

STUDIES IN PREPARATORY PROCESSES
BASED ON SODIUM CHLORITE

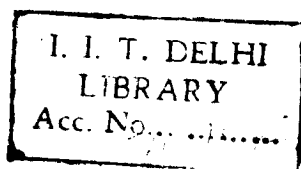
THESIS SUBMITTED TO
THE INDIAN INSTITUTE OF TECHNOLOGY, DELHI

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DOCTOR OF PHILOSOPHY

R M MITTAL

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DEDICATED TO
MY PARENTS
AND
Dr. T. RADHAKRISHNAN

CERTIFICATE

This is to certify that the thesis entitled "Studies in Preparatory Processes Based on Sodium Chlorite" being submitted by R.M. Mittal to the Indian Institute of Technology, Delhi for the award of the degree of Doctor of Philosophy is a record of bonafied research work carried out by him under my guidance and supervision.

To the best of my knowledge this thesis has reached the required standard. The material presented in this thesis, in part or full has not been submitted to any other university or any other institute for the award of degree or diploma.



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"As fire is covered by smoke,
as a mirror by dust
as an embryo by the womb
so is wisdom enveloped by desire"

He has always been very friendly and I wish that the beautiful relationship that we have developed would be an enduring one. I, sincerely, express my deep sense of gratitude to Mohan Gulrajani for his fraternal guidance, personal attention and encouragement without which it would not have been possible to complete this onerous task. Thank you very very much.

Another great personality is responsible for my carrying out this work and for him I do not have words to express. He kept himself acquainted with the progress of the work and made personal enquiries to Prof. Gulrajani whenever they met. He has been a tower of strength, guide, and all that throughout. His advices are always par excellence. On one occasion he recited a sanskrit shloka, which means -

Your right is to do action alone,
never to its fruits.
Let not the fruit of action be your
motive,
nor let your attachment be to inaction.

I have always tried to follow this to the best of my abilities. He took keen interest in this work and offered explanations for some of the observations, which have been duly incorporated in the write-up. The least I can do is to Dedicate this work to him, namely, Dr. T. Radhakrishnan, Director, Ahmedabad Textile Industry's Research Association (ATIRA), Ahmedabad, India.

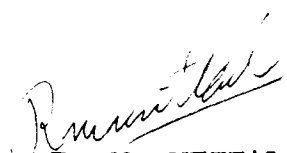
In scientific studies, many times one has to draw help and seek guidance from the fellow workers. I was extremely fortunate to have two intelligent co-workers in R. Venkatraj and Sanjay Gupta, who were by the side whenever called upon. On several occasions, they offered help of their own. I sincerely thank them for their whole hearted support.

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R M MITTAL

SUMMARY

SUMMARY

A thorough preparation is an essential prerequisite for subsequent satisfactory colouration and finishing of textiles. The treatment conditions in preparatory processes depend upon the nature of the constituent fibres of the textiles being treated. Designing of preparatory conditions become important in the case of blended textiles, such as polyester-cotton (PC) blends because of diverse nature of the constituent fibres. A practical solution to this is the use of sodium chlorite which can prepare not only polyester but also cotton effectively. The detailed studies have, therefore, been carried out in the preparation of PC blends with NaClO_2 . Efforts have been made to perform scouring and bleaching together in one step at low temperatures. For the low temperature treatment, formaldehyde (HCHO), and sodium bisulphite adduct of formaldehyde (F-A) have been used as activators. The bleaching of acrylic knit has also been attempted likewise.

The experiments have been conducted by employing a centrally rotatable plan. Optimisation of the treatment conditions has been achieved through regression analysis.

Further, efforts have also been made to explore possible usage of solar energy in sodium chlorite bleaching. For this, combined scouring and bleaching of PC blends

(suiting) has been attempted employing the conventionally used activator, i.e., formic acid.

