The Effects of the Changing Textile Technology on Detergent Formulations[1]

ROBERT T. HUNTER and ROBERT C. ROGA, Colgate-Palmolive Research Center, Piscataway, New Jersey 08854

Abstract

The rapidly changing character of the laundry load has created new cleaning criteria for the modern detergent composition. The effect of some likely changes in detergent formulations on the performance of a representative set of modern fabrics has been investigated. The results indicate that certain benefits in the cleaning of permanent press fabric can be achieved through some rather simple formulation changes. These changes include: the use of olefin sulfonate surfactant; and the use of mixed STPP-SNTA builders. Nonionics and nonionic-LAS mixtures were found to have rather flat response curves on the fabrics in this study. The maintenance of adequate use concentration when laundering with common detergents was also found to be quite beneficial in cleaning the modern textiles. The most apparent progress in achieving better appearance of laundered fabrics has been made by the development of the soil release finish for permanent press.

Introduction

The changes in textile technology that have taken place in the last few years have been extremely rapid. In about 1963, the Koratron Co. introduced the first permanent press fabrics to the market place. At that time, considerable difficulty was encountered in the laundering of permanent press garments because of extreme loss of abrasion resistance due to heavy resin add-on. Later, it was determined that a 65/35 polyester cotton blend would be an excellent substrate. Quantities of resins sufficient to create permanent press could be added to the blend without drastic losses in abrasion resistance and tensile strength. It is also significant that mass brightening of polyester fiber was also becoming important at that same time. From that point the textile industry has progressed very rapidly through many changes and expansion in permanent press concepts. Considerable gain has been made in the whitening of the basic fabrics, improvement of tensile strength, alterations in design of garments and other innovations, all of which have contributed to success in capturing a significant portion of the launderable market for permanent press. The most recent, and probably most widely heralded innovation in this area is the soil release fabric. Many textile-related companies have introduced soil release fabrics to the market place. The advertising for these fabrics has made the promise of overcoming the major problem of permanent press fabric—that is, tendency to hold on to acquired oily materials.

Previous work (1) in this laboratory was carried out with a group of fabrics common to usage before the emphasis on permanent press. The effect of changes in certain laundry conditions on the ultimate appearance of the fabrics was explored. With some of the newer materials available for detergent formulations, however, this work brings the performance of permanent press and soil release permanent press finishes into perspective.

Experimental Procedures

To establish some correlation between the known fact that permanent press polyester-cotton fabrics do retain oily stains, a test method, by Trowbridge (2), was used on a practical yet reproducible scale. In this procedure, the face, forehead and neck of male subjects are rubbed with swatches of the fabrics in question. Thus, it integrates a natural sebum soil with any variety of fabrics. Ten swatches of each of the fabrics shown in Table I were soiled at random and washed (separately by fabric) in a Tergotometer, using 0.15% of an all anionic built detergent. The soil-wash cycle was repeated six times. After six cycles, the swatches were evaluated instrumentally using a Hunter D25 Color Difference Meter with UV filter in place. Data from studies such as this are termed Skin Soil Test Data.

Spangler, Roga and Cross (3) recently published another method which measures the retention of synthetic sebum soil on fabric. As with the Trowbridge Skin Soil Test, this Sebum Yellowing Test allows for flexibility in the choice of substrate. Since the Sebum Yellowing Test is less time-consuming than the Trowbridge Test, it was chosen for a study of the relationship of the fabrics listed in Table I and the following variables in typical built detergent formulations: active ingredient; change in builder; and concentration changes. The model detergent framework in which the variables were studied consisted of: 15–20% active ingredient; 25–35% builder; 7% sodium silicate; 0.6% antiredeposition agents; and QS water and sodium sulfate. Unless otherwise indicated, all work was done under conditions representative of normal laundering: 0.15% weight per cent detergent concentration; 150 ppm water hardness (as $Ca\ CO_3$, 3:2 Ca^{++}/Mg^{++} ratio); and 120 F washing temperature.

Some additional practical scale testing was carried out in the Practical Laundry Laboratory. Real soil from family laundry was the basis for evaluating redeposition characteristics. Redeposition testing on a practical basis was described in the previously mentioned work (1). In essence, this method consists of including clean swatches of fabrics with soiled

TABLE I

Fabric[a] Identification

Code	Description	Count (W × F)
C	Bleached, mercerized combed cotton broadcloth	136 × 64
PE/C	65% Dacron 54–35% cotton shirting, brightener in polyester	88 × 80
PP	65% Dacron 54–35% cotton shirting with carbamate resin for permanent press	88 × 80
SR	Above permanent press with "come clean" finish	88 × 80

[a] All fabrics purchased from Test Fabrics, Inc.

