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The Effects of Storage Conditions on Performance Properties of Textile Materials Dyed with Reactive Dyestuffs and Top White

***Meliha OKTAV BULUT[1], Kadri AKÇALI[2]**
[1] *Süleyman Demirel Üniversitesi, Mühendislik Fakültesi, Tekstil Mühendisliği Bölümü*
[2]*Bartın Üniversitesi, Bartın Meslek Yüksekokulu, Tekstil, Giyim, Ayakkabı ve Deri Bölümü*

Key Words:
Fabric, Softener, pH, Colour Fastness, Storage Condition

ABSTRACT

In this study, the effects of storage conditions on the PH and fastness values of the product have been assessed. For this purpose, the softening of the dyed and optically bleached samples was done with a cationic/non-ionic softener and acetic acid /non-volatile acid. Then the samples were stored under different conditions for 104 days. The findings showed that the important properties of the finished product such as the ph and wet fastness values change depending on the storage conditions.

Depolama Koşullarının Optik Beyaz ve Reaktif Boyarmadde ile Boyanmış Tekstil Materyallerinin Performans Özelliklerine Etkisi

Anahtar Kelimeler:
Reaktifle boyalı kumaş, Yumuşatıcı, pH, Renk haslığı, Depolama koşulları

ÖZET

Bu çalışmada, depolama koşullarının materyalin pH ve haslık özelliklerinine olan etkisi değerlendirilmektedir. Bu amaç ile boyalı ve optik beyaz numunelerin katyonik/non-ionik yumuşatıcılar ve asetik/uçucu olmayan asit ile yumuşatıcıları verilmiştir. Daha sonra numuneler değişik koşullarda 104 gün bekletilmiştir. Elde edilen sonuçlar, bitmiş mamulun pH ve yaş haslık değerleri gibi önemli özelliklerinin depolama koşullarına bağlı olarak değiştiğini göstermiştir.

*Sorumlu Yazar (Corresponding author) e-posta: oktavbulut@sdu.edu.tr

1. Introduction

Some of the vital problems that affect the ecosystem are major climate changes and increasing temperatures around the world (Joyce et al., 2009). In the last century, earth's temperature rose dramatically and it still does. It is estimated that temperatures will rise 1.5°C to 4.5°C on average within the next 50 years due to global warming and climate change (Ahrens, 1994). Climate change will negatively affect the quality of life and it should be kept in mind that it also changes the performance values of textile goods that are widely used in our daily lives. In dyehouses, the biggest problem faced especially in the summer, when the temparature is high, is the decrease in their production fastness values, which might be the best example for this subject. Products with high color fastness lose this quality when kept in customers' stores under unfavorable conditions, and this might cause disagreements that could finally lead to a demand for a refund. The tendency of the world ecology to change and thus increase the temperature will most likely trigger the problem and this issue has been coming into question in various sectors (Başaran et al., 2011).

The output of reactive dyestuffs, which constitute about 20% of the worldwide dye consumption, is 25 million tones and this amount is expected to increase (Jekky, 2010). Reactive dyestuffs, which are mostly used in cotton dyeing/printing can be identified with their bright colors, wide color range, high production repeatibility, simplicity and adaptability to various dyeing methods as well as their good color/light fastness. They form a covalent bond by chemically reacting with fibre. In order to increase the absorption of this category of dyestuffs, which have a moderate substantivity in cotton fibre, electrolyte (up to 90 g/L) is added to the dye bath. The pH value of the dyeing bath is of critical importance in terms of high fixing productivity, easy washing, high degrees of fastness and repeatability and the variants ought to be kept under control (Oktav Bulut and Akar, 2010). Fixing such dyeings appropriately (min. pH 9.8, for the high temperature reactive dyes and 10.20 for the warm group) is the most important factor and final washing is restricted to 1 g/L electrolyte concentration (Dyestar, 2003). The fact that the bicarbonate values are higher than the limited values, which is the biggest problem in dyeing mills in Turkey, makes it difficult to obtain the real pH values (Mavruz and Oğulata, 2004; Mavruz and Oğulata, 2005). Utilization fastnesses in a dyeing treatment that haven't been completely fixed will be rather low; furthermore, it will be a great source of environmental pollution. Water consumption in textile dyeing/printing industry is over 150 million tones per year and it is quite an important sector. The amount of pollution accepted by legal regulations connected with such values as BOD, COD is approximately five times more than the parameter of water pollution regulations. The foremost factor in the treatment of textile wastes is color. With their low bio-degradation, the amount of dyestuffs in the waste water is about 10 mg/L (Cailean et al., 2009).