The combined scouring and bleaching of PC blends with formaldehyde activated sodium chlorite and self emulsifiable scouring agent has been attempted. Two varieties of 67/33 PC fabrics, a suiting and a shirting, have been used in these studies. The fabrics were given treatments after enzymatic desizing. The treated samples have been evaluated for Whiteness Index (WI), wettability, removal of moles and dye-receptivity. The multiple regression analysis carried out for WI reveals that the temperature (within the range studied) of treatment does not influence WI. The optimised conditions for preparation with sodium chlorite for satisfactory performance, as compared against the conventionally prepared fabrics, are - sodium chlorite 0.85%, time of treatment 6-8 h, temperature around 30°C, scouring agent 2%, formaldehyde 3 g/l and soda ash 3 g/l. It has been found that the low temperature sodium chlorite prepared fabrics yield satisfactory results in terms of dye-receptivity. Further, wettability of the samples prepared by the combined process is good. The removal of moles is satisfactory and for this concentration of sodium chlorite should be more than 0.35%.

Further, strength of the fabrics remains unaffected during preparation. Also, free formaldehyde content of the prepared fabrics is practically non-existent.

The studies with F-A have been carried out similar to HCHO. The optimised conditions are - sodium chlorite 0.85%, time of treatment 12-14 h, temperature 35-40°C, scouring agent 2%, F-A 6-8 g/l, and sodium bisulphite 1-2 g/l. This activator has also given satisfactory performance. Here, temperature has shown some effect on WI in the case of shirting fabric. Nevertheless, temperature 35-40°C is adequate.

Some work has also been carried out on a knitted acrylic fabric. The fabric before the bleaching treatment was washed and then hydroset (95°C/30 min). The bleached samples have been evaluated for whiteness (Hunter Whiteness) and single yarn strength. Time of treatment, temperature, and concentration of sodium chlorite have been varied and correlated through regression analysis. The optimisation has been done against a conventionally bleached sample. It has been possible to bleach acrylic fabrics at low temperature with both the activators. But, the satisfactory results have been obtained with F-A. The strength of the yarns drawn from the fabric samples was measured on Instron. And it remains unaffected in the bleaching treatment.

Further, application of solar energy has been explored. The solar oven used in the experiments contains a cylindrical reflector, and a circular hollow copper tube for keeping the samples. It was possible to attain the temperature over 90°C

on the samples kept inside the tube. The activation of NaClO_2 in this case has been achieved with formic acid. The pH of the pad-bath was adjusted to 4.0 with formic acid, and scouring agent 1% owf was added in the recipes. Sodium chlorite in six concentrations ranging between 0.25 and 1.5% was applied to the suiting fabric and the actual consumption of NaClO_2 ascertained. The maximum consumption of sodium chlorite was 0.83% in 3 h storage period. It took around 45 min for the fabric to attain the ambient temperature of the tube. The prepared samples have been evaluated for characteristic properties and it has been found that the preparation of the samples is satisfactory; the system seems to be promising one. Time of treatment, temperature of treatment and concentration of sodium chlorite all influence significantly the final results.

The optimised treatment conditions for PC blends were tested in large scale trials on the shopfloor. The problem of inadequate pad-bath stability, encountered during the large scale trial, was investigated. This led to the conclusion that even if the system was over stabilized 'in solution', it would exhibit satisfactory performance once the fabric was introduced. In other words, the substrate, i.e., fabric influenced the decomposition/consumption of sodium chlorite quite considerably. The performance of sodium chlorite prepared fabrics is quite good both in terms of whiteness and dye-receptivity. The overall appearance of sodium chlorite

bleached fabrics on dyeing has been found to be superior to that of conventionally bleached and then dyed fabrics. The study on effect of substrate on consumption of sodium chlorite has helped in structuring a process for shopfloor working. The process has technoeconomically been found to be a sound one.

Some studies have also been carried out on kinetics. It has been found that the activation of sodium chlorite through HCHO at low temperature is a catalytic reaction. The energy of activation has been estimated as 13.66 K cal/mole; as against the reported value of 30-40 K cal/mole for high temperature (70-80°C) activation.

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