UDC 677.029

APPLICATION OF ENZYMES FOR CELLULOSIC YARN PROCESSING

ПРИМЕНЕНИЕ ФЕРМЕНТОВ ПРИ ПОДГОТОВКЕ ЦЕЛЛЮЛОЗОСОДЕРЖАЩЕЙ ПРЯЖИ

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ABSTRACT

ENYZYME, CELLULASE, COTTON YARN, BIOSCOURING, BIOTECHNOLOGY

The enzymatic treatment of cellulosic (cotton) yarn has been investigated. It was found that the use of cellulases before peroxide bleaching allows to produce the yarn with improved characteristics: capillarity and tensile strength increase by 21–29 % and 15–22 %, respectively, and bending rigidity decreases by 9–14 % compared to traditionally prepared yarn.

АННОТАЦИЯ

ФЕРМЕНТ, ЦЕЛЛЮЛАЗА, ХЛОПЧАТОБУМАЖНАЯ ПРЯЖА, БИООТВАРКА, БИОТЕХНОЛОГИЯ

Исследован процесс ферментной обработки целлюлозосодержащей (хлопчатобумажной) пряжи. Установлено, что применение целлюлаз перед пероксидной отбелкой позволяет получить пряжу с улучшенными характеристиками: капиллярность и разрывная нагрузка увеличиваются на 21–29 % и 15–22 %, соответственно, а жесткость пряжи уменьшается на 9–14 % по сравнению с традиционно подготовленной пряжей.

Introduction

The production and consumption of textile materials and products from natural fibers occupy one of the leading positions [1]. To ensure the high quality of textiles, the properties of cellulosic (cotton) yarn must correspond to certain requirements,

the main ones of which are high hydrophilicity and tensile strength.

To impart the necessary properties to cellulosic yarn, it is subjected to a number of physical and chemical treatments, the main stages of which are deacidification, souring, bleaching, and finishing. The goal of these processes is the partial removal of non-cellulosic impurities by exposure to aggressive chemicals [2]

In the past few decades, research into biochemical methods for preparing textile materials from cellulose fibers has acquired particular importance. Enzymes selectively react with the substrate and minimize the formation of by-products, are safely inactivated without causing harmful effects on humans and the environment [3, 4].

Materials and Methods

Yarn

Cellulosic (cotton) yarn produced by Rechitsa Textile Company (Belarus) was chosen as the object of the study, the characteristics of which are given in Table 1.

Table 1 – Properties of a sample of cotton yarn

Property	Value
Nominal linear density, tex	38.0
Actual linear density, tex	37.4
Tensile strength, cN	357
Elongation at break, %	6.35
Twist	37.5

Enzymes

For enzymatic processing of yarn, we used ENZITEX CKP (Ferment Company, Belarus), which is a liquid form of cellulase with an activity of at least 500 U/cm^3 and an optimal pH of 4.5-5.5 and an optimal temperature of 50–60 °C.

Textile auxiliaries

The wetting stage was carried out using complex preparation FORYL ALL-IN (Pulcra Chemicals, Germany) containing surfactants and complexing agents.

The finishing stage was carried out using Belfasin GTN (Pulcra Chemicals, Germany), a special cationic softener for cellulosic yarn.

Processing mode

Experimental studies of the process of enzymatic treatment of gray cotton yarn with subsequent peroxide bleaching (FORYL ALL-IN 1.5 g/l, hydrogen peroxide (60 %) 4.5 g/l, caustic soda 2.5 g/l) in a periodic manner has been conducted according to the scheme which is shown in Figure 1.

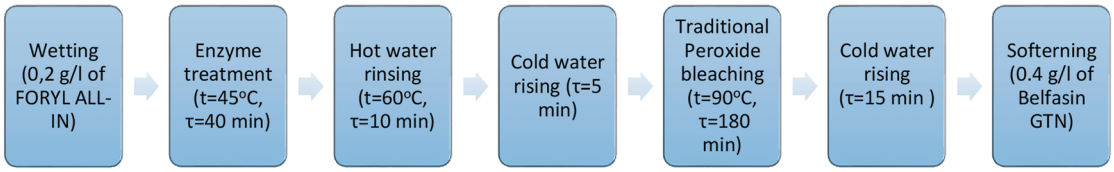

Figure 1 – Yarn processing mode

The assessment of the effect of enzyme preparations on the physical and mechanical properties of the yarn was carried out according to the following indicators: tensile strength, breaking elongation, bending rigidity, and capillarity of the yarn.

Results and discussion

The test results of yarn samples with and without enzymatic treatment are shown in Figures 2–5. Three replicates were carried out for each experiment; the figures show the average values.