The washing procedure is followed by cationic softener for colored products and non-ionic softener for white ones. The softening of the pH can be done with non-volatile acid mixtures as well as the conventional acetic acid. At the end of the stenter or sanforised machine, the finished product is immediately packed and kept in the producer's or customer's stock with rather unfavorable conditions until it is transferred to the garment stage so that there will be no hindrance in production.

Dermatological problems associated with reactive dyes are relatively rare in global market Hatch et al, 2003 noted such effects and named them 'colored clothing allergic contact dermatitis (Klemola, 2008). Moreau and et al. reported that if garments containing reactive dyes are not properly rinsed in the manufacturing process, the excess dye can be retained and this may cause allergic contact dermatisis (Moreau and Goossens, 2005). Öko-tex Standard 100 investigated whether textile products with this eco-label contain a harmful amount of certain compounds such as heavy metals, limited values of pH and color fastnesses of the finished product suitable for the skin (Öko-tex, 2011).

Studies into reactive dyes with a significant rate of utilization continue in regard to dyestuffs, new production techniques, bifunctional and polyfunctional structures in place of monofunctional ones (Broadbent et al. 2008) use of bio-degradable products in place of inorganic salt with high AOX, dyeing without salt, washing systems/ process efficiency (Ahmed, 2005; Zheng et al., 2012) and the treatment of the waste water (Cailean et al., 2009) and modified cotton (Wu et al., 2011). Studies into usage fastness focus on washing and particularly the decrease in perspiration and light fastness, and additionally the solution to these problems (Ferguson, 2008; Dubrovski et al., 2009).

Materials dyed with reactive dyestuffs have high color fastness at the end of the production. However, fastness decreases as a consequence of storage and the cleavage of the dye fiber bond after it reaches the customer and starts to be used. Dye fiber bond is sensitive to light, wet light in the presence of chemical residues, acidic gases, heat, and oxidative agents(Oktav Bulut and Akar, 2010). Until now, few studies have been carried out about the storage conditions and performance of the finished product. As a result, the changes that storage conditions cause in physical properties of fabrics have been a subject of great interest.

In this study, the effects of two different types of storage conditions on certain fabrics were investigated. For this purpose, the softening of the dyed and optically bleached fabrics was done with a cationic/non-ionic softener and acetic acid /non-volatile acid. Then the samples were stored under different conditions for 104 days. The PH and fastness values of the end product have been assessed.

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2. Material and Method

The list of the textile materials of different weights which were obtained from the Ekoten Corperation, Izmir and dyed according to various recipes can be seen in Table 1.

Table 1. Materials Properties

Material Color	**Weight (g/m^2)**	**Fiber Type**	**Dyeing Recipes**	
Brown	340	% 70 Cv/25 PA/5 lyc Interlock	-% 2.8 Evercion Yellow HE 4R Everlight CI: Reactive Yellow 84	-% 0.38 Lanaset Yellow 2R Huntsman CI: -
			-% 1.0 Evercion Crimson ESL Everlight CI: -	-% 0.184 Lanaset Red G Huntsman CI: -
			-% 2.02 Evercion Navy ESL Everlight CI: -	-% 0.31 Lanaset Grey G Huntsman CI: -
Blue	190	% 90 Co/10 Lyc Single-jersey	%0.06 Novacron Ruby S 3B	Huntsman CI: -
			%0.19 Novacron Ocean S R	Hunstman. CI: -
Red	190	% 90 Co/10 Lyc Single-jersey	% 1.32 Evercion Yellow HE 4R	Everlight. CI: Reactive Yellow 84
			% 2.26 Evercion Crimson ESL	Everlight. CI: -
			% 0.04 Evercion Navy ESL	Everlight. CI: -
Violet-pink	180	% 100 Co Single-jersey	%0.84 Evercion Crimson ESL	Everlight. CI: -
			%0.18 Evercion Blue HERD	Everlight CI : Reactive Blue 160
Black	300	% 69 Co/27 PA/4 Lyc Interlock	% 3.15 Everzol Black ED R	Everlight CI : Mix
			% 0.99 Everzol Black ED G	Everlight CI : Mix
			% 0.21 Remazol Gelb 3 RS A	Dystar CI : Reactive Yellow 145
Grey	180	% 94 Co/6 Lyc Single-jersey	% 0.066 Levafix Amber CA	Dystar CI: -
			% 0.0191 Levafix Rot CA Granulat	Dystar CI: -
			% 0.055 Levafix Blau CA Granulat	Dystar CI: -
Top white	220	% 94 Co/6 Lyc Single-jersey	%3 Leucophor BSB-B Liquid	Clariant, anionic stilbene derivative
Fuchsia	180	% 90 Co/10 Lyc Single-jersey	% 0.1 Levafix Brill Blau E-FFN 150	Dystar CI:Reactive Blue 181
			% 0.66 Levafix Rot CA Granulat	Dystar CI: -
Pale Pink	220	% 94 Co/6 Lyc Single-jersey	% 0.168Evercion Yellow HE 4R	Everlight CI:Reactive Yellow 84
			% 0.323 Evercion Crimson EFL	Everlight CI:-
			% 0.0019 Evercion Blue H-ERD	Everlight CI:Reactive Blue 160

