The Effect of Enzyme Finishing on the Mechanical Properties of Tencel Fabric

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1. Introduction

Tencel fabric has been considered as a new natural fiber of the future because it is 100% biodegradable and wood pulp used is grown on land not suitable for food crops. Tencel fabric has a few mechanical properties that it is natural, strong, and has a good feel. These properties are acquired by enzyme-finishing.

Enzyme have been used for improving a cleaning performance and fabric desizing since the beginning of the 20th century. Lately, fabrics were treated with enzymes for the purpose of improving surfce properties.

Some studies that natural-fiber fabrics treated with enzymes[1-4] were attempted but there has been little traces of the study about the effects of enzymes on the mechanical properties and handle of Tencel fabric although Tencel fabric was mainly finished by enzymes. In this paper, basic mechanical properties of Tencel fabric such as tensile, shear, bending, compression, and surface properties, were investigated through the finishing stages, especially enzyme-finished stage, by the KES-FB system.

2. Experiment

Three fabrics, the loomstate, at the stage of before finishing, and the enzyme-finished stage, were measured by KES-FB system. At the stage of before finishing, the desizing and the scouring had an important effect on the mechanical properties and handle of the Tencel fabric. The machine for enzyme-finishing was a large-sized washer of rotary type. The Tencel fabric was washed and beated simultaneously after treated wih enzyme to eliminate the fibril of short fiber, which deteriorated the quality of the fabric. A key point for the mechanical properties and handle, which indicated the quality of fabric was considered as enzyme-finishing.

The mechanical properties, such as tensile, bending, shear, compression, and surface properties of the Tencel fabric, were measured by KES-FB system. Sample size was 20×20 cm. All measurements were carried out at 65 ± 2%RH and 293 ± 1K temperature. The 16 mechanical parameters were obtained from those mechanical properties.[5,6] For

the SEM examination, three fabrics, loomstate, at the stage of before finishing, and enzyme-finished stage were examined to prove the effects of enzyme-finishing.

3. Results and Discussion

The trends of tensile parameters were shown in Fig 1. The linearity(LT) was decreased and the tensile energy(WT) was increased by enzyme-finished stage. It was inffered that the fabric became elastic and soft significantly in their tensile properties at the stage of before finishing. And at the enzyme-finished stage, the fabric became even softer and more elastic than that of the stage of before finishing. The gap of tensile resilience(RT) originated in each stage was rather small.

All parameters, shear stiffness(G), hysteresis of the shear force at 0.5 °(2HG), and 2HG5 which was hysteresis of the shear force at 5 ° were greatly decreased at the stage of before finishing. And all shear parameters was decreased a little bit at the enzyme-finished stage. So it was clear that the Tencel fabric was became very soft and elastic through the finishing stages. It was shown in Fig 2.

Bending rigidity(B) and hysteresis of the bending moment(2HB) decreased considerably at the stage of before finishing. And at the enzyme-finished stage, bending rigidity(B) and hysteresis of the bending moment(2HB) decreased a little bit. It meaned that the fabrics became very pliable, soft, and elastic through the finishing stages.

The friction among fibers or yarns decreased remarkably at the before-finish stage which was including some processes like scouring and desizing. By the enzyme finishing, bending rigidity(B) and hysteresis of the bending moment(2HB) decreased at enzyme-finished stage. By the way, what must be mentioned was the bending hysteresis curve of enzyme-finished stage because it had two important properties. The first was that the initial slope was close to the mean slope. The second, at the conversion point from face to back, bending moment was constant for a time. The changes of the bending parameters were shown in Fig 3.

The change of the compression / thickness curve was small at the stage of before finishing. At the enzyme-finished stage, the linearity(LC) and the compressional energy(WC) were increased. The compressional resilience(RC) was decreased slightly through the finishing stages. The changes in the compressional parameters of the Tencel fabric through the finishing stages were shown in Fig 4.

The frictional coefficient(MIU) was increased a little through the finishing stages and its mean deviation(MMD) was changed slightly. The geometrical roughness(SMD) was increased a little at the stage of before finishing but it was increased remarkably at the enzyme-finished stage. It must be caused by protruding microfibrils by enzyme -finishing in Tencel fabric, which made the soft touch of the surface and feeling of

fullness of Tnecel fabric. The changes of the frictional parameters were shown in Fig 5.

Tencel fabric was different from other fabrics on the point that microfibrils were generated on the fiber surface by enzyme-finishing, so the Tencel fabric needed lots of sizing agents(Ingray). The stiffness of the Tencel fabric was weakened very much by the desizing and the scouring, and the effect of the desizing was so large.

Enzyme finishing has been done to the natural-fiber fabrics like cotton, or cotton/wool blended. The main purpose of the enzyme finishing to the natural-fiber fabrics were decreasing the protruding loose fibers for decreasing abrasion resistance and increasing pilling, shrinkage, and resistance to wrinkle.[7] In case of Tencel, microfibrils were generated from its unique microstructure, which implied that crystalline areas were oriented along the fiber axis. Namely, the effects of enzyme-finishing on the Tencel fabric was basically different from those of the natural-fiber fabric because the latter was treated for cleaning and desizing, or getting rid of loose fibers but the former was treated for getting unique handle and mechanical properties.

Consequently, the effects of enzyme finishing of the tencel fabric was similar to those of the weight reduction finishing of the silk fabric by eliminating the sericine. And it was similar to the weights reduction finishing of polyester-fiber fabric for producing silk-like and peach-skin type polyester-fiber fabric. A noteworthy thing was the microstructure of the Tencel. The crystalline areas of the Tencel were originated in the direction of the fiber axis, and microfibrils were generated along the axis, therefore the unique handle of the Tencel fabric could be acquired.

