THE USE OF PERACETIC ACID IN THE TREATMENT OF COTTON

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Introduction

One of the most important criteria for determining the quality of industrial effluents is the content of halogenated organic compounds (AOX). This also affects on the textile industry. Until recently very popular bleaching agent was sodium hypochlorite. In spite of his low cost and bleaching at low temperatures, nowadays we must avoid it, because it raises AOX value of effluents. Hydrogen peroxide is now widely used. Reaction products of hydrogen peroxide are not toxic and not dangerous. But it is damaging to fibers and it needs a strong alkaline medium and high temperature for better bleaching effect.

Bleaching with peracetic acid (PAA) can be used as an alternative to hydrogen peroxide, sodium hypochlorite and chlorite bleaching. PAA is also used as a bleaching agent in paper industry and in launderettes.

PAA is strong oxidising agent and reacts exothermically with easily oxidising substrates [1]. It has excellent bactericidal, anti microbial and bleaching properties even at quite low concentration. PAA (100%) is a colourless liquid at room temperature, which is easily mixable with water. Solutions have a pungent smell.

Peracetic acid could be produced directly in a bleaching bath from acetic anhydride and hydrogen peroxide [2,3]. This method was used earlier mainly because of high prices of industrial peracetic acid. Due to the risk of explosion this method of syntesis was abandoned.

Commercially it is produced from hydrogen peroxide and acetic acid as shown in the equation 1. The reaction is reversible and the final product of reaction is an equilibrium mixture.

$$CH_3COOH + H_2O_2 \rightleftharpoons CH_3COOOH + H_2O \quad (1)$$

Due to easier usage and reduced prices, commercial solutions equilibrium PAA is more and more widely used. They are stabilized with minimal addition of some sequestering agent. On the market equilibrium PAA is accessible as 5, 15, and 40 % solution. For textile treatments are more suitable less concentrate solutions, because they are not explosive. Commercial solutions are stable for about six mounts, depending on the temperature conditions. Prepared bleaching baths are not stable for a long time. A spontaneous decomposition of PAA takes place in the bleaching bath, which is accelerated by high temperatures, high pH and the presence of metal ions:

$$2\ CH_3COOOH \rightarrow 2\ CH_3COOH + O_2 \quad (2)$$

Decomposing products are environmentally safe, not toxic and biodegradable. The acetic acid component released during the bleaching process causes a slightly higher COD value. PAA can also hydrolyse to form acetic acid and hydrogen peroxide. Since hydrogen peroxide and oxygen are not effective bleaching agents under the typical peracetic bleaching conditions, both the decomposition and the hydrolysis are not desirable. [4]

In the bleaching process PAA causes epoxidation of colouring compounds on the fibre. A simplified presentation of bleaching gives the reaction:

$$coloured\ \ incrust + CH_3COOOH \rightarrow oxidised\ incrust + CH_3COOH \quad (3)$$

The maximum bleaching effect is theoretically reached at the pH value of 8,2, but experimental results show that the optimal bleaching condition is between 7 and 7.5. If the pH value is over 9, the decomposition of peracetic acid takes place extremely fast. In this case bleaching effects are worse and fiber damage is possible. In acid condition PAA is not active and bleaching effect is poor [2, 5].

The aim of this work was to bleach different kind of cotton substrates with PAA at different conditions and to compare the obtain results.

Experimental

Materials:

- cotton noil, low (gauze) and high density woven fabric (poplin)
- Superol KD Bio (Teol) - anionic and nonionic wetting agent and dispersing agent
- Lawotan RWS (CHT) - nonionic wetting agent
- Persan S15 (Belinka) - 15% solution of peracetic acid
- NaOH 1N

Method

Bleaching was carried out on raw, desized and alkaline scoured cotton noil, gauze and poplin according the pre-treatment and bleaching conditions given in Table 1.

Table 1: Scouring and bleaching conditions

	alkaline scouring	bleaching
Superol KD-Bio (g/l)	1,5	-
NaOH 100% (g/l)	5	pH 5 - 9
Persan S15 (ml/l)	-	15
Lawotan RWS (g/l)	-	1
t (min)	60	10 - 80
T (°C)	95	60
liquid ratio	1:10	1:20

The bleaching effects were characterized by CIE whiteness measured on Datacolor Spectraflash SF 600, fibre damage was evaluated by measuring the degree of polymerisation (DP) with the viscosimetric method in cuoxam. Water absorbency was in the case of poplin evaluated by measuring how long it took for a drop of water to be absorbed, but in the case of noil and gauze accordingly to the standard of Pharamcopoeia by measuring the sinking time of defined mass of the substrate [6]. Wax and ash content were evaluated accordingly to the same standard.