The materials used in this study were supplied after the dyeing and washing processes had already been completed by the firm but without the application of the softening process. Soon after that, the pH and conductivity measurement was done with Mettler Toledo MA 235; pH/ ion analyzer.

The dyed materials were treated for 30 min at 40 ºC with 3% cationic softener (Tubingal KY, oil acid condensation product, CHT), pH 5 (acetic acid, Riedel- de Haen 100% and Neutracid NV non-volatile organic and inorganic tampon acid combination, CHT) at a liquor ratio of 10:1 in Atac Lab-Dye HT 10. Following the softening process, the samples were squeezed at pick up 80%, and then dried for 3 min at 140 ºC in Mathis CH-8156. The pH tests of the samples, ISO 3071:2005, AATCC 81-2006, were then carried out.

Non-ionic softener (Tubingal NY, oil acid condensation product, CHT) 3% was processed with a softening treatment using pH 5.5 (acetic acid, Riedel-de Haen 100% and Neutracid NV non-volatile organic and inorganic tampon acid combination, CHT) at a liquid ratio of 10:1 in Ataç Lab-Dye HT 10 for 30 min at 40 ºC for top white fabrics. After the softening process, the substance squeezed at pick up 80% was dried in Mathis CH-8156, 140 ºC for 3 min. The pH tests of the samples (ISO 3071:2005, AATCC 81-2006) were then done.

The softened samples were conditioned in 20±2ºC temparature and 65±2% relative humidity for four hours. They were separately inserted into polyethylene foil sheets that contained no BHT, then sealed with a band and left to wait for 104 days in the Isparta Mensucat firm, Turkey under two different conditions, **Condition 1**: 30±2 ºC temparature, 80±2% relative humidity according to the firm's conditioning requirements and **Condition 2:** 20±2 ºC temparature and %65± 2 RH, laboratory condition.

At the end of the waiting process the pH tests (ISO 3071:2005 ve AATCC 81-2006) were repeated and their fastness in washing with detergent (BS EN ISO C06), dry/wet rubbing (BS EN ISO 105 X12) and water (ISO 105 E01) were evaluated. All tests were carried out twice.

3. Results

3.1. The pH values and conductivity of the materials

The pH values and conductivity of the materials whose properties are mentioned in Table 1, were measured in two different measurement procedures. The results can be viewed in Table 2.

Table 2. The pH values and conductivity of the materials

Material Color	**pH**		**Conductivity (ms/cm)**
	ISO 3071:2005	**AATCC 81-2006**	
Brown	7.30	7.80	0.08
Red	7.49	7.84	0.09
Blue	7.19	7.71	0.09
Violet-pink	7.00	8.10	0.11
Black	7.25	8.00	0.14
Grey	7.82	7.96	0.07
Top white	7.51	7.69	0.07
Fuchsia	7.86	7.91	0.09
Pale pink	7.89	8.01	0.07
Final washing process (1g/L NaCl)	8.00		216
Ultra-pure water	7.00		0.0182

As can be seen in Table 2 values, when the ISO3071:2005 and AATCC 81-2006 methods were applied, the pH values in the after washing and before softening stages showed differences due to the variations in the application of the test procedure. The fact that conductivity was mostly the result of the elecrolyte used in dyeing can be seen from the increase in these values in parallel with the pH and color depth of the samples. The electrolyte value was rather low due to to efficiency of the washing steps in that firm.

