permeability significantly as well as changing the many properties of the fabric. However, tests have shown that thickness and weight are effective parameters on air permeability. And the most effective parameter on these changes was found as yarn fineness. The results are graphically and statistically verified. In this case, the most obvious findings of the study are that the twist coefficient does not change the air permeability under constant pressure and that the air permeability will raise as the pressure raises, regardless of all other variables

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