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Low temperature bleaching of cotton cellulose using peracetic acid

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ABSTRACT

In this study peracetic acid was prepared by the reaction of hydrogen peroxide with glacial acetic acid in the presence of concentrated sulfuric acid as a catalyst. Factors affecting peracetic acid formation were studied, together with following up the amount of residual hydrogen peroxide and amount of converted peracid throughout the reaction period. The so prepared peracetic acid was used for bleaching cotton fabrics, and different variables affecting the bleaching process were extensively studied. The bleached fabrics were fully characterized and results obtained show that optimum conditions for bleaching were using peracetic acid at concentration of 40 ml/l at 70 °C, using a material to liquor ratio of 1:30 at pH 6 for 30 min and then turning the pH to 10.5 and continuing bleaching for extra 30 min. These conditions were found to give bleached fabric with satisfactory whiteness index with reasonable loss in tensile properties.

1. Introduction

Technology for preparation of cellulosic fiber materials aiming to improve their performance comprises several consecutive operations, i.e. desizing (Ahlawat, Dhiman, Battan, Mandhan, & Sharma, 2009; Bae et al., 2006; Peng et al., 2010), scouring (Abdel-Halim, Fahmy, & Fouda, 2008; Abdel-Halim, Konczewicz, Zimniewska, Al-Deyab, & El-Newehy, 2010; El Shafie, Fouda, & Hashem, 2009) and bleaching (Hashem, El-Bisi, Sharaf, & Refaie, 2010; Hebeish et al., 2009; Hou, Zhang, & Zhou, 2010; Ibrahim, Sharaf, & Hashem, 2010). The whitening of textiles is achieved with different oxidizing or reducing agents, capable of destroying the natural coloring matter present in the fibers. Nowadays hydrogen peroxide, due to its biodegradability, almost entirely replaced the conventional chlorine oxidizing chemicals (Spirro & Criffith, 1997; Weck, 1991). Hydrogen peroxide precursors, such as perborates and percarbonates are incorporated in a major part of commercially available detergent compositions. Alternatively, hydrogen peroxide could be produced enzymatically by glucose oxidase catalyzed conversion of glucose in the presence of oxygen in aqueous solutions (Aly, Moustafa, & Hebeish, 2004).

Fabrics made of cotton are very comfortable to wear and easy to dye because cellulose has excellent properties such as higher water and moisture absorbency. For these reasons, the apparel industry is predominantly cotton based, and the share of cotton in total fiber consumption is about 50%. Cotton is composed almost entirely of cellulose (90–96% based on weight of fibers). The impurities in cotton fiber range from 4% to 10%. The overall composition of raw cotton fibers depends on its type, origin, fibers maturity, weathering and agricultural conditions (Mandal & Venugopalan, 2005; Stathakos, Gemtos, Tsatsarelis, & Galanopoulou, 2006; Wolf & Hadas, 1984). The impurities include protein (1.0–2.1%), wax (0.4–1.7%), ash (inorganic salts) (0.7–1.8%), pectin (0.4–1.9%) and others (resins, pigments, hemi-cellulose) (1.5–2.5%) (Gallo & Almirall, 2009; Karmakar, 1999; Plant, Kerby, Zelinski, & Munk, 1998). The yellowish or brown coloration of the cotton fiber is related to the protoplasmic residues of protein and the flavones pigments of cotton flowers (Abidi, Cabrales, & Hequet, 2010; Ghule, Chen, Tzing, Lo, & Ling, 2004). With the exception of natural coloring matters that may be removed by bleaching using certain oxidants, many other impurities are removed by alkali treatment in scouring stage. The latter in common practice involves boiling the cotton in sodium hydroxide (2–5%) for 1 h (Degani, Gepstein, & Dosoretz, 2004). Hydrogen peroxide is a well-known environmentally safe bleaching agent for cotton fabrics. However, bleaching of cotton based fabrics with hydrogen peroxide requires alkaline medium (normally NaOH aqueous solution), stabilizer and either high temperatures or long treatment times (Abou-Okeil, El-Shafie, & El Zawahry, 2010; Mistik & lu, 2005). After bleaching and before dying, large amount of water is required for washing the residual un-decomposed hydrogen peroxide and the residual alkali (Abou-Okeil et al., 2010; Götz, Duschner, White, & Klukowska, 2007). It is thus desirable to use bleaching systems that operate well at lower temperatures, shorter reaction times and/or using lower chemical charges than current, without causing unacceptable

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damage to textile fibers. This, indeed, stimulates the present work which is undertaken with a view to develop a new approach for bleaching cotton based fabrics with peracetic acid.

