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Ozone bleaching of cellulose

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Abstract

In this study, ozone treatment has been investigated in seeking of a more environmentally friendly alternative process for bleaching of cellulosic fibers. The primary advantage of ozone treatment is reduced environmental impact especially in case of chemical oxygen demand (COD) values of the process effluent. The highly oxidative ozone gas substitutes conventional harsh chemicals and decomposes back to oxygen owing to its limited half-life. Hence, ozone treatment seems as a good alternative for oxidative bleaching purposes of cellulose.

1. Introduction

Untreated cotton has a natural yellow-brown color. This natural yellow-brown color of cotton is related to the pigments of the cotton flower. This natural yellow-brown color of cotton is preferably removed before dyeing especially at light shades, because it changes the final color of the dyed textile material if not removed [1-3].

The removal process for the natural yellow-brown color of cotton is the bleaching process. Bleaching is a very common process for textile finishing, especially for cellulose, and hydrogen peroxide is the most widely used bleaching agent. Hydrogen peroxide bleaching of cellulose is carried out at elevated temperatures, usually at the boil. Conventional cellulose bleaching process by hydrogen peroxide includes the use of hydrogen peroxide along with an activator which is usually caustic soda (NaOH), a stabilizer which is usually silicates or organic ones and a wetting agent [1-5].

The use of various chemicals in a process pollutes water with chemical components left in the effluent. Therefore, research has been made to achieve more environmentally friendly preparation processes using enzymes or other bleaching agents such as ozone [1, 6-9].

Research on the bleaching effect of ozone on cotton has been performed considering the high redox potential of ozone. The redox potential of ozone is 2.07eV and the redox potential of conventional bleaching agent hydrogen peroxide is 1.77 V. Ozone gas was produced in ozone generators and cotton was treated by this ozone. Promising results were reported by ozone treatment [1, 9-11].

2. Bleaching of Cotton by Ozone

Prabaharan and Rao [10] studied the ozone bleaching of cotton fabrics on a commercial quality grey cotton fabric with starch size on it. They adjusted several wet pickup rates and placed the samples in a reactor in which ozone gas was fed. They reported that treatments were conducted at room temperature with 100g/m³ ozone concentration for 5, 10 and 15 min. They reported that wet pickup rates effected the final whiteness values after ozone treatments and a peak was observed at 24% wet pickup rate. The whiteness index values increased up to 90 at 24% wet pickup rate for 15 min



treatment. The authors explained this phenomenon as: whiteness increased by the hydration of hydroxyl group but then decreased by excess water above 24% which probably fills intermisellar spaces to retard ozone.

Eren and Ozturk [9] studied bleaching of cotton by ozone treatment in water. They used 5,7 mg/min ozone to treat the greige cotton fabrics in water at a liquor to goods ratio of 20:1 at room temperature. They reported that the whiteness degrees achieved after 60 and 90 min ozone treatments were comparable to the whiteness degrees of the conventional peroxide bleached samples for the pre-scoured samples (Figure 1).

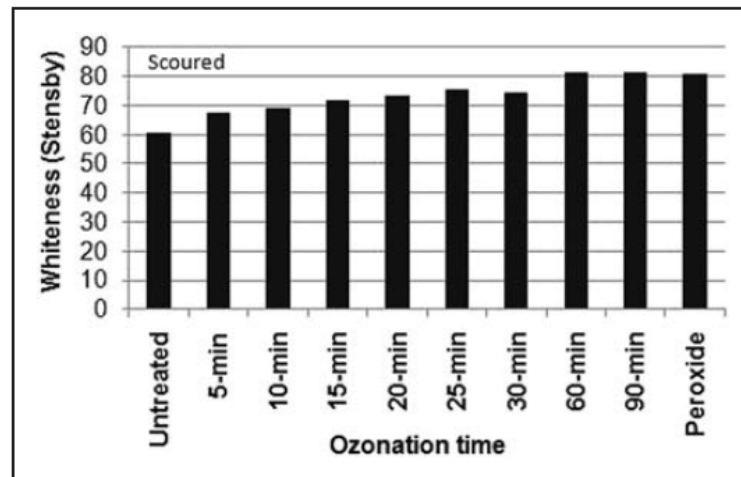


Figure 1. Whiteness of the scoured samples after peroxide and ozone bleaching treatments [9].

3. Bleaching of Cotton by Ozone and Ultrasound

Eren et al. [1] also tested the bleaching effect of ozone on cotton by ultrasonic support. The whiteness (Stensby) results achieved by ultrasonic support are presented on Figure 2. Ozone bleaching yielded very successful results in 30 min time under ultrasonic support. These whiteness values were accompanied by substantial reductions in the COD load of the process effluent in case of ozone treatment [1].

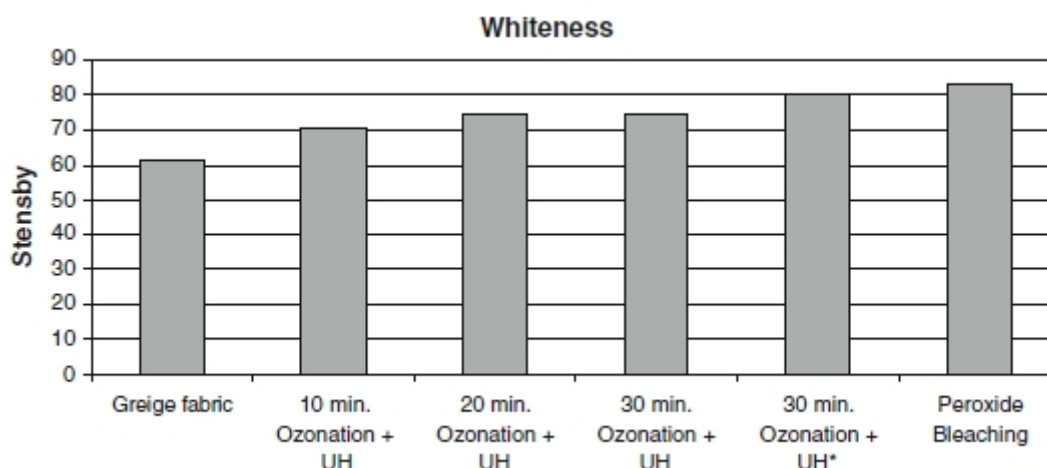


Figure 2. Effect of the ozonation and ultrasonic homogenizer (Ozonation+UH) combination on the whiteness of cotton fabrics (The temperature of the Ozonation + UH bleaching bath solution increase to 45,60 and 70 °C after 10, 20 and 30 min. of application respectively and 30 min. Ozonation+ UH*

processing was stabilized at 30 °C through the process by cooling for comparison. Peroxide bleaching was carried out at 90°C for 60 min.) [1]

4. Result

The results of few studies on ozone bleaching of cotton has been summarised. Researchers reported that considerable whiteness degrees could be achieved by ozone treatment without severe damage to fabric. Consequently, ozone treatment can be considered as a more environmentally friendly alternative for bleaching of cotton.

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