4. Conclusions

1. Tencel fabric was very hard and stiff in the loomstate, whereas it was treated through the finishing stages it became very smooth and soft.
2. At the stage of before finishing, especially desizing and scouring, Tencel became very soft. More sizing agents was used than other fabrics, such as cotton, wool, polyester-fiber fabrics, because microfibrils were generated on the surface of Tencel. So Tencel became very soft and elastic by the desizing and scouring.
3. Tencel was even softer by the enzyme-finished stage. Because the microfibrils were generated by the degradation caused by enzyme-finishing.
4. If the values of mechanical properties of enzyme-finished stage were compared with those at the stage of before finishing, it was known that the numerical difference was not considerable. But the difference of touch or handle between them were considerable.
5. Tencel had a unique handle with high strength and soft hand because of harmony between microstructure and mechanical properties.

6. Environmental and consumers' demands for making fabric looked and felt like high quality were supported by enzyme-finishing to the Tencel fabric.

5. References

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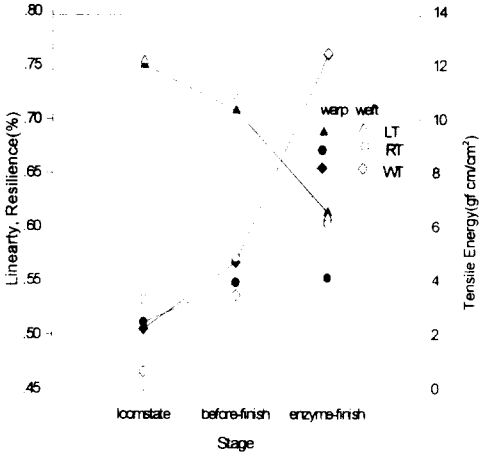

Fig 1. Changes of the tensile parameters through the finishing stages.

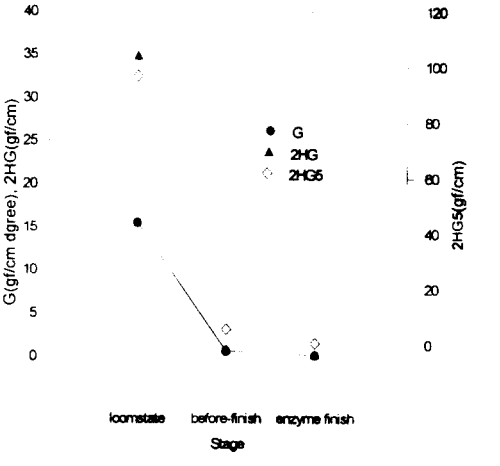

Fig. 2 Changes of the shear parameters through the finishing stages.

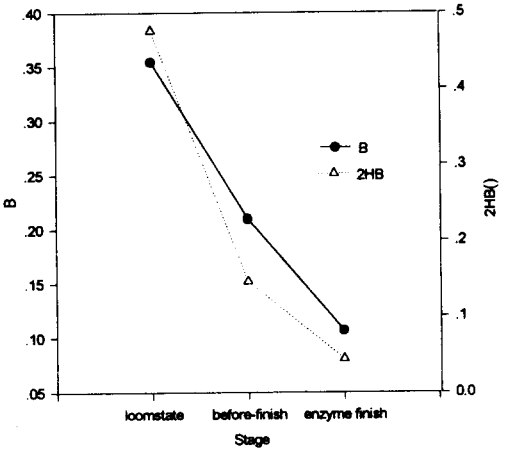

Fig 3. Changes of the bending parameters through the finishing stages.

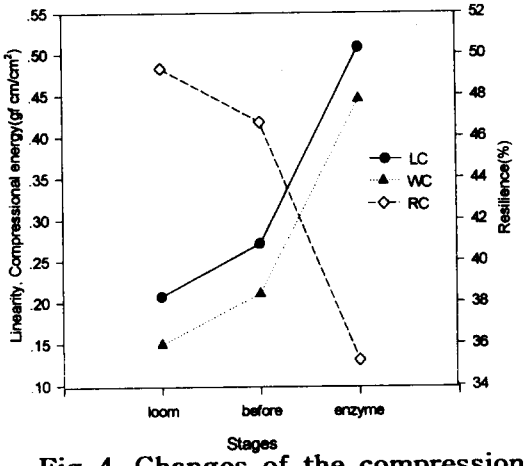

Fig 4. Changes of the compressional parameters through the finishing stages

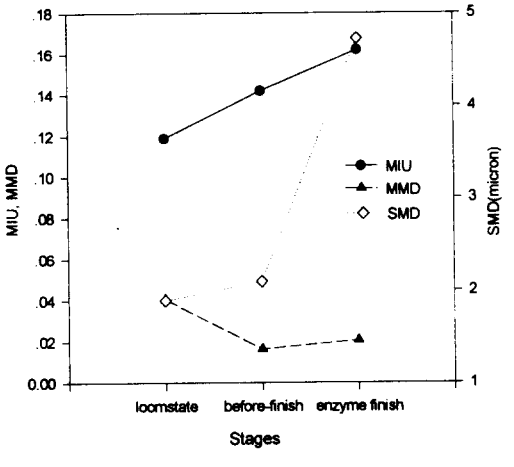

Fig 5. Changes of the surface properties through the finishing stages.