Peracetic acid is an equilibrium solution consisting of hydrogen peroxide, acetic acid and peracetic acid. It can be used for bleaching of nylon, viscose rayon, cellulose acetate and even cotton. Peracetic acid is commercially available for textile bleaching in 5%, 15% and 40% solutions as what is known as "equilibrium peracid". Peracetic acid can be prepared by the interaction of concentrated hydrogen peroxide and acetic acid in the presence of strong mineral acid such as sulfuric acid. Alternatively, it can be prepared by mixing hydrogen peroxide with acetic anhydride at room temperature in the presence of suitable catalyst like caustic soda or EDTA. The optimum reaction takes place with 1 part of hydrogen peroxide and 6 parts of acetic anhydride after about 4 h at room temperature to give a yield of about 80%. The excess acetic anhydride may, however, cause an undesirable side reaction to yield highly explosive diacetyl peroxide. Peracetic acid has proven to be effective bleaching agent in the household detergents and also found wide application in the laundry industry. To reduce the danger in the on-site production of peracetic acid from acetic anhydride/hydrogen peroxide, activators can be used in household detergents to generate peracetic acid in situ. The commonly used activators are sodium perborate and acetylated oxygen or nitrogen compounds such as tetraacetylethylenediamine. The perborate activators are assumed to act via the stages of peracetic acids. Perborate hydrolyses in aqueous solution and hydrogen peroxide is produced. Peracetic acid is an environmentally safe alternative bleaching agent. European textile mills are now using peracetic acid in totally chlorine free (TCF) bleaching (Guersy & Dayioglu, 2000). For use as bleaching agents for cotton fabrics, peracetic acid can be generated by reaction of H_2O_2 with bleach activator. Bleach activators are peracid precursors, which generate peracids in situ in an alkaline hydrogen peroxide solution. The most widely used bleach activators are tetraacetylethylenediamine (TAED) and nonanoyloxybenzene sulfonate (NOBS) (Krizman, Kovac, & Tavcer, 2005; Lim, Lee, Hinks, & Hauser, 2005). The application of these bleach activators in textile preparation has been reported as an attempt to minimize the problems caused by the conventional peroxide bleaching. It is claimed that NOBS gives better bleaching performance than TAED and the poor water solubility of TAED limits its application in textile bleaching (Krizman et al., 2005; Lim et al., 2005). Sodium perborate (H_2O_2 precursors) hydrolyzed in aqueous solution and produce H_2O_2 which, in turn, dissociated to perhydroxyl anion. The latter reacts with TAED or NOBS to form peracetic acid and diacetyl ethylene diamine (DAED). At pH above 5, peracetic acid form active oxygen, this acts as a bleaching agent (Guersy & Dayioglu, 2000; Krizman et al., 2005; Lim et al., 2005). Peracetic acid is most effective as a bleaching agent for cotton in the following conditions: pH 6–7, bleaching temperature 50–80 °C and bleaching time of 20–60 min depending on the temperature. This results in lower energy and water consumption both during bleaching and rinsing of the fabric. Neutralization of the fiber after bleaching is not required, unlike bleaching with hydrogen peroxide, where large amounts of alkali must be removed before dying. There is also much less damage to the cotton fiber when peracetic acid is used (Guersy & Dayioglu, 2000; Krizman et al., 2005; Lim et al., 2005). Though the use of peracetic acid has been suggested for bleaching of cotton but has never reached the commercial success like hypochlorite, chlorite and peroxide (Winkler, Smith, & Compton, 1997). The mechanism of reaction is somewhat similar to that of hydrogen peroxide. Recently, peracetic acid is used as a replacement of hypochlorite in multi-stage bleaching process of cotton and linen (Winkler et al., 1997). Peracetic acid is most effective as a bleaching agent for cotton in the pH range of 6–7. The preferable bleaching temperature range is between 50 °C and 80 °C and bleaching time of 20–60 min depending on the temperature. The degree of brightness increases proportionately with the concentration of bleaching agent. To avoid the damage of cloth, a sequestering agent may be added to remove those catalytically active ions such as Cu, Fe etc., which can be absorbed by fiber. Bleaching of 100% cotton in rope form in a J-Box with peracetic acid (1.5–2.5 g/l) at room temperature, followed by an alkaline hydrogen peroxide treatment at 90 °C yield a good whiteness (Winkler et al., 1997). Linen could be successfully bleached using a process consisting of scouting, alkaline hydrogen peroxide bleach and a peracetic acid bleaching stage.

