Optimization Of Bleaching Parameters By Whiteness Index And Bursting Strength Of Knitted Cotton Fabric

Abu Naser Md. Ahsanul Haque, Md. Azharul Islam

Abstract: The study comprises the effect of different bleaching parameters on scoured single jersey cotton fabrics. Three different concentrations (1.8 g/L, 2.0 g/L and 2.2 g/L) taken from 5% stock solution of hydrogen peroxide were considered for the experiment. In each concentration, bleaching was performed in four individual temperatures (78°C, 88°C, 98°C and 108°C). In each of the temperatures bleaching were continued for four individual time period (20, 30, 40 and 50 minutes). The weight of sample fabric was 12.5 grams and 1:10 liquor ratio was maintained in each operation. The bleached samples were tested in a reflectance spectrophotometer (datacolor 650) and also their bursting strengths were found from an Autoburst instrument following ISO 13038-1 method. The results show that bursting strength and whiteness index have an inverse relation between themselves. For the nominated concentrations of peroxide, 88°C to 98°C temperature with 30 to 40 minutes time duration is suggested as the optimum bleaching parameter for knitted cotton fabric.

Index Terms: Bursting strength, Whiteness index, Parameters, Bleaching, Time, Temperature, Concentration.

1 Introduction

The coloration of cotton will not give the optimum efficiency without bleaching. This process means removing natural color from cotton and to produce a permanent white color so that dyeing or shade matching can be possible accurately. There are different bleaching agents for this purpose, mostly they are oxidative. They remove the coloring part from cotton by oxidation and hydrogen peroxide is the most popular bleaching agent among them. Whiteness of cotton can also be achieved by application of blue or optical brightening agent [1]. But those are not suitable for the finishing rather than the pretreatment process. Several researchers worked on peroxide bleaching of cotton. Saravanan and Ramachandran (2010) examined the bleaching effect of cotton fabrics using hydrogen peroxide which was produced by glucose oxidase enzyme. But glucose oxidase had shown whiteness values lower than that expected in the commercial processes [2]. Abdul and Narendra (2013) worked for accelerated Bleaching of Cotton by hydrogen Peroxide. In their study they found that an increase in temperature can increase the rate of bleaching and also can reduce the process time. Again an increase in concentration of peroxide whiteness can be increased but the weight of material will decrease. According to them hardness of water and concentration of stabilizer can reduce whiteness and increase weight loss [3]. There is no absolute certainty about the nature of bleaching action of hydrogen per oxide but it is believed that the per-hydroxyl ion is the active group. These are formed when hydrogen peroxide breaks in the following manner [4] -

$$H_2O_2 \rightleftharpoons H^+ + HO_2^-$$

The per-hydroxyl ion is very much unstable and in the existence of oxidizable substance like colored impurities in fiber, it starts the bleaching action. Hydrogen peroxide gets more activated by addition of alkali although it is much stable in acidic medium. The oxidative damage of cotton can also occur during bleaching for which stabilizer is necessary. Stabilizers slow the decomposition of hydrogen peroxide, so that the maximum amount of Hydrogen Peroxide is available for bleaching [5]. Kumbasar *et al* [6] tried to optimize the bleaching recipes in terms of hydrophility and whiteness degree. They found that an Increase in hydrogen peroxide and activator concentrations, temperature and duration can improve the hydrophility and whiteness degree generally. Comparison of whiteness index of cotton fabric was done by Sonaje and Chougule [7]. They actually focused on the use of recycled wastewater in textile wet processing. They had compared whiteness index of cotton fabric with fabric processed with ground water and Municipal water. Morshed *et al* [8] also searched for the effect of scouring- bleaching on cotton. They also took bursting strength and the whiteness index value of fabric though from an economical angle.

2 Materials and Methods

2.1 Materials and Sample Preparation

Single jersey cotton fabric was considered for the experiment. The specifications of the grey fabrics are listed in Table 1.

TABLE 1
SPECIFICATION OF THE FABRIC

Parameter	Single jersey grey fabric
CPI	59
WPI	28
Yarn type	Combed
Yarn count	30 Ne
Stitch length	2.60 mm
GSM (g/m^2)	110

The equipments and test instruments were used in this research work are listed in Table 2.

