

Research Article

Improvement of the Comfort Features of Denim Products

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Abstract

Today, while people's expectations from textile materials are increasing, the comfort features expected in casual clothes are also increasing. Some important parameters in terms of comfort are protection against wind and rain conditions; protection from the cold; passage of body vapor through layers of clothing; providing the necessary freedom of movement of the garment, etc. The aim of the project is the thermal comfort feature that includes a chemical and membrane layer in a multi-layered structure; is to produce breathable (water vapor permeable) and water-repellent denim fabric and to determine the optimum production method. In this context, optimization studies were conducted by applying membrane and chemicals to the denim fabric. Water vapor resistance, air permeability, capillary wetting, thermal resistance, thermal conductivity, thermal absorbance, and bond strength tests were applied to the product created within the scope of this project. In the experiments, better results were obtained in the air permeability and water vapor resistance parameters of the 10 g/m², polyurethane membrane laminated water-repellent silicone coated sample compared to the other membranes. It was observed that the percent of vertical capillary wetting in the rigid fabric was higher than the membrane laminated, and water repellent applied samples. When different membranes were evaluated, there was no enormous difference between thermal resistance, thermal conductivity, and thermal absorbance values, but the best values of separation bond strength were observed in the sample with 10 g/m² polyurethane membrane and silicon water-repellent outer coating.

Keywords: denim product comfort, breathability, membrane, water vapor permeability, water repellency

1. Introduction

In recent years, denim fabrics are among the most preferred fabric types in the textile industry due to their special qualities. In this sector where competition is at a high level, it is very important to obtain new products with high added value through research-development and product-development studies carried out in order to be innovative and to lead the sector [1].

The changes in the features expected from clothes along with today's rising living standards have brought the use of laminated fabrics to become widespread and the importance of mechanical (such as tensile strength) and comfort properties (such as water vapor permeability, air permeability) that can be achieved with these products [2]. One of the most important parameters of comfort is thermal comfort. Thermal comfort is related to the thermal and water vapor permeability properties of clothing. Thermally comfortable clothing preserves body temperature (temperature and humidity) [3]. Breathability indicates the degree to which a fabric is actively breathing. While materials should easily transfer air and spread water vapor to the environment in order to provide more breathability, sweat or moisture should be evaporated from the skin and water droplets should be prevented from entering the fibers in order to provide thermal comfort in routine activities [4].

The subject of our project is the development of breathable and water-repellent denim products with thermal comfort properties, which include a multilayered chemical and membrane layer, and the determination of the optimum production process. While conventional denim products do not have technical textile features, the product to be developed with this project will also have technical textile features, although it has a standard denim appearance. Unlike traditional denim products, a new product with breathability and water repellency is targeted. In addition to standard chemicals, the determination of new chemical and membrane types and their application in denim products are among the important innovative works of the project.

The aim of the project is to create a product with air permeability and water repellent properties for the relevant customer group, as well as to determine the most suitable chemical and membrane for the product, and to combine it with denim fabric by determining the appropriate type and optimum conditions. It is aimed to evaluate the application conditions in terms of criteria such as cost, lightness, washing resistance and to design and implement the most suitable recipe and process.

2. Materials and Methods

Within the scope of the project, researching chemicals and membranes that can be used in denim products and selecting suitable products; Studies were carried out to determine the optimum conditions, to apply them on the product and to test and evaluate their effects on the finished product.

2.1. Laboratory scale membrane applications (breathability)

The raw material, structure (porosity), density, thermal properties, appearance, water vapor permeability, water vapor resistance, thickness and weight, airtightness properties of the membrane selection were evaluated. Evaluations were made by laminating the polyurethane membrane with two different properties and weights.

2.2. Laboratory scale chemical coating applications (water repellency)

Water-repellent coatings were made by applying two different chemicals and water-repellent chemicals to the cotton fabric, and then the physical and thermal comfort parameters were tested with and without washing, and the results were interpreted.

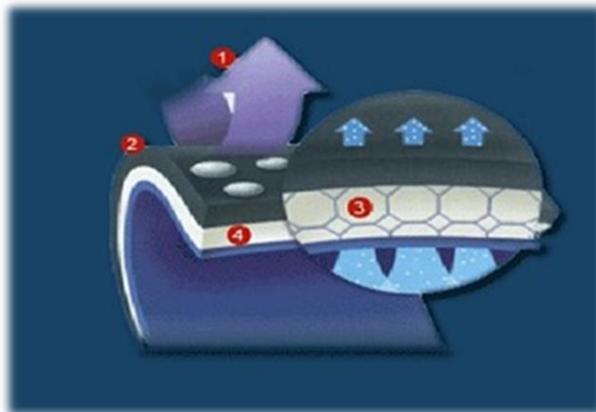


Figure 1: The structure of the layered fabric (1, Air and water blocking; 2, Outer layer; 3, Denim fabric; 4, Membrane Layer)

2.2. Testing performance characteristics

As a result of the trials, the samples; water vapor resistance , air permeability, thermal resistance, thermal conductivity, thermal absorptivity, capillary wetting, transfer wetting and Alambeta thickness tests were applied.

3. Results

The sample definitions for comparison are as follows; Rigit, no action taken; Sample 1, A membrane and X water repellent chemical were applied; Sample 2, A membrane and Y water repellent chemical were applied; Sample 3, B membrane applied.