The present study aims at enhancing the degree of whiteness of the scoured cotton cellulose in one step using peracetic acid as ecofriendly bleaching agent. Besides searching for the proper conditions for attaining better degree of whiteness along with good tensile properties.

2. Experimental

2.1. Materials

Plain weave 100% cotton fabric was supplied by Misr Company for Spinning and Weaving, Mehalla El-Kobra, Egypt. The fabric specifications were as follows: fabric weight, 150 g/m^2, weft 30 yarn/cm, warp 36 yarn/cm. The fabric warps were tested for sizing agent and the test showed starch-based sizing agent.

2.2. Chemicals

Sodium hydroxide, hydrogen peroxide, glacial acetic acid, sulfuric acid, sodium carbonate, potassium permanganate, potassium iodide, potassium bromide were all laboratory grade chemicals. Non-ionic surfactant (Marlipal O13/80) was supplied by BDH. Non-ionic wetting agent, namely Texazym T and bacterial alpha-amylase, namely Texamyl BL, were supplied by Inotex Company.

2.3. Desizing

Grey cotton fabric was treated with an aqueous solution containing 0.1% (owf) Texamyl BL, 5 g/l, Na_2CO_3; 2 g/l, Texazym T using material to liquor ratio of 1:30. The desizing bath temperature was raised gradually to 70 °C and the desizing treatment continues for 60 min. The fabrics were washed thoroughly with boiling water to kill the enzymes and remove degraded starches then with cold water till neutralization. The fabric was tested for sizing agent removal by means of simple iodine test.

2.4. Scouring

Desized cotton fabric was treated with an aqueous solution containing 5 g/l, NaOH; 3 g/l, Na_2CO_3; 2 g/l, Marlipal O13/80 using material to liquor ratio of 1:30. The bath temperature was gradually increased to 95 °C and the scouring treatment continues for 60 min. The fabric was washed thoroughly with boiling water then with cold water.

2.5. Preparation of the bleaching agent

Mixture of peracetic acid and caro's acid was prepared by mixing (0.5 mole) glacial acetic acid with (0.0625–0.375 mole) sulfuric acid and the mixture was cooled to (5–10 °C). The cooled mixture was added to (0.5 mole) hydrogen peroxide taking in consideration that the total volume of the reaction mixture is 100 ml. The reaction temperature was maintained at 20–25 °C during the acid premix addition. The reaction mixture was then stirred for 60 min and monitored by measuring the amounts of hydrogen peroxide

Table 1
Effect of H_2SO_4 concentration on peracetic acid formation.

$[H_2SO_4]$ (mole)	Duration of peracid preparation									
	Percent remaining peroxided					Percent converted peracid				
	10	20	30	40	60	10	20	30	40	60
0.0	100	100	100	100	100	0	0	0	0	0
0.0625	62.9	55.5	53.5	49.8	30	30.7	36.5	37.3	40.8	69
0.125	41.5	33.5	31.5	30.1	26.8	48	52.8	53.4	54	57.8
0.25	31.5	25.4	19.5	16.9	14	51.04	53.9	55.05	56.1	56.8
0.375	13.4	12.04	16.7	10	10	53.2	51.4	50	48.5	47.06

[hydrogen peroxide], 0.5 mole; [acetic acid], 0.5 mole.

and peracid during the reaction course (Pinkernell, Effkemann, & Karst, 1997).

2.6. Bleaching of cotton fabric

Desized and scoured fabric was impregnated in a bleaching solution containing different amounts of the prepared peracetic acid mixture (20–120 ml/l) and 2 g/l non ionic wetting agent (Marlipal O13/80) for different time intervals (15–240 min) and different initial pH's which was adjusted by adding sodium carbonate. The bleaching reaction was carried out at varying temperatures (30–70 °C) using material to liquor ratio of 1:30. The extent of hydrogen peroxide and peracetic acid decomposition was monitored via determining the amount of residual H_2O_2 and peracetic acid concentration throughout the bleaching reaction (Yin et al., 2011). At the end of reaction duration, the bleached samples were washed thoroughly with hot and then cold water and finally air dried.