3.2 The pH values of the softened materials

The cotton materials dyed according to various recipes taken from Ekoten A.S. had similar pH values to those before the softening treatment as were mentioned in Table 2. The softening treatment stated in 2 was applied to both colored and white materials. The pH values measured after the treatment can be found in Table 3.

In accordance with the results of Table 3, the pH values of the softened materials were significantly reduced and limited in Öko-tex Standard 100.

Table 3. The pH values of the softened materials

	pH			
	Acetic Acid		Neutracid Acid	
Material Color	**ISO 3071: 2005**	**AATCC 81:2006**	**ISO 3071: 2005**	**AATCC 81:2006**
Brown	6.19	6.45	6.09	6.87
Red	6.77	6.94	6.67	6.70
Blue	6.15	6.70	6.01	6.98
Violet-pink	6.32	6.68	6.16	7.02
Black	6.12	6.35	6.20	7.04
Grey	6.44	6.63	6.73	7.03
Top white	6.09	6.20	6.17	6.73
Fuchsia	6.59	6.62	6.35	7.13
Pale pink	6.33	6.70	6.58	6.68

3.3. The pH and color fastness of fabrics after storage

The pH values obtained after the softened materials had been left to wait for 104 days for two different conditions stated in 2 were as in Table 4.

Upon the evaluation of Table 4 along with Table 3, it can be clearly seen that the pH values of all the materials increased as a result of the storing. That the temparature and humidity of the medium had a significant effect on this change could be understood from the fact that Condition 2 values yield higher pH values for each sample and test method. The difference in the pH change created by softening with Neutracid NV and acetic acid could not be clearly seen. This might be due to the drying of the fabrics in laboratory machine, in Mathis. Some of the results that are obtained were above the Öko-tex Standard 100 limits especially when the AATCC 81-2006 test method had been applied.

Table 4. The pH values of samples after storage

	pH							
	Acetic Acid				Neutracid Acid			
	Condition 1		Condition 2		Condition 1		Condition 2	
Material Color	**ISO 3071:2005**	**AATCC 81:2006**	**ISO 3071:2005**	**AATCC 81:2006**	**ISO 3071:2005**	**AATCC 81:2006**	**ISO 3071:2005**	**AATCC 81:2006**
Brown	6.56	7.23	6.73	7.65	6.53	7.48	7.01	7.58
Red	6.95	7.30	7.15	7.78	7.00	7.43	7.20	7.75
Blue	6.67	7.26	7.08	7.43	6.71	7.56	6.96	7.67
Violet-pink	6.59	7.15	6.90	7.85	6.67	7.43	7.08	7.88
Black	6.60	7.66	6.84	7.90	6.69	7.51	6.92	7.80
Gray	6.86	7.61	7.10	7.65	6.92	7.47	7.06	7.58
Top white	6.78	7.44	7.01	7.73	6.70	7.32	7.03	7.65
Fuchsia	6.92	7.42	7.11	7.59	6.62	7.56	7.06	7.52
Pale pink	6.73	7.38	6.99	7.50	6.88	7.35	7.00	7.59

*Condition 1: 30±2 ºC temparature, 80 % ±2 RH, Condition 2: 20±2 ºC temperature, 65 % ± 2 RH

The water, washing with detergent and rubbing fastness of the samples after the waiting were shown in the Table 5, 6, 7, 8.

Table 5. The fastness values of samples that were treated with cationic softening, the pH adjustment of which were done with acetic acid, and kept in storage according to Condition 1.

Material Color	Water fastness (ISO 105 E01)							Rubbing fastness (BS EN ISO 105 X12)		Washing fastness (BS EN ISO C06)						
		Staining									Staining					
	Color Change	CV	CO	PA	PES	PAC	WO	Dry	Wet	Color Change	CV	CO	PA	PES	PAC	WO
Brown	3-4	4-5	3-4	3-4	4	4-5	4	4	3	3-4	4-5	3-4	3-4	4-5	4-5	4
Red	3-4	4-5	3-4	4	4	4-5	4-5	3-4	3	3-4	4	3-4	4	4-5	4-5	4-5
Blue	3-4	4-5	4	3-4	4	4-5	4-5	4	3-4	4	4-5	4	4	4-5	4-5	4-5
Violet-pink	4	4-5	4	4	4	4-5	4-5	4	3-4	4	4-5	4	4	4-5	4-5	4-5
Black	3-4	4-5	3	3-4	4	4-5	4	3	2-3	3-4	4-5	3-4	3-4	4	4-5	4
Gray	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4	4-5	4-5	4	4-5	4-5	4-5	4-5
Fuchsia	3-4	4-5	3-4	3-4	4	4-5	4-5	4	3-4	4	4-5	4	4-5	4-5	4-5	4-5
Pale pink	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5