Table1: Abrasion Test Results (Without Industrial Washing) (TS EN ISO 12947-2)

Trial No.	Abras. % 5000 dev.	Abras. % 10.000 dev.	Abras. % 15.000 dev.	Abras.% 20.000 dev.	Separation bond strength	Fabric Hardness
Rigid -No Washing	4,9	1,7	1,2	0,6	-	A: 0,55 Ç:0,65
Sample No. 1 Without Washing	3,9	0,6	0,6	0,9	12,2	A: 2,72 Ç:2,30
Sample No. 2 Without Washing	0,6	1	0	0,6	7,7	A:2,92 Ç:2,32
Sample No. 3 Without Washing	2,4	1,5	0,5	0,2	3	A:3,26 Ç:2,47

As seen in Table 1.; It is seen that the weight loss gradually decreases in the abrasion test of the unwashed samples in the trials where the membrane no.1 and water-repellent coating was applied, and the membrane no.3 was applied. It is seen that the water repellency chemical used in the sample no. 2 significantly prevents the weight loss in the abrasion resistance test compared to the other samples. Since the rigid fabric does not have a second layer structurally, a test for tensile bond strength was not performed. Separation bond strength in other unwashed samples; The separation between the membrane layer and the lining fabric indicates the bond strength. The cleavage bond strength (N) test result indicates the strength of the liner to separate from the membrane

surface. While the membrane was unwashed from the surface of the fabric on which it was laminated, it could not be separated by the separation bond strength test.

Table 2: Capillary and Transfer Wetting Test Results (No Industrial Washing)

Example	Capillary Wetting % Vertical	Transfer soak (0-5 min)	Transfer soak (5-10 dk)	Transfer soak (10-15 dk)	Transfer soak (15-20 dk)	Transfer soak (20-25 dk)	Transfer soak (25-30 dk)
Rigid Fabric Without Washing	14,4	24.37	30.58	34.40	37.20	40.36	43.18
No. 1 No Washing	1,3	25.63	33.87	42.21	48.70	54.88	60.98
No. 2 No Washing	2	18.78	28.83	37.37	44.51	52.77	60.19
No. 3 No Washing	0,8	25.84	36.31	44.37	51.37	56.88	61.37

When the test results of the unwashed products are compared, it is seen that the % of vertical capillary wetting in the rigid fabric is higher than the other 3 treated samples. Capillary movement of water between fibers and yarn in rigid fabric is faster than other samples with membrane lamination and water repellency coating. Therefore, at the end of a certain time, the vertical rise distance of water has the highest value (14.4%) in rigid fabric. The ability of fibers to keep water molecules on the fiber surface affects the wettability of fabrics. The wetting angle has a higher value than the rigid sample in the experiments with water repellency. This shows that the factor affecting the wetting behavior of water-repellent fabrics is the water-repellent treatment of the fabric (Table 2).

Table 3: Capillary and Transfer Wetting Test Results

Example	Water Vapor Resistance (Ret m ² Pa/W)	Air Permeability (l/m ² s)	Water Repellent	Waterproofing (cm Su Sütünü)	Thermal Resistance (Ret)	Thermal conductivity Alambeta (W/mK)	Thermal resistance Alambeta	Thermal absorption Alambeta (Ws 1/2 m ² K)
Rigid Fabric Without washing	4,8	35,6	ISO 1	206,3	0,0066	0,070	0,0112	244,1
Rigid Fabric Wash	4,2	32	ISO 0	The test could not be performed because the sample was completely wet	0,0100	0,065	0,0174	178,7
Exp. 1 Without washing	6,9	1,56	ISO 3	> 10000	0,0005	0,072	0,0115	246,8
Exp. 1 Wash	5,9	1,05	ISO 1	6960	0,0020	0,069	0,0186	244,1
Exp. 2 Without washing	The fabric is not water vapor permeable.	The fabric is not airtight.	ISO 3	> 10000	0,0004	0,069	0,0121	257,6
Exp. 2 Wash	7,2	The fabric is not airtight.	ISO 1	6960	0,0030	0,068	0,0184	244,6
Exp. 3 Without washing	The fabric is not water vapor permeable.	The fabric is not airtight.	ISO 3	> 10000	0,0130	0,073	0,0115	267,3
Exp. 3 Wash	47	The fabric is not airtight.	ISO 1	6960	0,0030	0,066	0,0193	199,5

It was found that the application made on samples 2 and 3 prevented water vapor permeability; However, due to the removal of the sizing chemical after washing, it can be said that it regains its water vapor permeability to some extent, although it is less than the rigid fabric. Again, it was observed that applications no. 2 and 3 prevented air permeability in the products. A decrease was observed in the water repellency values of

all samples after washing. Although the waterproofing results were obtained similarly in all samples, a decrease was observed in the values after washing. However, it is thought that the application gives a successful result since there is a good improvement compared to the rigid product. When the thermal resistance and thermal absorption values were compared, it was observed that the treated samples provided some improvement compared to the rigid fabric (Table 3).

4. Discussion and Conclusion

In the experiments, better results were obtained in the air permeability and water vapor resistance parameters of the 10 g/m², polyurethane membrane laminated water-repellent silicone coated sample compared to the other membrane. It was observed that the percent of vertical capillary wetting in the rigid fabric was higher than the membrane laminated, and water repellent applied samples. When different membranes are evaluated, there is no enormous difference between thermal resistance, thermal conductivity and thermal absorbance values, while the best values of separation bond strength were seen in the sample with 10 g/m² polyurethane membrane and silicon water-repellent outer coating.

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