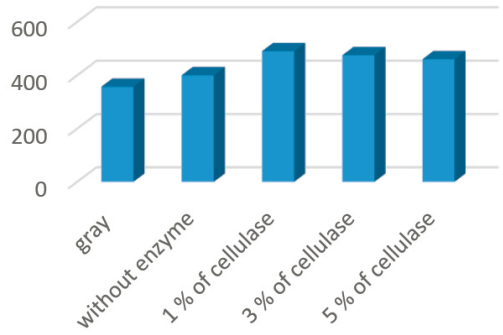

Figure 2 – Tensile strength of yarn

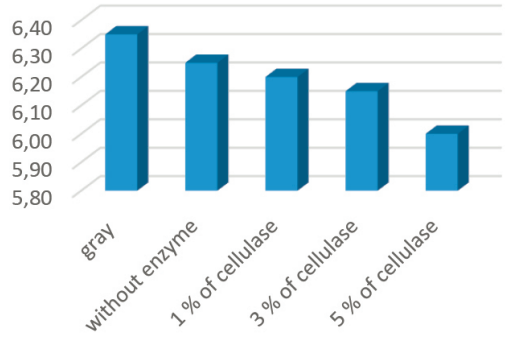

Figure 3 – Elongation at break of yarn

Enzymatic treatment has promoted additional strengthening of the yarn by an average of 30 % over the entire varying concentration range. With an increase in the concentration of cellulase, the breaking load of the yarn decreases slightly, but remains higher than for conventionally processed yarn. The elongation at break of biotreated yarn is less than for yarn without enzymatic treatment by 0.8-5.0 % and decreases with increasing enzyme concentration.

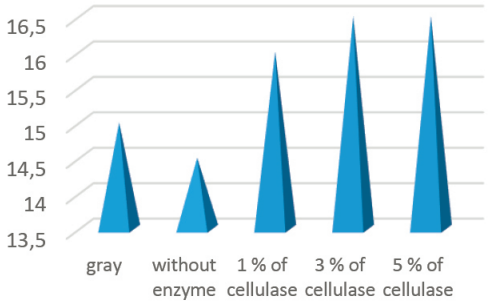

Figure 4 – Deflection of yarn

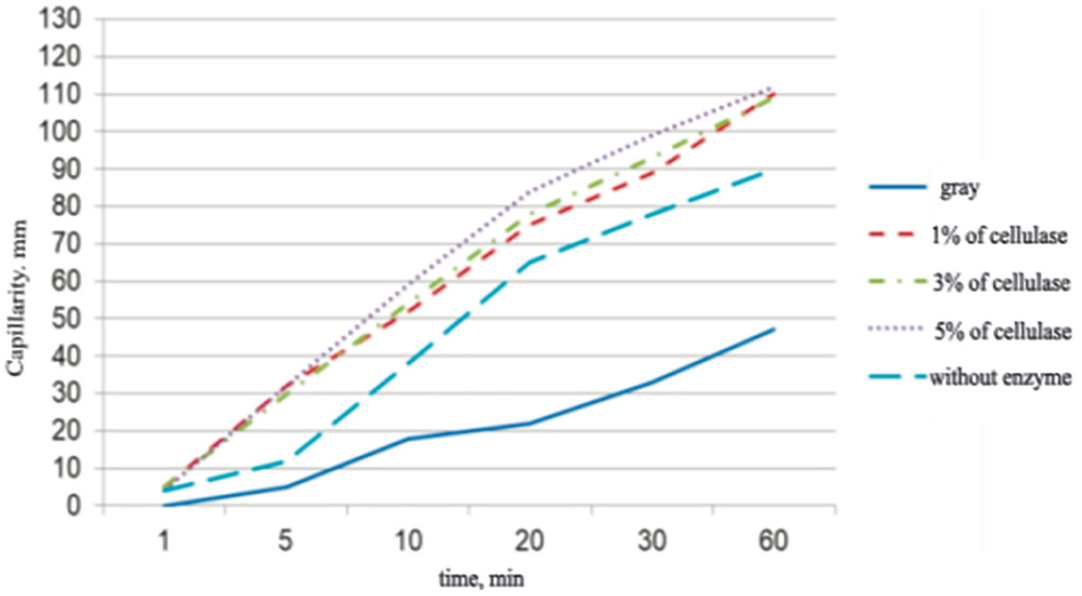

Figure 5 – Capillarity of yarn

The bending rigidity determined by the console method shows that bending rigidity reduces when the deflection increases. It was found that the bending rigidity of traditionally prepared yarn increased in comparison with gray, and for biotreated yarn decreased. It was shown the bending rigidity of the yarn is slightly reduced with the dosage of cellulase increases.

The capillarity of gray yarn does not exceed 50 mm/h, traditional peroxide bleaching enabled to produce yarn with a capillarity of 90 mm/h, and the capillarity of bioprocessed yarn was 110–116 mm/h depending on the concentration of ENZITEX CKP. Thus, the addition of a bioprocessing step provided an increase in the capillarity of the yarn by over 20 % compared to the yarn that had not undergone enzymatic treatment.

Conclusions

As a result of research, it has been shown that enzymatic treatment with the use of cellulase for cotton yarn processing enables to increase the tensile strength of the yarn by 15–22 %, increase the capillarity of the yarn by 21–29 % and reduce the bending rigidity by 9–14 % compared to the traditional processing method.

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