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TABLE 2
LIST OF EQUIPMENTS USED

Name of equipments	Manufacturer	Experiment performed
Auto dispenser (Robolab XPN)	TALOS, Greece	Dye distribution
Electric balance (Adventurer)	Ohaus Corporation, USA	Fabric weighting
Lab dyeing machine (Mathis Labomat)	Mathis Univision, Switzerland	Scouring & Bleaching
Dryer (Electrolux)	SDL Atlas, Thailand	Drying
Micropipette (ecopipette)	CAPP, Denmark	Measurement of solutions
Reflectance spectrophotometer (datacolor 650)	Datacolor, USA	Testing dyed fabric sample

Fabric was scoured in regular factory parameters. The sample fabric weight for bleaching was 12.5 gram constant each time. Three concentrations of hydrogen peroxide were considered, they are- 1.8 g/L, 2.0 g/L and 2.2 g/L. Sodium silicate was used as the stabilizer and its quantity was 1 g/L constant for each process. Caustic soda (NaOH) was used as the alkali for the bleaching process and its amount was also 1 g/L constant. In each of the concentration of hydrogen peroxide, bleaching performed in four individual temperatures (78°C, 88°C, 98°C and 108°C). Moreover, in each of the temperatures bleaching process continued for four individual time durations (20, 30, 40 and 50 minutes). Thus a total of 48 bleached samples were collected. The after treatment was done by the following steps-

Hot wash (70°C)
↓
Cold wash (27°C
↓
Squeezing
↓
Drying (70°C, 30 minutes)

2.2 Sample Analysis Procedure

The whiteness index of the samples was measured by a reflectance spectrophotometer (datacolor 650). D65 illuminant was considered in all the cases. Each sample was tested 5 times and the average value was considered. The results are shown in Table 3.

TABLE 3
BURSTING STRENGTH OF BLEACHED SAMPLES

Peroxide	Temperature	Bursting strength (psi) 20 min	30 min	40 min	50 min
1.8 g/L	78(°C)	92.92	91.52	90.42	86.85
	88(°C)	92.01	90.96	88.44	85.28
	98(°C)	91.47	90.02	87.78	84.26
	108(°C)	87.32	86.75	84.24	82.65
2.0 g/L	78(°C)	92.54	91.24	90.46	86.14
	88(°C)	91.56	90.26	87.98	85.76
	98(°C)	91.06	89.65	87.15	83.45
	108(°C)	86.24	85.95	83.56	81.01
2.2 g/L	78(°C)	92.06	90.55	89.65	85.27
	88(°C)	91.04	89.45	87.22	85.01
	98(°C)	90.39	88.83	86.65	82.55
	108(°C)	85.31	84.46	82.49	80.14

After that all the samples were tested by an bursting strength testing instrument (Autoburst, SDL Atlas, England) by following ISO 13038-1 method. Each specimen was placed under the bell ensuring that it is flat and free from creases and any distortions. Then the two clamp buttons were pressed and standard flow rate was selected. It determines the speed at which the bell will inflate. Then 'start' button was clicked and the diaphragm was automatically inflated until the specimen bursts. The reading was collected from the instrument as pound per square inch (psi). The average value of five consecutive tests was considered as the bursting strength of that fabric. The results are shown in Table 4.

TABLE 4
WHITENESS INDEX OF BLEACHED SAMPLES

Peroxide	Temperature	Whiteness index 20 min	30 min	40 min	50 min
1.8 g/L	78(°C)	47.21	56.53	58.65	59.26
	88(°C)	55.55	59.23	61.25	61.74
	98(°C)	58.65	61.45	62.85	63.16
	108(°C)	58.95	62.05	63.04	63.62
2.0 g/L	78(°C)	47.76	57.31	59.03	59.64
	88(°C)	56.21	60.11	61.84	62.04
	98(°C)	59.16	61.95	63.45	63.86
	108(°C)	59.85	62.45	63.51	63.99
2.2 g/L	78(°C)	48.25	57.88	59.64	60.11
	88(°C)	57.32	60.54	62.66	62.73
	98(°C)	59.98	62.53	63.89	64.03
	108(°C)	60.27	63.01	64.02	64.65

3 Results and Discussion

Bursting strength of the fabric was always decreasing with the increase time in cases of all the concentrations of peroxide and at all the temperatures of bleaching which are shown in Figure 1, Figure 2 and Figure 3. The strength was found far lower in the cases of 108°C. And the best strengths were obtained in lower temperature like 78°C. Moreover with the increase of concentration of peroxide, the bursting strength also falls down.