2.7. Analysis and measurements

2.7.1. Fabric wettability

The wettability of the desized, scoured and bleached cotton samples was measured using the drop penetration test (Arbeitsgruppe, 1987).

2.7.2. % Loss in weight

The percent loss in weight of cotton fabric after bleaching treatment was calculated according to the following equation:

$$\% \quad \text{weight loss} = (W1 - W2) \times \frac{100}{W1}$$

where W1 is the weight of cotton fabric sample before peracetic acid bleaching treatment and W2 is the weight of the sample after the treatment.

2.7.3. Determination of percent decomposed hydrogen peroxide and peracetic acid

The percent decomposed hydrogen peroxide and peracetic acid was calculated via quantitative estimation according to a reported method (Pinkernell et al., 1997).

2.7.4. Determination of degree of whiteness

The degree of whiteness of peracetic acid bleached cotton fabric samples, expressed as whiteness index was measured using a Hunterlab Reflectometer (Model D25 M/L-2). The WI was calculated in terms of CIE Y (green) and (blue) reflectance components using the equation (ASTM Method E31373).

$$\text{W.I.} = \frac{4Z}{1.18} - 3Y$$

where Y and Z are the readings of the device.

2.7.5. Tenacity and percent elongation at break

The tensile strength and percent elongation at maximum force for bleached cotton fabrics were measured according to DIN 53857.

2.7.6. Determination of carboxyl content and carbonyl content

Reported methods were used for determination of carboxyl contents (Mattisson & Legendre, 1952) and carbonyl content (Tihlérik & Pasteka, 1992).

3. Results and discussion

3.1. Preparation of peracetic acid

Peracetic acid is an equilibrium solution consisting of hydrogen peroxide, acetic acid and peracetic acid. Peracetic acid was prepared in this study by the interaction of concentrated hydrogen peroxide and acetic acid in the presence of strong mineral acid such as sulfuric acid. Previous studies (Jimenez et al., 2008) for the preparation of peracetic acid from a mixture of H_2O_2 and acetic acid in the presence of sulfuric acid suggested that acetic acid is partially converted to peracetic acid, and that the sulfuric acid and/or permonomer–sulfuric acid aids as the acid catalyst needed for the reaction.

$$H_2O_2 + CH_3COOH \xrightarrow{H_2SO_4} CH_3CO \cdot O \cdot OH + H_2O \qquad (1)$$

Although the total amount of peracid in the final mixture can be measured experimentally, the actual distribution of the peracid (CH_3CO_3H) is not known.

Table 1 shows the effect of the amount of sulfuric acid, used for the preparation of the peracid, on the stability and percent conversion of peracid. The data indicates that: (a) peracid is not formed in the absence of sulfuric acid and this fact enhances the suggested mechanism for peracetic acid preparation (Eq. (1)), (b) the residual H_2O_2 in the reaction mixture decreases by increasing the amount of H_2SO_4 incorporated in the reaction medium and prolonging the duration of reaction which indicates that as concentration of the catalyst sulfuric acid increases, the amount of hydrogen peroxide consumed in forming peracid increases, (c) the percent of peracid formation increases by increasing the amount of H_2SO_4 incorporated in the reaction medium up to 0.25 mole and (d) the stability of the peracid decreases at H_2SO_4 concentration higher than 0.125 mole.

3.2. Bleaching

The freshly prepared peracetic acid (Eq. (1)) is an equilibrium solution consisting of H_2O_2, acetic acid, water and peracetic acid. The mechanism of reaction is somewhat similar to that of hydrogen peroxide as shown in Eq. (2).

$$CH_3COOOH \rightarrow CH_3COOH + (O) \qquad (2)$$

Different factors affecting the bleaching process of cotton fabric were systematically studied in details. These factors include pH

