Crosslinking of Cellulose Fabric and Chitosan by Epichlorohydrin(ECH) in a Mercerizing Process

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INTRODUTION

Chitosan is a n under-utilized polymer which possesses many of the desired characteristics for this application; i.e., it is readily mineralized in the environment through the actions of microbes and weathering. These biopolymers are biocompatible, biodegradable, and biofuctional and are therefore utilized to good effect as special products in the surgical treatment of the human body, because chitosan has various practical properties such as microbial resistance, non-toxicity, biodegradability, and metal ion adsorption, many investigators have concentrated on applying chitosan to a wide variety of textiles.

The viscose rayon is the chemical fiber but it is so ecological and homing to nature because it is composed of 100% cellulose. The characteristics of viscose rayon excel in hygroscopic property, absorption, dyeing property, anti-conductivity, heat stability and drape. Generally rayon have been used in many of the same kind of products for which cotton is used. Otherwise, rayon have some defects that they have poorer dimensional stability, stretching and shrinking than cotton; and they lose strength when wet so that rayon must be handled carefully both in industrial processing and in home laundering. To improve this kind of defects we can use the crosslinking between fiber polymers, so we can increase the elastic recovery rate and decrease the absorption. This crosslinking can prevent from wrinkle and reduce the absorption, so we can get some profit to reduce the drying time, simultaneously the shrinkage of textile can be decreased.

The purpose of this study is to improve the defects of rayon to crosslink with chitosan by crosslinking agent ECH and to describe the change of hand of chitosan crosslinked viscose rayon fabrics. ECH was selected as a convenient base-catalyzed crosslinking agent. An advantage of ECH is that it does not eliminate the cationic amine function of chitosan.

EXPERIMENTAL

Materials and measurements

Chitin from red crab of the East sea was acquired from the Dongbo Chemical Company of Korea. Acetic acid (Aldrich), sodium hydroxide (Fluka), and ECH (Sigma) were used as reagent grade. Chitosan was prepared by deacetylation of chitin in an alkali solution of 50wt% NaOH and 10wt%, which was heated to 110℃ for 2hr. Chitosan was depolymerized by oxidizing agent, 0.5wt% sodium perborate($NaBO_3 \cdot 4H_2O$) at 65℃, for varying in reaction time from 0 to 60min ; the samples were labeled CHI-0, CHI-20, CHI-40, and CHI-60, the numbers referring to the reaction time(min). The characteristics of crosslinking were evaluated by degree of swelling and dyeability of acid dye. Physical properties of the chitosan crosslinked fabric were investigated using Kawabata Evaluation System(KES; KESFB-AUTO-A).

Crosslinking process of cotton fabric and chitosan

Figure 1 depicts a schematic drawing of the crosslinking process used in this study. A padding solution was prepared by dissolving 0-1.0wt% chitosan in a solution of 2wt% aqueous acetic acid and labelled as CHIX, X=0, 0.25, 0.5, and 1.0, the number referring to the chitosan concentration(% w/w). In addition to, it was prepared by using ECH, for varying in concentration from 0.0 to 10.0 × 10^{-2}M. The solutions were mechanically stirred for 5hrs in order to be homogenized; then the solutions left standing for 5hrs at 20 ℃. At this experiment, four different molecular weight chitosans were used for treating fabrics.

The cellulose fabric samples were first dipped in the padding solution for 10 minutes at 20℃ and then, pick-up is kept 100wt% by mangle roller. And subsequently, that fabric predried on pin frame at 130℃ for 2minutes and the cotton fabric were mercerized in 20%