[1] Presented at the AOCS-AACC Joint Meeting, Washington, D.C., April, 1968.

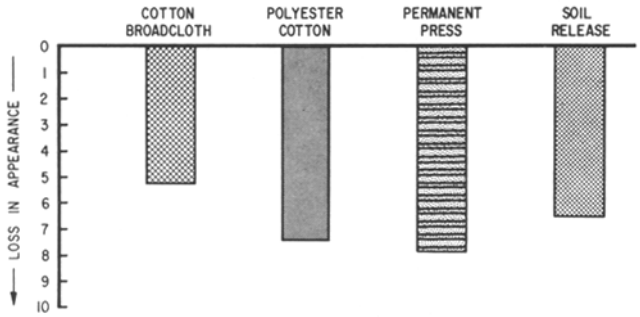

FIG. 1. Loss of appearance values, Skin Soil Test.

laundry. Generally, the selection of detergents and soiled laundry was random; it is felt that the performance of the fabrics, as shown in the results, is typical of that which might be observed by a careful housewife.

Results and Discussion

Skin Soil Test

Earlier work by Trowbridge and Hunter (4) had indicated that, with nearwhite fabrics, visual appearance preference most closely follows the equation: Rd − 4.3 b = P, where Rd and b are instrumental readings from the Hunter D25 instrument and P is visual preference. The data from the 6 cycle Skin Soil Test are shown in Figure 1. Appearance changes were arrived at by calculating P for the original unwashed fabric and subtracting the P value after the 6 soil/wash cycles. In all cases an appearance loss was noted. Note that, in this study, the new soil release permanent press fabric performs about as well as unmodified cotton broadcloth. Polyester-cotton 65/35 lost considerably more appearance value, and permanent press definitely retained the most natural sebum.

Sebum Yellowing Test

Correlation Check. As a check on the correlation of the Skin Soil Test with the Sebum Yellowing Test, an experimental run was made in which the identical detergent (corresponding to the model formulation above) was evaluated by both test methods. The Sebum Yellowing data are given in Figure 2. These can be compared to Figure 1. This comparison showed good ability to rank the relative cleanability of cotton, polyester-cotton and permanent press polyester-cotton in the same order by each test method. The newest fabric, soil-release permanent press, did not correlate particularly well for reasons that will be brought out further in this discussion. One early conclusion from this comparison is quite clear—soil release permanent press has outstanding washing characteristics.

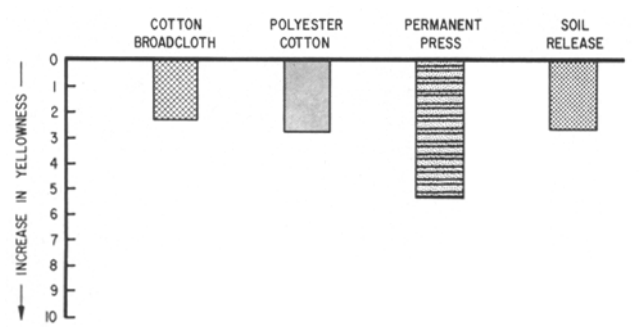

FIG. 2. Fabric yellowing in 0.15% model detergent, Sebum Yellowing Test.

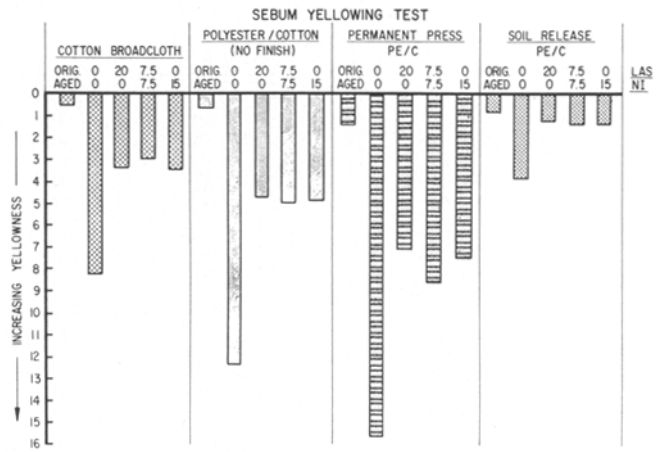

FIG. 3. The effect of active ingredient variation on fabric performance (LAS-nonionic), Sebum Yellowing Test.