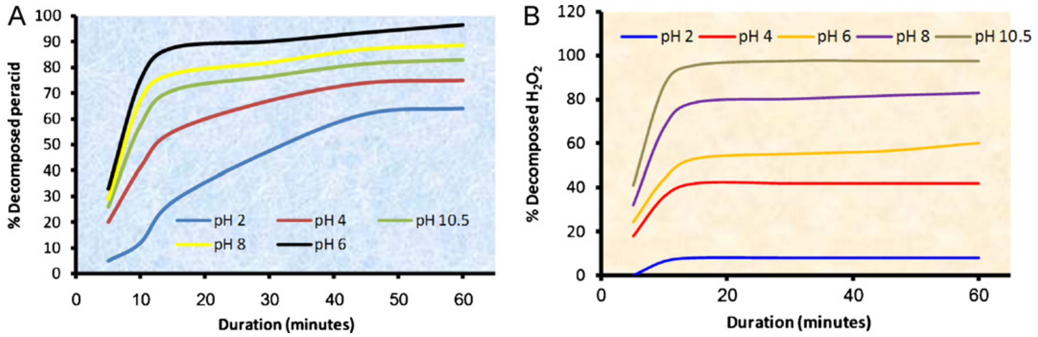

Fig. 1. Effect of pH of the reaction medium on the decomposition rate of peracetic acid (A) and hydrogen peroxide (B). Mixture concentration, 40 ml/l; material to liquor ratio, 1:30; bleaching temperature, 70 °C.

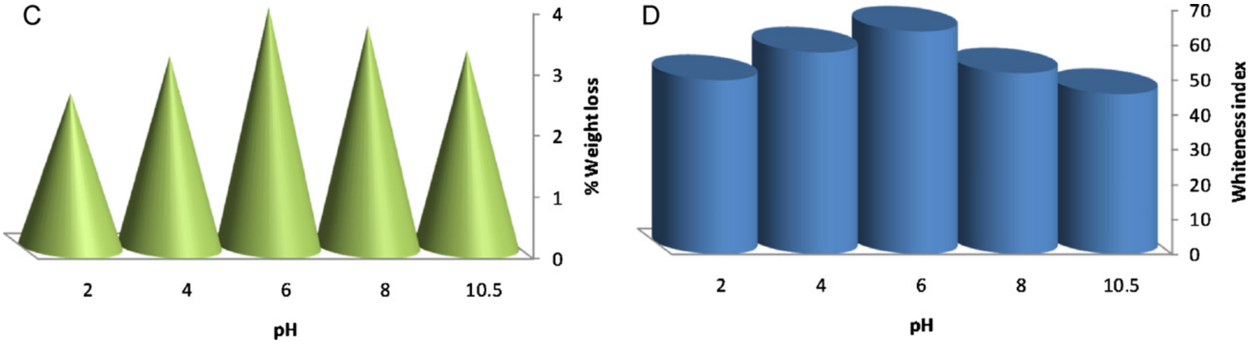

Fig. 2. Effect of pH of the bleaching medium on the percent loss in fabric weight (C) and whiteness index (D). Mixture concentration, 40 ml/l; material to liquor ratio, 1:30; temperature, 70 °C; duration, 1 h.

of the bleaching reaction medium, concentration of the oxidant components, reaction temperature and duration.

3.2.1. pH of the reaction medium

Fig. 1 shows the effect of pH of the reaction medium on the decomposition rate of peracetic acid (A) and hydrogen peroxide (B), respectively. The reaction was carried out using 40 ml/l of the freshly prepared bleaching solution at 70 °C using a material to liquor ratio of 1:30 for 60 min.

Fig. 2 shows the percent loss in fabric weight due to bleaching (C) and the whiteness index (W.I.) of the resultant bleached fabrics (D). Table 2 shows the mechanical properties (tenacity and percent elongation at break), and chemical properties (carbonyl content and carboxyl content) of the bleached fabrics. The given data indicate that: (a) the rate of decomposition of peracetic acid and H_2O_2 increases significantly by increasing the duration of reaction up to 20 min, increasing the reaction duration above this limit is accompanied by a slower rate, (b) the rate of decomposition of the bleaching components depends on the pH of the reaction medium and follows the order:

- for peracetic acid component, pH 6 > pH 8 > pH 10.5 > pH 4 > pH 2,
- for H_2O_2 component, pH 10.5 > pH 8 > pH 6 > pH 4 > pH 2,