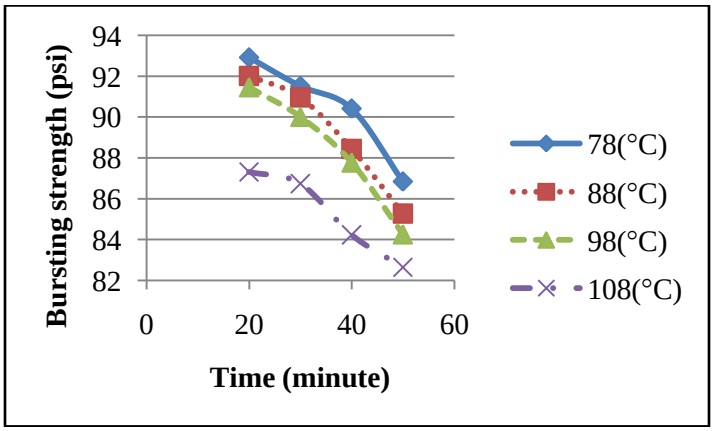

Fig.1. *Effect on bursting strength of fabric by 1.8 g/L peroxide*

But on the other hand, whiteness index of the bleached fabric were always increasing with the increase of time duration in

cases of all the concentrations of peroxide and also at all the temperatures of bleaching (Figure 4, Figure 5 and Figure 6. Whiteness was found lowest at 78°C. The highest whiteness was found at 108°C though the value was quite close to 98°C bleaching. And also the increase in peroxide amount can increase the whiteness of fabric, no doubt about it.