Results and discussion

The most important parameters in the bleaching process are pH, temperature, bleaching time and concentration of the bleaching agent. From our previous work [7,8] we can conclude that the degree of whiteness rises with the increasing concentration of the bleaching agent, but only up to 10 ml/l of Persan S15. After that concentration the whiteness does not increase any more. Even at high concentrations of PAA, the DP values are not much lower and are always higher than the values obtained with other bleaching processes [7]. Further on it was established that the increasing of the temperature of the bleaching bath causes an increase in whiteness degree, but at a higher temperature the damages are greater.

Treatment time has a significant effect on all-important values of bleached samples. Longer time of treatment improves the whiteness degree, but only to defined value (Figure 1). Further time of treatment does not improve much more the results. From Figure 1 it can be seen that the optimal bleaching time is 40-60 minutes.

Another important parameter is pH. The whiteness degree obtained in neutral and alkaline media is higher than in an acidic media (Figure 2). A higher degree of whiteness and high DP could be achieved at pH 7. At pH 8 and 9 the degree of whiteness is a little bit higher, but the bleaching effect is unequal, because at this conditions PAA decomposes faster. Subsequently the DP value is lower.

If we want to achieve a greater whiteness at these bleaching conditions the pre-treatment is necessary. The results in Table 2 show that the whiteness of previous scoured samples is higher than that of unscoured ones in all cases. Even a good absorbency could not be achieved by bleaching only. After scouring of cotton the absorbency increase substantially, but only samples previously scoured and then bleached reached the values prescribed by Pharmacopoeia, which are up to 10 seconds. On fine poplin very good absorbency is obtained even without scouring. The main reason is that fibres of noil and gauze contain more wax than that of poplin, which cannot be removed only by bleaching at low temperature.

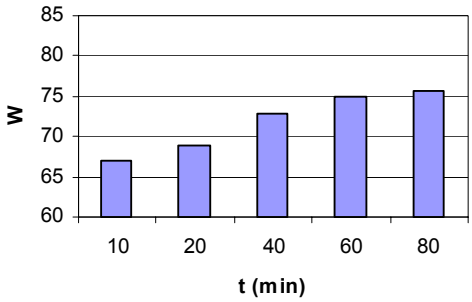

Figure 1: Whiteness (W) versus time (t) at bleaching noil with PAA at pH 7 and 60 °C for 40 min

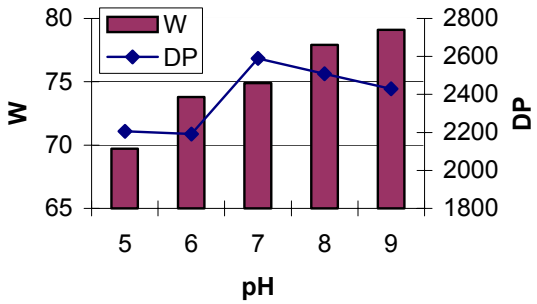

Figure 2: Whiteness (W) and DP versus pH at bleaching noil with PAA at 60 °C for 40 min

Table 2: Whiteness and sinking time of noil, gauze and poplin

	Noil			gauze			poplin		
	raw	raw+PAA	scoured+PAA	desized	desized+PAA	scoured+PAA	desized	desized+PAA	scoured+PAA
whiteness	33,5	74,9	78,6	4,5	65,5	76,8	9,2	60	81,4
absorbency (s)	∞	237	2,2	∞	∞	<1	∞	<1	<1

Table 3 shows wax and ash content of cotton noil before and after treatment. The content of wax as well as ash decreases substantially with scouring, with further bleaching even more, which corresponds to our results for absorbency.

Table 3: The wax and ash content of raw, scoured and bleached noil

sample	wax (%)	ash (%)
raw	0,65	1,44
scoured	0,37	0,43
bleached	0,36	0,13

We can conclude that bleaching with PAA is appropriate process for different kind of cotton substrates, but the results of whiteness and absorbency depends very much on the initial quality of goods.

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