TECHNICAL BULLETIN

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EFFECTS OF LAUNDERING CONDITIONS ON COLORFASTNESS TO HOME LAUNDERING

INTRODUCTION

Consumers in focus groups have consistently cited color and loss of color in home laundering as one of the major negative issues associated with cotton products. Of consumers surveyed by Cotton Incorporated's *Lifestyle Monitor*™, 68% reported problems with color fading of clothing after only a couple of washings. Although most people say they don't know why their garments fade, almost one-third of respondents say that poor quality and dye problems are responsible. Another 18% blame laundering components such as the detergent, chlorine, or other water factors for the fading.

Some research has been done at Cotton Incorporated to understand the phenomenon of color fading and the effects of fuzzing on apparent color loss.[1,2] Dye selection, dyeing procedure, and other mill processing parameters have been investigated. A few studies have examined the effects of commercial detergents or the use of detergents with "color-safe" bleaching agents on color loss.[3,4,5,6] This technical bulletin summarizes the investigations of laundering with different types of detergents. Some results of the effects of laundering additives are also included.

EXPERIMENTAL

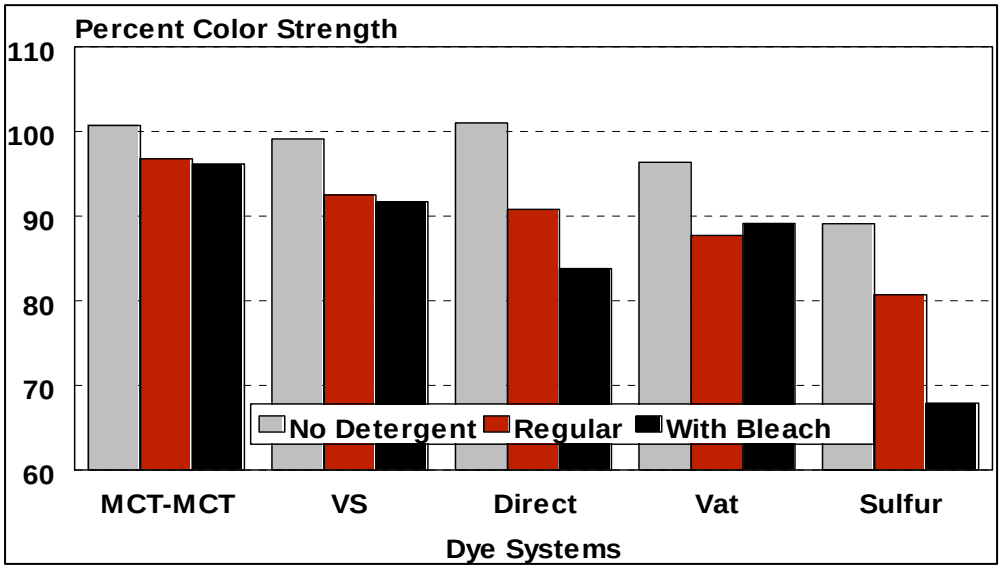
All studies were done using 100% cotton interlock knit fabric. Black, green, red, and navy were the colors that have been chosen. Red, black, and blue have been cited by consumers as having the most fading problems. In most cases, shades were matched using reactive, sulfur, or direct dyes. In two reports, vat dyes were also used.[5,6] Some samples were treated with acid cellulase enzymes, either before or after dyeing to reduce fuzzing by removing loose fibrils. Most of the fabrics received either a softener only or a softener plus resin finish. A few of the samples received no finish at all.

In addition to experiments with no detergent, the following powder detergents have been used: 1993 AATCC Standard Reference Detergent 124 without optical brightener, a commercial detergent with oxygen-based bleach and two different commercial detergents without bleach. The liquid detergents were all commercial detergents without bleach. All launderings were done according to AATCC procedures in warm water (41C) and most wash water did not contain chlorine ("process water"). Municipal water that is used in most homes does contain chlorine, but most of these studies were done to examine other sources for color loss. Both the color difference (DEcmc) and percent color strength (%CS) were measured for all fabrics versus a control fabric after 5, 10, and 20 home launder-tumble dry (HLTD) cycles. In two studies, other colorfastness properties, such as light, crocking, perspiration, IIA accelerated wash, and cold water bleeding were also measured. However, this bulletin will focus on the DEcmc and %CS. Based on discussions with industry at the time of each study, good fastness was defined as DEcmc between 0.8 and 1.5 and with %CS above 90% after 20 HLTDs.

