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Research Article

Effect of Chemical Concentration on the Pre-treatment Performance of Cotton Woven Fabric

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Abstract

This work aims on the determination of the pre-treatment performance on the basis of scouring and bleaching chemical concentration. Cotton fabrics were pretreated with combined scouring and bleaching at a fixed processing time and temperature with varying amount of hydrogen peroxide and caustic soda. After the operation, the pre-treatment performance, i.e., absorbency, whiteness index, weight loss etc. were measured. It was found that with the increment of both caustic soda and hydrogen peroxide concentration, performance of pre-treatment became better.

Keywords: *Scouring, Bleaching, Concentration, Absorbency, Weight-loss, Whiteness index.*

1. Introduction

Cotton is the most important natural fibre (Choudhury, 2006). Natural fibres contain oils, fats and waxes, together with other impurities (Trotman, 1975). Water absorption is one of the key properties of a textile fibre (Broadbent, 2001). Presence of fats and waxes in cotton fabric imparts poor water absorbency. In order to remove these impurities, scouring of cotton fabric is normally carried out with strong alkali at high temperature and for longer duration (Uddin, 2010). Although, this treatment gives very good results, one of the problems is high loss in weight of cellulosic material (Sorbe Biotechnology, 2005). The total amount of impurities to be removed is less than 10 % of the total weight (Choudhury, 2006). On the other hand, the aim of bleaching is to remove any unwanted color from the fibres. This process also eliminates any traces of other impurities remaining from the previous preparation steps and improves the absorbency of the material for dyeing and printing (Broadbent, 2001). During bleaching process it is unexpected to loss excessive wt. of fabric because; excessive weight loss in bleaching can reduce fabric strength, durability and dimension (Tailfer, 1998). Commercially a weight loss of 3-6% and strength loss of about 10% is considered acceptable (Choudhury, 2006). So, a standard weight loss in the pre-treatment process must be controlled for optimum production.

Industrially scouring and bleaching is performed simultaneously. The advantages of this process are increased production with reduction of labour cost and reduced treatment time; the loss in wt. and strength of material is less (Choudhury, 2006). Hydrogen peroxide is a powerful oxidizing agent that rapidly destroys the natural colouring matters present in cotton without undue oxidative damage to the fibres (Broadbent, 2001). High alkalinity at elevated temperatures produces efficient scouring action. Hence a combined scouring bleaching process for cotton using peroxide in winch and package has gained commercial success (Shenai, 1995).

The scouring process effect can be estimated by Partial test of absorbency and by measuring the weight loss percentage (Choudhury, 2006). The bleaching performance can be estimated by the whiteness index as well as the color strength value of the treated fabric.

2. Materials and Methods

2.1 Materials

2.1.1 Raw Materials

The fabric selected for this experiment was collected from the local market. The composition and specification was as follows:

Table 1: Fabric Specification

Fabric Composition	Cotton
Fabric Type	Woven
Fabric Structure	Twill
Fabric G.S.M	168
Ends Per Inch (EPI)	130
Picks Per Inch (PPI)	70
Warp Count	30
Weft Count	30

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2.1.2 Chemicals

The following chemicals were used for this experiment.

Table 2: Name and Function of the Chemicals

Kieralan Jet-B Conc.	Wetting agent
Lubifrol MSD	Sequestering agent
Caustic Soda	Scouring agent
Hydrogen peroxide	Bleaching agent
Sodium silicate	Stabilizing agent

2.1.3 Machineries

The following machines were used for the treatment and testing of the treated sample. The specifications of the machines were as follows:

Table 3: Name and Function of the Machineries

Machine (Manufacturer)	Function
High Temperature Dyeing Machine (James H. Heal & Co. Ltd)	For combined scouring-bleaching
Spectrophotometer (Datacolor)	For determination of whiteness value and color strength

2.2 Methods

2.2.1 Combined Scouring and Bleaching

Combined scouring-bleaching was performed on the fabric sample according to the following recipe (Hossain 2009).

Table 4: Process Parameters for combined scouring-bleaching

Fabric weight	X gm
Wetting agent	1 g/L
Sequestering agent	1 g/L
Caustic soda	1-4 g/L
Hydrogen peroxide	1-4 g/L
Sodium silicate	2 g/L
Material : Liquor	1:50
pH	10
Time	60 minutes
Temperature	95˚C

The bath was set with substrate at room temperature with wetting agent, sequestering agent, peroxide stabilizer and caustic soda. The temperature was raised to 60˚C and after a few minutes peroxide was added. The temperature was further raised to 95˚C and the bath was run for 60 minutes. After that, the temperature was cooled down at 70˚C to drop the bath. The sample was rinsed twice with hot and cold water.