*Condition 1: 30±2 ºC temparature, % 80±2 RH

Table 6. The fastness value of the sample that were treated with cationic softening, the pH adjustment of which were done with Neutracid NV, and kept in storage according to Condition 1.

Material Color	Water fastness (ISO 105 E01)							Rubbing fastness (BS EN ISO 105 X12)		Washing fastness (BS EN ISO C06)						
		Staining									Staining					
	Color Change	CV	CO	PA	PES	PAC	WO	Dry	Wet	Color Change	CV	CO	PA	PES	PAC	WO
Brown	3-4	4-5	3-4	3-4	4-	4-5	4	4	3	4	4-5	4	3-4	4-5	4-5	4
Red	3-4	4-5	3-4	4	4	4-5	4-5	3-4	3	3-4	4-5	3-4	3-4	4	4-5	4-5
Blue	3-4	4-5	4	3-4	4	4-5	4-5	4	3-4	4	4-5	3-4	3-4	4-5	4-5	4-5
Violet-pink	3-4	4-5	4	4	4-5	4-5	4-5	4	3-4	4	4-5	3-4	3-4	4-5	4-5	4-5
Black	3-4	4-5	3	3	4	4-5	4	3	2	3-4	4-5	3-4	3-4	4-5	4-5	4
Gray	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4	4	4-5	4-5	4-5	4-5	4-5	4-5
Fuchsia	3-4	4-5	3-4	3-4	4	4	4-5	4	3-4	3-4	4-5	4	4	4-5	4-5	4-5
Pale pink	4-5	4-5	4-5	4	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5

*Condition 1: 30±2 ºC temparature, % 80±2 RH

While the initial fastness values of particularly the samples with dark colors such as brown, red, purple, blue, black and fuchsia are not found in the fastness table, these values could be considered to be mim. 4C (color change)/ 4S (staining) including wet rubbing fastness, the washing, water and rubbing fastness values are seen to have dropped 1-2 points depending on the pH value increasing in parellel with the wait.

The decreases are apparent in all the colors except for grey and pale pink regardless of the waiting conditions and acid type used in softening. If acetic acid and tampon acid have been used under the terms of Condition 2. The fastness values of grey and pale pink fall a little bit- by about half a point. A remarkable point is that the samples contain lycra and the brown and black colors are double

dyed. Only the Co part of the black fabric is dyed. The PA was obtained already dyed from the supplier and the fastness value was high owing to the fact that the firm that provided the samples had a certain quality standard and the after alkali pH and washing processes of each party were done under considerable control.

Table 7. The fastness value of the samples that were treated with cationic softening, the pH adjustment of which were done with acetic acid and then kept in storage according to Condition 2.

Material Color	Water fastness (ISO 105 E01)							Rubbing fastness (BS EN ISO 105 X12)		Washing fastness (BS EN ISO C06)						
	Color Change	Staining								Color Change	Staining					
		CV	CO	PA	PES	PAC	WO	Dry	Wet		CV	CO	PA	PES	PAC	WO
Brown	3-4	4-5	3-4	3-4	4	4-5	4	4	3	3-4	4-5	3-4	3-4	4-5	4-5	4
Red	3-4	4-5	3-4	4	4	4-5	4-5	3-4	3	3-4	4-5	3-4	3-4	4	4-5	4-5
Blue	3-4	4-5	4	3-4	4	4-5	4-5	4	3	3-4	4-5	4	3-4	4-5	4-5	4-5
Violet-pink	3-4	4-5	3-4	4	4-5	4-5	4-5	4	3-4	4	4-5	3-4	3-4	4	4-5	4-5
Black	3-4	4-5	3	3-4	4	4	4	3	2	3-4	4-5	3-4	3-4	4-5	4-5	4
Grey	4-5	4-5	4-5	4	4-5	4-5	4-5	4-5	4	4-5	4-5	4-5	4-5	4-5	4-5	4-5
Fuchsia	3-4	4-5	3-4	3-4	4	4-5	4-5	4	3-4	3-4	4-5	4	4-5	4-5	4-5	4-5
Pale pink	4	4-5	4-5	4	4-5	4-5	4-5	4-5	4	4	4-5	4-5	4-5	4-5	4-5	4-5

***Condition 2:** 20±2 ºC temperature, %65± 2 RH

Table 8. The fastness value of the samples that were treated with cationic softening, the pH adjustment of which were done Neutracid NV, and kept in storage according to Condition 2.