(c) maximum W.I. and total percent loss in weight is obtained at pH 6, (d) the values of the carboxyl content and carbonyl content increase by increasing the pH of the reaction medium up to pH 6, further increase above this limit is accompanied by a marginal decrement and (e) there is a gradual loss in the tenacity by increasing the pH from 2 to 6 and further increase above this limit results in higher tenacity and the reverse holds true with respect to the elongation percentage. It could be concluded from the data that (i) maximum effect for bleaching and removal of the impurities is obtained at pH 6, (ii) the loss in tenacity and increasing in elongation percentage is due to the removal of the noncellulosic materials from the cotton fiber structure, and (iii) it is expected that maximum bleaching effect can be obtained by starting bleaching at pH 6, where peracid works well at this pH and then raising to pH 10.5 after 30 min, where hydrogen peroxide function very effectively as bleaching agent in pHs higher than pH 10.

Table 2
Effect of pH of the bleaching medium on the physical and chemical properties of the bleached fabric.

pH	–C=O (m eq/100 g)	–COOH (m eq/100 g)	Tenacity (kg f)	Elongation (%)
2	8	9	62	25
4	12.3	17.6	55	30
6	14.2	22.5	52	33
8	13.4	18.2	53	28
10.5	12.5	14.3	53.4	24
Grey fabric	5	4	67	22

Mixture concentration, 40 ml/l; material to liquor ratio, 1:30; temperature, 70 °C; duration, 1 h.

3.2.2. Effect of bleaching mixture concentration

Fig. 3 shows the effect of the amount of bleaching mixture incorporated in the reaction medium on the percent loss in fabric weight (E) and whiteness index (F), while Table 3 presents the physical and chemical properties of the bleached cotton fabric. The bleaching process was carried out at 70 °C for total duration of 60 min. The initial pH of the reaction medium was adjust at pH 6 and kept for 30 min then the pH was turned to 10.5 and the bleaching reaction was continued for extra 30 min. The obtained results reveal that: (a) increasing the amount of the bleaching agent incorporated in the reaction medium up to 40 ml/l is accompanied by significant enhancement in the percent loss in fabric weight, W.I., carboxyl content and carbonyl content compared with the grey fabric. Further increase in the bleaching mixture concentration above this

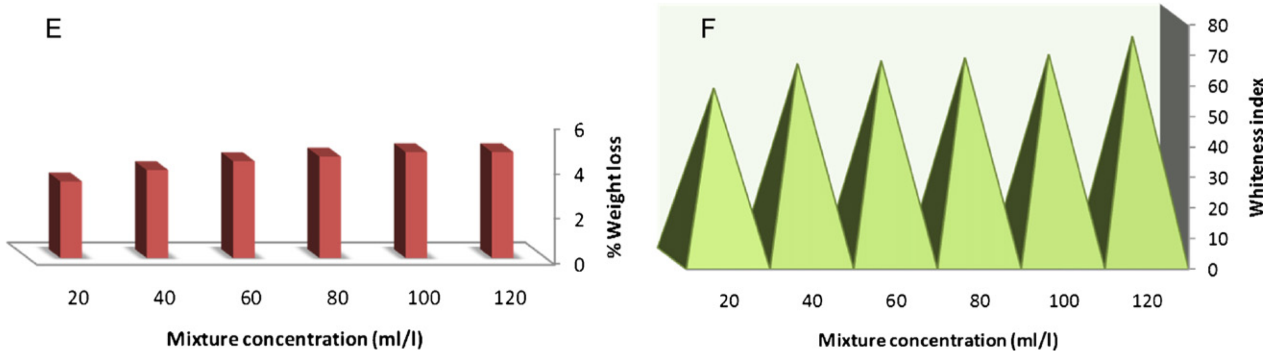

Fig. 3. Effect of mixture concentration on the percent loss in fabric weight (E) and whiteness index (F). Initial pH of the bleaching medium, 6 then turning to 10.5 after 30 min and completing the bleaching for extra 30 min; material to liquor ratio, 1:30; temperature, 70 °C.