2.2.2 Absorbency Test (Immersion test)

A well scoured fabric sample will take less time to be immersed into the water than an untreated sample. Based on this principle immersion test was carried out. A predetermined sample (1cm X 1cm) was put gently on the surface of fresh water. The time in seconds was recorded by a stopwatch for submerging the sample into the water.

2.2.3 Measurement of Weight-loss Percentage

During scouring, textile fibres loss a remarkable amount of impurities (oil, fats, wax, salts etc). The scouring effect, thus, can be evaluated based on this weight loss of fibre. Usually, it is calculated from the difference of un-scoured and scoured sample weight, measured in percentage of un-scoured weight of the sample.

$$\% \text{ Weight loss of the sample} = \frac{W1-W2}{W1} X\ 100$$

Where, W1=Weight of the sample before scouring
and, W2=Weight of the sample after scouring

2.2.4 Measurement of Whiteness Index

Whiteness index is the measure which correlates the visual ratings of whiteness for certain white and near-white surfaces. The whiteness indexes of differently treated samples were compared. For calculating whiteness,

Whiteness Index (WI) = $Y + 800\ (x_n - x) + 1700\ (y_n - y)$

Where, Y is the tristimulus value and x and y are the coordinates. x_n and y_n are the coordinates for MgO. For D65/10˚ the values were 0.3138 and 0.3309 respectively.

2.2.5 Measurement of Color Strength

By using this reflectance value into the Kubelka Munk`s equation, color strength (K/S) values were measured of the scoured-bleached sample.

$$\frac{K}{S} = \frac{(1-R)^2}{2R}$$

Where, R= reflectance percentage, K=absorption co-efficient, S=scattering co-efficient

The K/S values were measured by spectrophotometer and a comparison of the values for different concentration of peroxide and caustic was carried out.

3. Results and Discussions

3.1 Absorbency test (Immersion test)

Figure 1 represents the effects of caustic soda and hydrogen peroxide concentration on the absorbency (immersion test) of treated samples. It was found that,

increment of both the concentrations reduced the time for submerging the fabric sample. This is because, with the increment of caustic and peroxide concentration, more scouring were occurred, thus, more impurities were removed resulting in increased hydrophilicity of the samples. The increased hydrophilic nature assisted in quick immersion of the samples in fresh water.

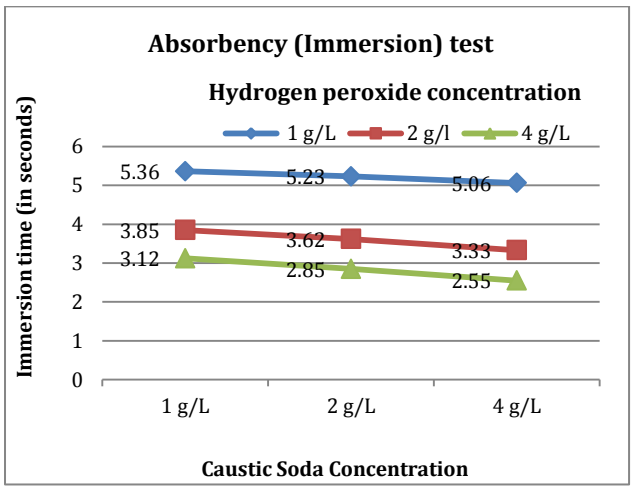

Figure 1: Effect of Caustic and Peroxide Concentration on Absorbency (Immersion) test