Material Color	Water fastness (ISO 105 E01)							Rubbing fastness (BS EN ISO 105 X12)		Washing fastness (BS EN ISO C06)						
	Color Change	Staining								Color Change	Staining					
		CV	CO	PA	PES	PAC	WO	Dry	Wet		CV	CO	PA	PES	PAC	WO
Brown	3-4	4-5	3-4	3-4	4	4-5	4	4	3	3-4	4-5	3-4	4	4-5	4-5	4
Red	3-4	4-5	3-4	4	3-4	4-5	4-5	3-4	3	3-4	4-5	3-4	3-4	4	4-5	4-5
Blue	4	4-5	4	3-4	4	4-5	4-5	4	3	3-4	4-5	3-4	3-4	4-5	4-5	4-5
Violet-pink	4-5	4-5	4	4-5	4-5	4-5	4-5	4	3-4	4	4-5	4	4	4-5	4-5	4-5
Black	3-4	4-5	3	3-4	4	4-5	4	3	2	3-4	4-5	3-4	3-4	4-5	4-5	4
Grey	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4	4	4-5	4-5	4	4-5	4-5	4-5
Fuchsia	3-4	4-5	3-4	4	4	4	4-5	4-5	3-4	3-4	4-5	3-4	3-4	4-5	4-5	4-5
Pale pink	4	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4	4	4-5	4	4-5	4-5	4-5	4-5

***Condition 2:** 20±2 ºC temperature, %65± 2 RH

As is known, the reactive dyestuff is attached to the covalent bond with fibre in the alcali medium and the dyestuff hydrolized by washing is kept away. The finished pH will be between 5-7 in a well fixed dyestuff depending on an effective washing and the pH value of the softening liquid. The samples were not directly wrapped in foil as in the production stage but packaged after 4 hours of conditioning and therefore the results reflect only the effect of the storage conditions. As the heat and moisture values increase and the hydrolized dye-fibre bonds are cleavaged the pH and fastness values may change.

4. Conclusion

In this study, the pH and fastness values of nine knitted fabrics that had been kept in two different conditions after softening were evaluated. According to the results of the experiment, the waiting conditions had a significant role in the decrease in pH and fastness values. Two different test procedures were used to measure the fastness values. The values obtained might differ in accordance with the method that had been used. Therefore, it was really crucial that the test procedure be openly explained in the deals made with the customer. The effect of the acid used in softening was not clearly observed, which is attributable to the fact that these experiments were done in laboratory conditions.

In this study, which was carried out as a model for management, the real production conditions were not obtained on account of the fact that the samples taken after the dyeing process were dried under laboratory conditons, the material taken out of the drier cooled for a short while as it was just a sample and a certain amount of humidity existed after conditioning. That's why whereas, according to Öko-tex Standard 100, the pH values obtained after waiting 104 days were below the limits when the ISO 3071:2005 test method was used, they were above the acceptance criteria according to AATCC 81-2006. However, it's not uncommon to see materials with a pH value above 8 according to ISO 3071:2005 standard and with fastness values that have been considerably decreased on the market as the washing which is a costly treatment, cannot be done properly, the softening pH is adjusted with acid, which becomes ineffective in the dryer, the material taken out of the dryer is continuously packaged in foil without waiting and kept in unfavorable conditions. When this problem shows up before the confection stage, it leads to the customer's complaints and even to demands for refund and when it is not noticed, it causes low fastness, makes the skin dirty because of friction and dirties the laundry it is washed together with in the

washing machine. And with the high pH and low fastness values, it also causes some usage problems such as itching and allergic reactions. Considering that average temperatures will continue to rise in the coming years due to global warming, it is postulated that ph and fastness values of finished fabrics may exhibit further changes as a result of environmental conditions. In conclusion, addressing the effects of various atmospheric conditions on stored fabrics in detail is very important with a view to determining useful life and performance values of the processed final products.

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