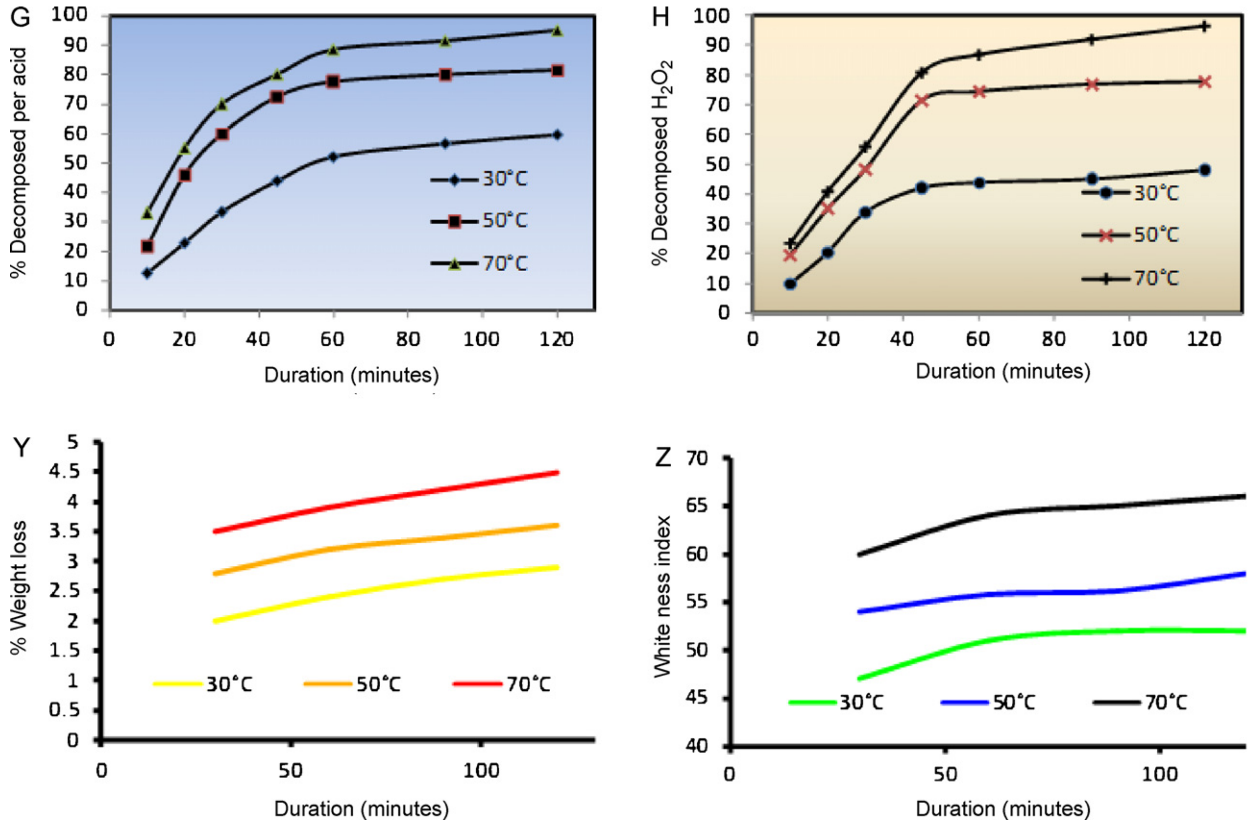

Fig. 4. Effect of bleaching temperature on the decomposition rate of peracetic acid (G) and hydrogen peroxide (H) as well as percent loss in fabric weight (Y) and whiteness index (Z). Mixture concentration, 40 ml/l; material to liquor ratio, 1:30; initial pH of the bleaching medium, 6 then turning to pH 10.5 after 30 min and completing the bleaching for extra 30 min.

Table 4
Effect of bleaching temperature on the mechanical properties, carbonyl content and carboxyl content of the bleached fabrics.

Duration (min)	–C=O (m eq/100 g)			–COOH (m eq/100 g)			Tenacity (kg f)			Elongation (%)		
	30 °C	50 °C	70 °C	30 °C	50 °C	70 °C	30 °C	50 °C	70 °C	30 °C	50 °C	70 °C
30	9.5	12.2	13.2	15.7	18.4	20.5	56	55	53.5	25.8	28.8	31
60	11.1	13.3	14.2	16.8	20	22.5	55.5	53.5	52	27.8	29.7	33
90	12	14	15	17.6	21	24	53.5	51.6	50.4	28.9	31.4	35
120	13.3	14.8	15.5	18.7	21.8	25.2	52.3	50.3	49.2	29.8	32.3	35.3
180	13.4	14.6	15.5	19.5	23.5	25.5	51.8	49.7	47.8	30.1	32.7	35.4
240	13.3	14.7	15.3	20	23.9	25.8	51.7	49	47.2	30.2	32.7	35.3
Grey fabric		5			4			67			22	

Mixture concentration, 40 ml/l; material to liquor ratio, 1:30; initial pH of the bleaching medium, 6 then turning to pH 10.5 after 30 min and completing the bleaching for extra 30 min.