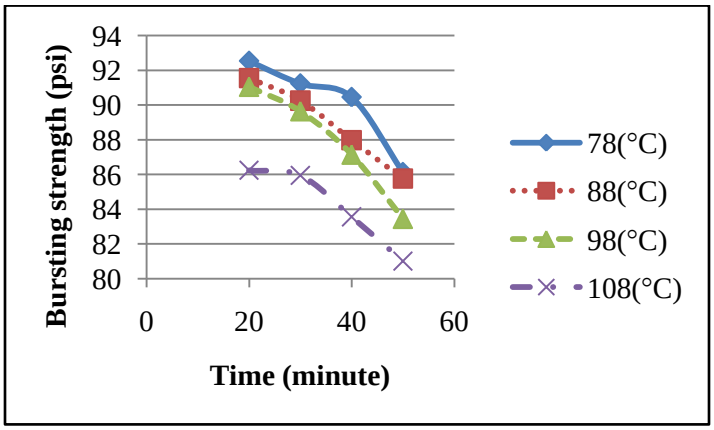

Fig.2. *Effect on bursting strength of fabric by 2.0 g/L peroxide*

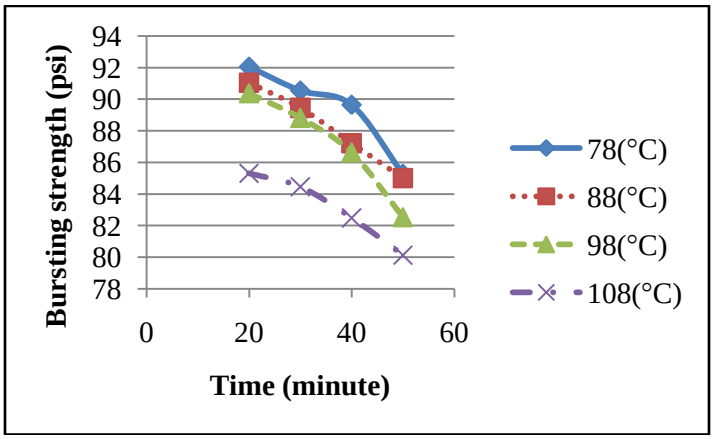

Fig.3. *Effect on bursting strength of fabric by 2.2 g/L peroxide*

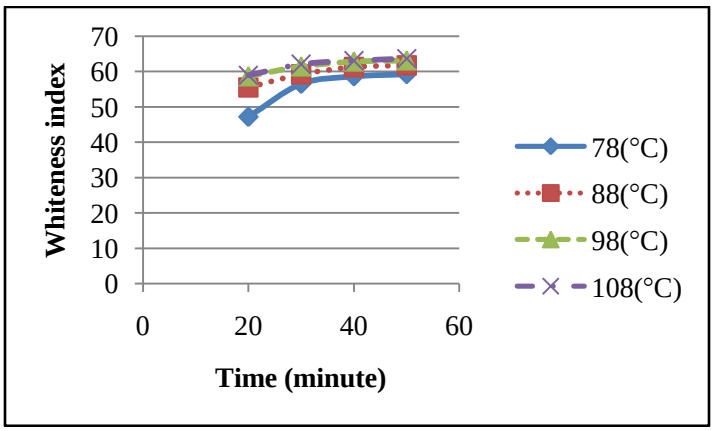

Fig.4. *Effect on whiteness index of fabric by 1.8 g/L peroxide*

By analyzing all the figures it was very clear that whiteness were not quite achieved at 20 minutes time, because the distance of the whiteness values were greater between 20 and 30 minutes. But in 30, 40 and 50 minutes the whiteness values were quite close all the time. And there is a greater loss of fabric strength at high temperature like 108°C. So it would not be wise to continue bleaching over 98°C or over 40 minutes as time also decrease the strength. As 78°C temperature bleaching does not give proper whiteness. Bleaching should be done in between 88°C to 98°C for 30 to 40 minutes.

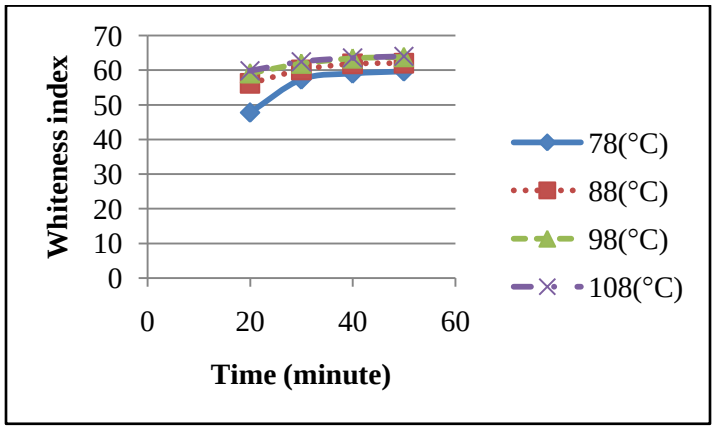

Fig.5. *Effect on whiteness index of fabric by 2.0 g/L peroxide*

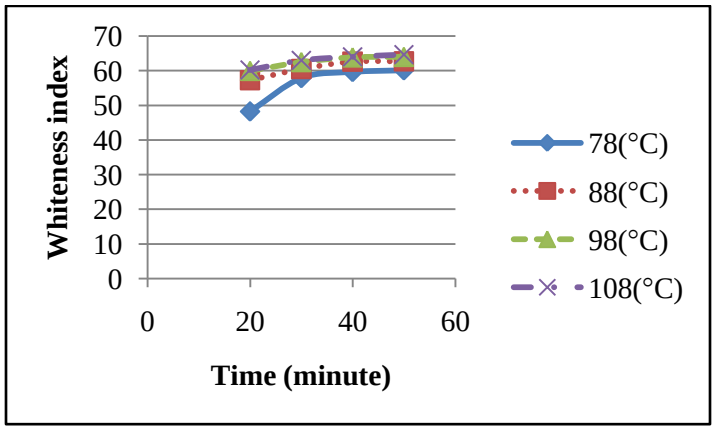

Fig.6. *Effect on whiteness index of fabric by 2.2 g/L peroxide*

4 Conclusion

The following decisions can be made from the above experiment-

1. The more hydrogen peroxide, the more whiteness but fabric strength will also hampered.
2. Temperature increase has a positive effect on whiteness but can negatively affect on fabric strength.
3. The result of whiteness is higher in greater time. But time also weakens the fabric.
4. The optimum bleaching parameter should be 88°C to 98°C for 30 to 40 minutes.

Acknowledgment

The author gratefully acknowledges the support from Impress-Newtex Composite Textile Ltd, Mirzapur, Tangail, Bangladesh.

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