

Application of Ultrasound in Anti-felting Finishing Process

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Abstract

In this paper ultrasound was applied in Savinase shrink-proof finishing process for wool fabric. A two-step procedure was adopted. Initially, hydrogen peroxide was used for pre-treatment in order to facilitate the subsequent enzymatic attack and to peel the outer scale layer effectively. The effects of enzyme concentration, temperature, time and ultrasonic power were explored through orthogonal experiments thoroughly. The results showed that ultrasound could remarkably speed up the scale-peeling process and greatly improve the shrinkage of wool fabrics. In contrast with the results obtained under conditions without the presence of ultrasound, much better shrinkages were obtained under ultrasound. Moreover, the weight loss and strength reduction were within acceptable limits. Therefore, ultrasound became a beneficial means for wool anti-felting treatment in enzymatic process. It helped to achieve better results in lesser time and lower temperature. The optimal technology was Savinase concentration (owf) 0.8%, temperature 50°C, pH=8.5, time 40 min, ultrasonic power 175 W and bath ratio 25:1. Under these conditions, the shrinkage, weight loss and tensile strength of treated sample were 1.1%, 5.40% and 417N respectively.

Keywords: Wool; Textile Finishing; Anti-felting; Enzyme; Ultrasound

1 Introduction

It is a long troublesome question for controlling the felting shrinkage in wool processing. This phenomenon which is called directional friction effect results from its unique scale structure of wool fabric. The Hercosett process is still the most widely-used industrialized method. However, this process can produce Absorbable Organic Halogen (AOX) by-products. People have done much work to search for an environmental benign substitution. The enzymatic one absorbed worldwide concern and showed promising future [1-7]. Enzymes might show a synergetic effect when they are used in combination with other treatment methods [8]. Some new technology such as supercritical CO₂ and low atmospheric plasma were also used for combined enzymatic

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process [8-11]. However, the enzymatic process is usually time-consuming and expensive. As a part of our study on seeking a green and practical anti-felting means [1-3], which should not only improve the quality of wool fabrics but also meet the needs for environmental protection, the effect of ultrasound was explored. As everybody knows, ultrasound does not interact directly with molecules to induce the chemical change. Instead, it causes cavitation which causes local extremes of temperature and pressure in the liquid where the reaction happens [12, 13]. It breaks up solids and removes passivating layers of inert material to give a larger surface area for the reaction to occur over. This in turn leads to wetting and swelling easier and faster. Both of these forward the reaction. Much work has been done on the wet processing in textiles [14], but only a little is found on wool functional finishing [15, 16]. Combining the advantages of pre-oxidation step in which green oxidant hydrogen peroxide was used and enzymatic treatment, the ultrasound is expected to benefit the scale peeling and accelerate the whole process, thus enhancing the treating effect and efficacy.

2 Experimental

2.1 Materials and Instruments

Material: 100% pure wool woven fabrics 221 g/m²; Savinase enzyme, provided by Novozyme China; Other chemical reagents were all purchased as commercial products.

Equipments: Thermostatic water bath (Shanghai Shuli Instrument Com. Ltd, China); Adventurer electronic balance (Ohaus Shanghai Com. Ltd, China); AATCC Fabric Testing Stability System (A/B) (American Whirlpool Corporation, US); HD026N-300 electronic fabric tensilemeter (Nantong Hongda Experimental Instrument Com. Ltd, China); KQ-250TDE Digital Ultrasonic Cleaner (Kunshan Ultrasonic Instrument Com. Ltd, China); XGQ-FA Series automatic washing and dehydrating machines; DHG-9023A Thermostatic oven (Shanghai Experimental Equipment Com. Ltd, China); UV-7054 PC UV-Vis spectrophotometer.

2.2 Finishing of Wool Fabrics

2.2.1 Determination of Enzyme Activity

The activity of Savinase enzyme was determined according to Chinese standard SB/T 10317-1999.

2.2.2 Hydrogen Peroxide Pre-oxidation

30% (V/V) hydrogen peroxide was used in all pre-oxidation process. The relevant parameters were given as below: Hydrogen peroxide 22.5mL/L, sodium silicate 0.7% (w/w), sodium carbonate 0.2% (w/w), liquor to goods ratio 30:1, temperature 50°C, time 30 min. After pre-oxidation, the treated fabrics were washed and dried for the next ultrasonic enzymatic process [1-3].

2.2.3 Ultrasonic Enzymatic Treatment

The treatment of wool fabrics was conducted in an ultrasound generator under the related