Table 3
Effect of mixture concentration on the physical and chemical properties of the bleached fabric.

Mixture (ml/l)	–C=O (m eq/100 g)	–COOH (m eq/100 g)	Tenacity (kg f)	Elongation (%)
20	10.5	13.2	58.4	30
40	14.2	22.5	52	33
60	15.2	23.1	51	33
80	16.4	24.2	49.3	33.6
100	17.5	25.9	47.2	33.9
120	18	25.2	43	34.5
Grey fabric	5	4	67	22

Initial pH of the bleaching medium, 6 then turning to 10.5 after 30 min and completing the bleaching for extra 30 min; material to liquor ratio, 1:30; temperature, 70 °C.

limit leads to a marginal increment in the above mentioned values, (b) increasing the bleaching mixture concentration leads to gradual decrement in the tenacity of the treated samples. The reverse holds true for values of elongation percentage. These behaviors reflect the extent of removal of the noncellulosic materials from the cotton fiber structure. It could be concluded from the obtained data that the optimum concentration of the bleaching mixture to be used in the bleaching process giving satisfactory whiteness index and retaining great deal from the fiber mechanical properties is 40 ml/l.

3.2.3. *Effect of reaction temperature*

The bleaching process was carried out at different temperatures 30 °C, 50 °C, and 70 °C using 40 ml/l of the bleaching mixture, material to liquor ratio 1:30 for 120 min. The starting pH was 6 then turned to pH 10.5 after 30 min and bleaching continued for extra 30 min. Fig. 4 shows the rates of peracetic acid decomposition (G), H_2O_2 decomposition (H), percent loss in fabric weight (Y) and W.I. of the bleached fabrics (Z). Table 4 shows the physical and chemical properties of the untreated and bleached fabrics. It is clear from the data that increasing the reaction temperature is accompanied by: (a) enhancement in the rate of decomposition of peracetic acid and H_2O_2, (b) marginal increase in the percent loss in fabric weight, (c) improvement in the W.I. of the bleached samples, (d) increment in the elongation percentages, carboxyl content and carbonyl content and (e) acceptable decrement in the tenacity.

4. Conclusion

Peracetic acid was prepared from the reaction of hydrogen peroxide with glacial acetic acid in the presence of concentrated sulfuric acid as a catalyst. Factors affecting peracetic acid formation, like sulfuric acid concentration and its effect on the amount of residual hydrogen peroxide and converted peracetic acid were studied together with following up the amount of residual hydrogen peroxide and amount of converted peracid throughout the reaction period. Peracid was not formed in the absence of sulfuric acid and the residual H_2O_2 in the reaction mixture decreases by increasing the amount of H_2SO_4 incorporated in the reaction medium and prolonging the duration of reaction which indicates that as concentration of the catalyst sulfuric acid increases, the amount of hydrogen peroxide consumed in forming peracid increases. The percent of peracid formation increases by increasing the amount of H_2SO_4 incorporated in the reaction medium up to 0.25 mole and the stability of the peracid decreases at H_2SO_4 concentration higher than 0.125 mole. The so prepared peracetic acid was used for bleaching desized and scoured cotton fabrics at low temperature and different variables affecting the bleaching process, like pH of the reaction medium, bleaching mixture concentration and bleaching reaction temperature were extensively studied. The bleached fabrics were fully characterized by measuring the fabric wettability, the whiteness index, tensile strength and carboxyl and carbonyl contents. Results obtained show that optimum conditions for bleaching were using peracetic acid at concentration of 40 ml/l at 70 °C, using a material to liquor ratio of 1:30 at pH 6 for 30 min and then turning the pH to 10.5 and continuing bleaching for extra 30 min. Theses conditions were found to give bleached fabric with satisfactory whiteness index (64) with reasonable loss in tensile properties.

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