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ORIGINAL RESEARCH

Preparation and adsorption properties of amphoteric viscose fiber

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Abstract

Among the regenerated cellulosic fibers, viscose fiber is the most harmless material on human skin. Nonetheless, viscose fiber has some disadvantages such as low wet strength, high elongation, flammability, and poor color fastness. To improve adsorption and color fastness properties of viscose fiber, amphoteric viscose fibers were prepared. In the current study, viscose fiber was modified with 2,3-epoxy propyltrimethyl ammonium chloride and sodium chloroacetate using sodium hydroxide as catalyst. With adsorption performance of methyl orange and methylene blue as target dyes, the modification conditions were optimized in terms of temperature, time, and catalyst dosage with orthogonal test and single-factor experiment. The modified product was characterized using Fourier transform infrared spectrometry, scanning electron microscopy, ultraviolet spectrophotometry. Meanwhile, nitrogen content, degree of substitution, tensile strength, and adsorption property were measured. It was concluded that the best cationic reaction process conditions were reaction temperature of 70 °C, reaction time of 1 h, and sodium hydroxide dosage of 0.09 g, which was 1% of the amount of viscose fiber when the amount of etherifying agent was 30% of viscose fiber. The best anionic reaction conditions were reaction temperature of 70 °C, reaction time of 1 h, and 3.3 g of 10% sodium hydroxide solution. The adsorption properties of amphoteric modified viscose fiber towards methylene blue and methyl orange were excellent. The maximum adsorption of methylene blue and methyl orange was obtained at 1.483 and 0.234 mg g^{-1}, respectively.

Keywords Viscose fiber · Amphoteric · Chemical modification · Adsorption · Dyeing

Introduction

In 1891, Cross and his colleagues found that cellulose could be converted into its water-soluble sulfonate derivative in alkaline disulfide solution, and the viscose fiber was obtained by reduction [1]. In 1905, Muller further improved the production process of viscose fiber and realized its industrialization process [2]. In recent years, lyocell, modal, richel and other new varieties have been produced [3, 4]. Among the regenerated cellulosic fibers, the moisture content of viscose fiber is the most suitable for human skin. Viscose has the advantages of good spinning, comfortable wearing and not easily generating static electricity [5]. Viscose fiber also can be blended with all kinds of fibers, either natural or synthetic fibers [6]. It can not only be used as an excellent dressing material, but also has a wide application in industry, medical treatment, etc. [7, 8], but viscose fiber also has the disadvantages of low wet strength, high elongation, flammability and poor color fastness [9, 10].

To improve properties of viscose fiber, chemical modification is often carried out [11–13]. There are three hydroxyl groups in each glucose unit of viscose fiber, so a series of chemical reactions can be carried out, including esterification, etherification, cross-linking and grafting reactions [14–16]. In addition, the composites of viscose fiber with chitosan, polylactic acid and nano-silver particles have been widely studied and applied [17–19].

At present, the modification of viscose fibers mainly focuses on flame retardant, antibacterial, moisture absorption, dyeing, and adsorption properties [16, 20, 21]. Bychkova et al. [22] modified the viscose fiber with dimethyl phosphonate and methazine derivatives and studied on its structure and fire proof performance. Totolin et al. [23] investigated plasma modification of viscose fiber for environmentally friendly

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