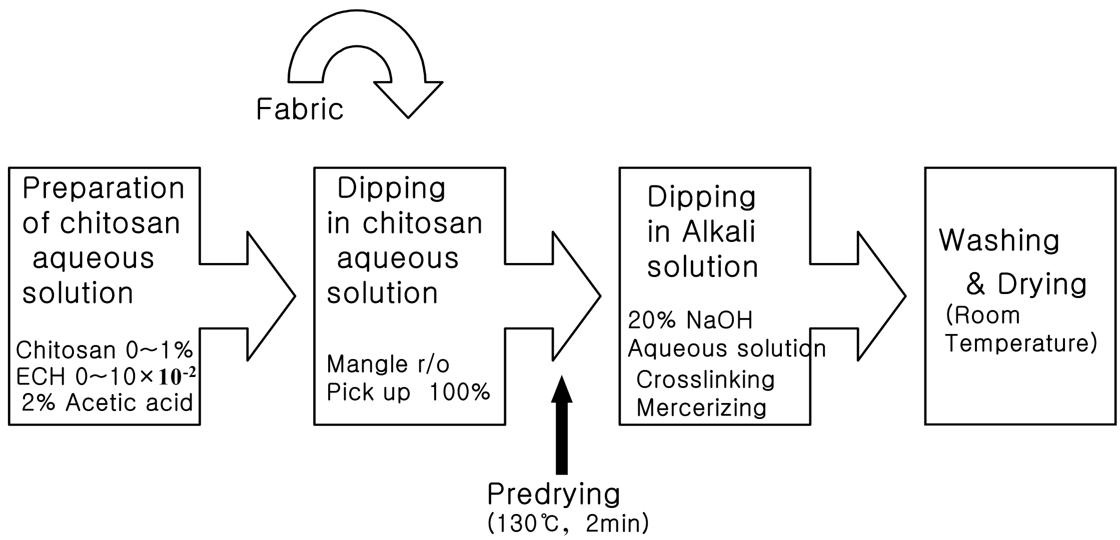
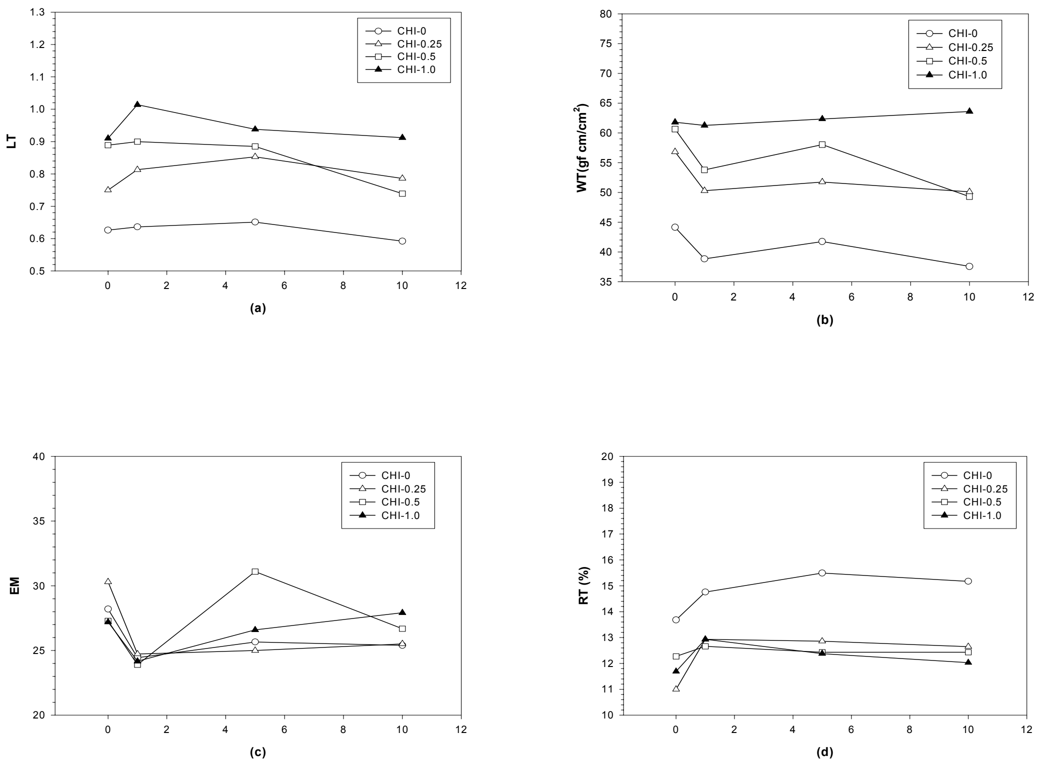


Figure 1. Schematic diagram of crosslinking apparatus.

aqueous NaOH solution, simultaneously crosslinked between cotton fabric and chitosan with epichlorohydrin in mercerizing bath. Finally, the fabric were washed throughly with distilled water and dried completely at room temperature.

RESULTS AND DISCUSSION



Concentration of epichlorohydrin(×10^{-2}M)

Figure 2. Effect of epichlorohydrin concentration(%) on tensile properties of rayon fabric
: (a) LT(linearity), (b) WT(tensile energy), (c) EM(maximum value of tensile strain), (d) RT(resilience).

Figure 2 showed the tensile property of crosslinked viscose rayon. The chitosan cross linked viscose rayon's tensile energy and tensile strain was decreased at 1wt% ECH. But LT(linearity) and RT(resilience) was increased at 1wt% ECH. Viscose rayon have many amorphousness parts and the arrangement is low. After viscose rayon crosslinked chitosan by ECH. The tensile strength is increased because the weak point was strengthen by increased coherence of molecules as the chitosan crosslinked viscose rayon by ECH.

As regarding bending rigidity and bending hysteresis in Figure 3, the crosslinking chitosan with rayon is suitable when the concentration of crosslinking agent ECH is 1 wt% and the concentration of chitosan is 10wt%. Like above case, the rayon is not easy to be bendable so it can be expected to get the efficiency of ventilation based on keeping enough space between body. As the consistency of chitosan increase, the bending strength was increased, and it assumes that ECH for crosslinking contributed to promo

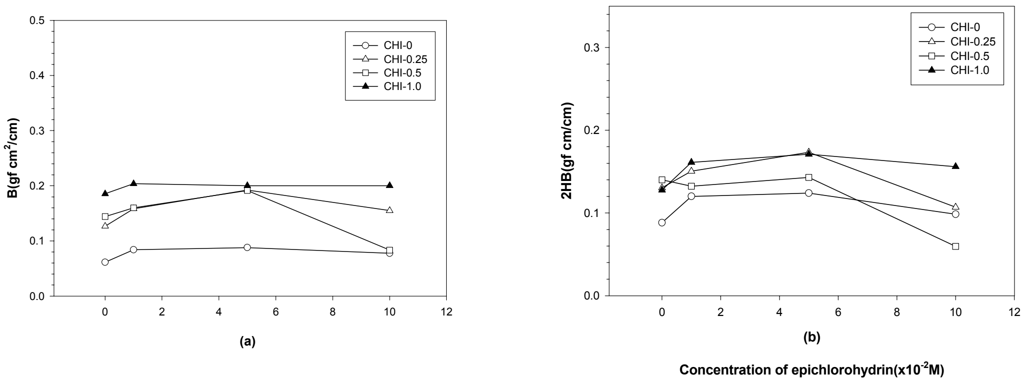


Figure 3. Effect of epichlorohydrin concentration on bending properties of Rayon fabric : (a) B(bending rigidity), (b) 2HB(bending hysteresis).

tion and endurance of chitosan crosslinking based on result of ECH effect test. It seems that the increase of bending property make the cross pressure between threads increase by chitosan crosslinked between threads of textile and the resistance to bending rigidity increase because the thickness of textile is thicker since chitosan was crosslinked and coated on the textile surface simultaneously.

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