RESULTS AND DISCUSSION

Most of the past investigations have focused on examining the colorfastness of different dye types or dyeing procedures on fabrics laundered with process water and powdered detergents. In general, powder detergents have a more detrimental effect on the color strength than no detergent. This effect is illustrated by Figure 1, which shows the performance of samples that were dyed with different types of dyes and that were laundered with two commercial detergents and no detergent. MCT and VS refer to two types of reactive dyeing systems.

Figure 1. Effect of laundering with detergent on %CS. (MCT = monochlorotriazine reactive; VS= vinyl sulfone reactive)

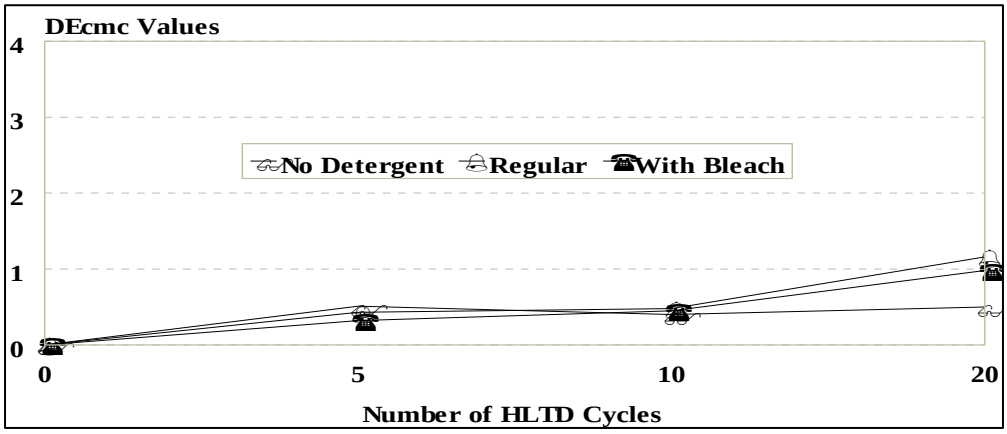


Very few studies have compared powder and liquid detergents. However, one study with a powder detergent and a second study with a liquid detergent used the same type of fabric (interlock), dye formulations (based on C.I. Reactive Black 5) and finishes. The laundering was done in process water to eliminate any effects from chlorine. Comparison of the data between those two sets of experiments suggests that liquid detergent may be more detrimental to color on knitted fabric than powdered detergents. TABLE I shows some of the data for the samples laundered in liquid detergent and Figure 2 displays the data for samples washed in different powder detergents. All of the DEcmc values in TABLE I were obtained after laundering with a liquid detergent. These color differences are considered perceivable and are greater than the color differences in Figures 2 and 3 at 10 HLTDs, which were measured after laundering with two commercial powdered detergents. This amount of color change indicates a greater shift in the color after laundering with liquid detergent.

TABLE I
DEcmc After 10 HLTD Cycles with Liquid Detergent

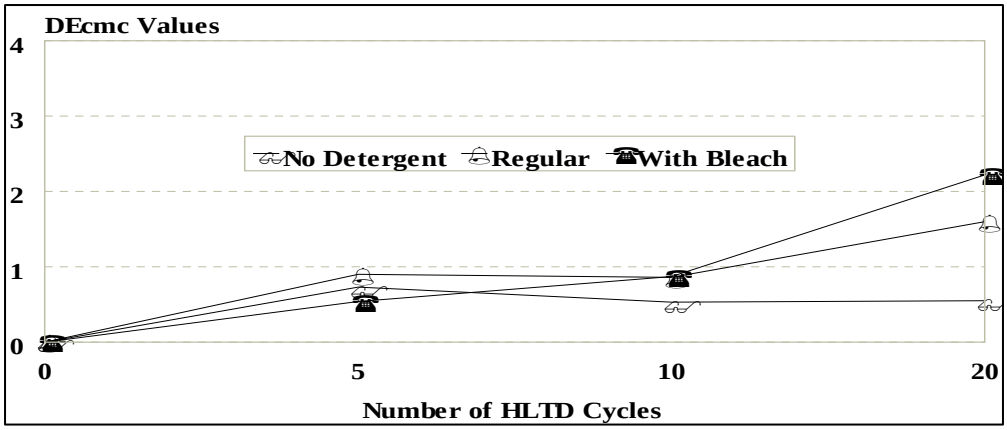
	Control	Finish 1	Finish 3
Direct No Enzyme	1.88	1.65	1.31
Direct With Enzyme	0.77	1.72	1.65
Reactive No Enzyme	0.75	1.67	1.01
Reactive With Enzyme	0.85	1.11	1.00

Figure 2. DEcmc Values for Vinyl Sulfone-Dyed Navy Fabric after Laundering with and without a Powder Detergent.