3.2 Weight-loss percentage

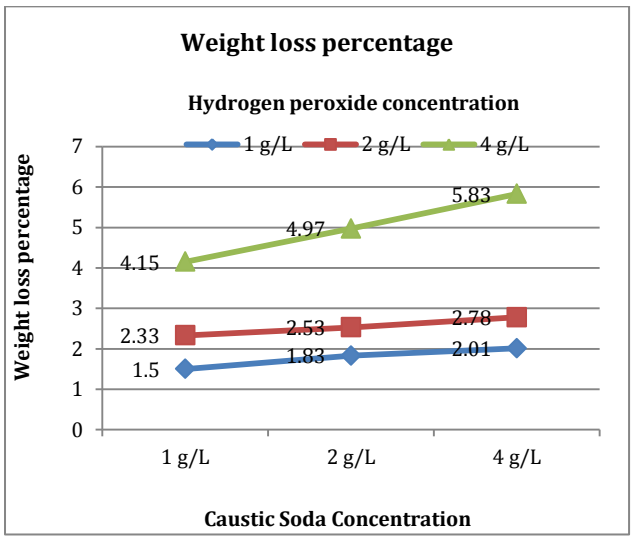

Figure 2: Effect of Caustic and Peroxide Concentration on Weight-loss percentage

Figure 2 illustrates the weight-loss percentage of the treated samples. From the figure, it is clear that, increased concentration of caustic and peroxide increased the weight-loss percentage. This is attributed by the fact that, increased concentration of caustic and peroxide resulted in increased removal of impurities from cotton fibres. So, the removal of impurities increased the weight-loss of the treated samples.

3.3 Whiteness Index

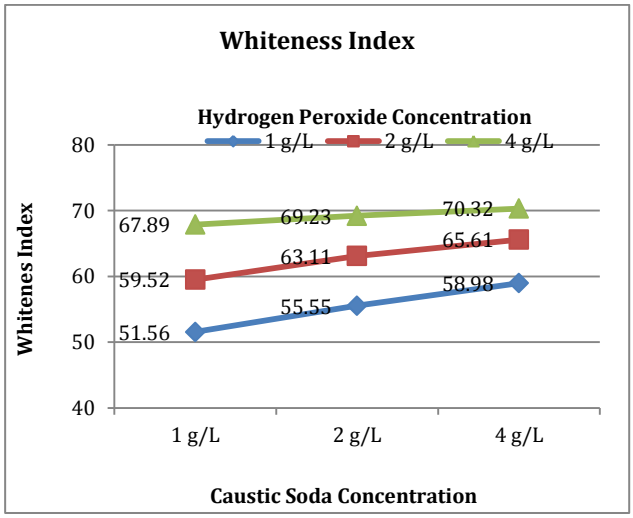

Figure 3: Effect of Caustic and Peroxide Concentration on Whiteness index

Figure 3 represents the whiteness indexes of the treated samples. It is observed that, with the increasing concentration of caustic and peroxide, whiteness values also increased. The increasing concentration of hydrogen peroxide accelerated the bleaching action, thus more natural colors were removed. So, more perfect whiteness was achieved, resulting in increased whiteness indexes.

3.4 Color Strength (K/S) Value

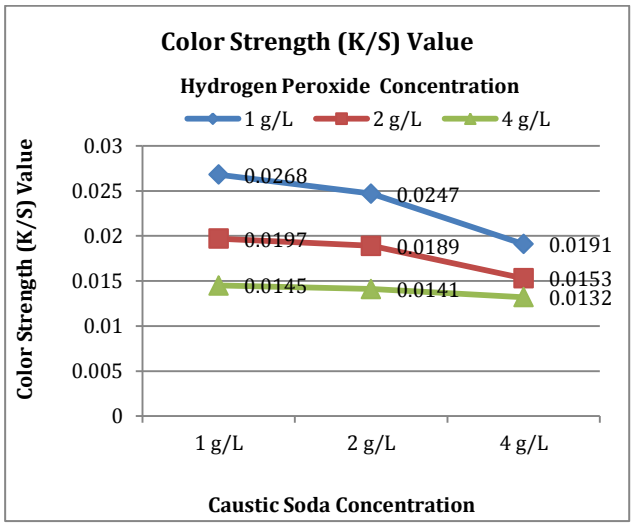

Figure 4: Effect of Caustic and Peroxide Concentration on Color Strength (K/S) values

Figure 4 shows the color strength values of the treated samples. It is clearly shown that, increased concentration of caustic soda and hydrogen peroxide reduced the color strength. The increased value of caustic soda and hydrogen peroxide performed more bleaching action. So, more whiteness was achieved resulting in a reduced color value.

Conclusions

Pre-treatment (i.e. scouring and bleaching) is an inevitable step in wet processing. To increase the hydrophilic nature, impurities must be well removed by efficient scouring process. For successful dyeing, a perfect bleaching action is also necessary. Weight-loss is a natural phenomenon during scouring, but over scouring can damage the substrate. So, a standard weight-loss must have to be maintained for standard scouring with a good absorbency required for successive dyeing and finishing. To obtain a desired shade in dyeing, a perfect white is to be obtained during bleaching. Increased concentration of caustic soda and hydrogen peroxide may improve the whiteness index a bit more, but it can also damage the fabric. So, an optimum processing parameter has to be maintained for successful pre-treatment.

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