Based on the data in these two studies, a statistically significant difference was found for both DEcmc and %CS between the mean effects of liquid and powder detergents. The samples that were washed in liquid detergent had higher %CS and higher DEcmc values. Therefore, although the liquid detergent caused slightly less color loss, the color loss was more off-shade. There was no significant difference between the means of the two powder detergents, indicating that the type of powder was not as important as the difference between solid and liquid. (These detergents were not necessarily the same as those used in previous experiments.)

Figure 3. DEcmc Values for Direct-Dyed Navy Fabric after Laundering with and without a Powder Detergent.



Several other studies have briefly examined the effects of a single parameter on one shade with one or two types of finishes. Using a commercially available liquid detergent, one series of experiments examined the effect of two liquid softeners, that were added during the rinse cycle, and one dryer sheet on appearance of a reactive navy knit fabric with two types of finishes.[7] In municipal water with chlorine, the branded liquid softener seemed to have a negative effect on the color after 20 HLTDs. The reason for this effect is unknown because the components of the fabric softener are unknown. There was no significant difference between the dryer sheet, the generic liquid softener or no softener when no interaction between softener type and finish is assumed. This difference is presented in Figure 4.

Figure 4. Mean %CS and 95% confidence limits for various types of home laundry softeners.

In other testing of a black shade on interlock fabric, the effect of water level in a vertical axis washer on the color retention was examined.[8] The laundering was performed in muncipal water with chlorine using a liquid detergent. Since two different model year machines were used in this testing, differences in machine variables may have had some impact on the difference in colorfastness. However, most of the color loss that occurred is attributed to the increase fiber-to-fiber friction that occurred when a lower water level was used. This effect may be partially explained by the change in water-to-fabric ratio.

In order to isolate any differences due to chlorine and to minimize machine differences, additional black samples were washed with process water that did not contain chlorine. These samples were compared to one of the machines that was an identical model used in the water level study.[9] For these fabrics, no differences in color loss were observed between the samples washed in municipal water and in process water.

Finally, the effects of horizontal axis laundering have been investigated using the same black interlock fabric. In comparison to the samples described above, the samples that were washed in the front-loading washer had better color retention.

A summary of conclusions related to laundry detergents from the various studies is given below.

Navy Interlock

1. The detergent with bleach caused a greater change in DEcmc for the direct and sulfur systems, when compared with the control, than the commercial powder detergent.

2. The greatest initial reduction in color strength was attributed to the detergent containing bleach followed by the commercial powder detergent. After 20 HLTD cycles, no significant difference was seen between the commercial powder detergent and the detergent containing bleach for the reactive systems.

3. Both the direct and sulfur dye systems experienced a significant reduction in color strength when laundered with detergent containing bleach.

4. The vat dye system displayed a greater color strength loss when laundered with the commercial powder detergent.

Red Interlock

1. The detergent with bleach had the least color change in the reactive triazine-type dye system as compared to the vinyl sulfone or direct dye systems.

2. The commercial powder detergent caused the greatest color change in the vinyl sulfone dye system.

3. All of the washing conditions affected the direct system to an equal level.

4. The color strength values of the reactive dyes were not significantly affected by any detergent condition.

5. The direct system reported significantly lower color strength values after 20 HLTD cycles when laundered with detergent containing bleach.

Green Interlock

1. For powder detergents, the presence of bleach did not significantly affect the DEcmc values of the vinyl sulfone or the vat dyed fabrics.

2. All powder detergents caused a significant change to the DEcmc values associated with the sulfur dyed fabric.

3. For powder detergents, the presence of bleach did not affect the color strength values of the reactive or vat dyed fabrics.

4. All powder detergents produced a significant change in color strength for the direct and sulfur dye systems.

Black Interlock

1. The reactive dye formulation showed the best overall performance regardless of detergent type.

2. The direct dye formulation was affected more severely with respect to color loss and shade change by the powder with bleach than the AATCC Standard Detergent.

GENERAL CONCLUSIONS

Because the majority of the work was done on a few reactive dyes, these conclusions are really only indicative of the reactions of the most common reactive dyeing systems. Powder detergent had less effect on color change (as measured by DEcmc) than liquid detergent. The liquid detergent in one study did contribute to better overall color retention. A name brand softener reduced color retention more than a dryer sheet or a more generic version liquid softener. Water level in vertical axis machines was a critical parameter that needs to be controlled to minimize color loss.

On the positive side, using a front-loading machine minimized color loss in one brief study. When appropriate reactive dyes were selected, chlorine found in municipal supplies did not affect color retention. Therefore, the selection of appropriate laundering conditions can minimize color change and color loss of cotton fabrics.

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