Active Ingredient Variation. Three different detergent active ingredients and combinations within the three have been studied. The standard of performance was established as a 20% linear alkylate sulfonate (LAS) with 35% sodium tripolyphosphate (NaTPP) as a builder.

LAS-Nonionic Mixtures: The relative performance of the present basic active ingredient, LAS, and nonionic surfactants has been the subject of much discussion in our industry. Some workers in the field believe that the presence of some nonionic surfactant in the active ingredient system should improve performance on synthetic fabrics. Workers at duPont (5,6) have carried out basic investigations on films and fabrics using a radio tracer technique. They concluded that anionic surfactants worked best on cellulosics but that the more hydrophobic fibers were cleaned best by nonionics. Gordon et al. (7), at Shell, have arrived at basically the same conclusion by an entirely different radio tracer approach. The Shell group also felt that nonionics were better for cold water washing. The previously mentioned work by Spangler et al. indicated that the Sebum Yellowing Test led to essentially the same conclusions. However, since that work did not cover the blends and finishes currently under investigation, probably some expansion was in order.

Figure 3 shows the results of the recent investigation on the fabrics in question. Basically, changing from an all-anionic to an all-nonionic system showed little or no advantage. The differences among the various substrates were as in the Fig. 2 study. As

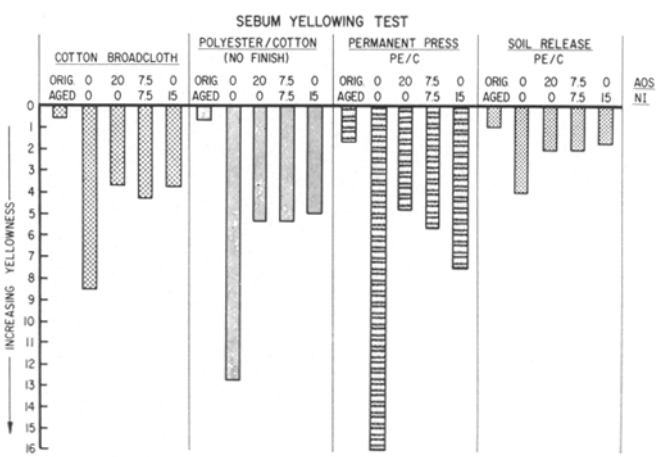

FIG. 4. The effect of active ingredient variation on fabric performance (AOS-nonionic), Sebum Yellowing Test.

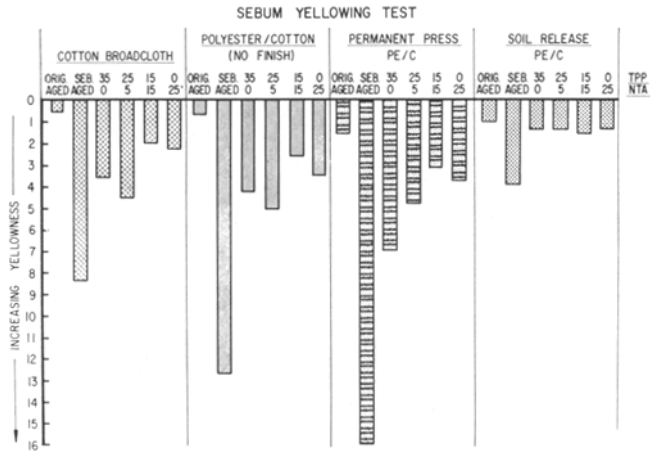

FIG. 5. The effect of NaTPP-NTA builders on fabric performance, Sebum Yellowing Test.

will be shown later, the all-LAS system is quite concentration sensitive in cleaning synthetics whereas most nonionic systems are not. Perhaps it is this phenomenon which has led to the conclusions of others.

Olefin Sulfonate-Nonionic Mixtures: Olefin sulfonates have been mentioned as good future active ingredient sources (8). An exploration of this potential on the new synthetics and the combination of an α-olefin sulfonate (AOS) and a nonionic are presented in Figure 4. The AOS studied did appear to offer some slight benefit over LAS on cotton and permanent press. In this series of tests, the addition of nonionic did not appear to improve the effect of either LAS or AOS.

Change in Builder. Increasing attention is being paid to potential substitutes for NaTPP as the fundamental builder in heavy duty detergent systems. One of the leading candidates for this substitution is the trisodium salt of nitrilotriacetic acid (NTA). Two or three laundry products containing NTA appeared in test markets during 1967. Figure 5 shows the effect of sebum yellowing if the phosphate content of the model detergent is partially or totally replaced by NTA. The soil release fabric showed no response

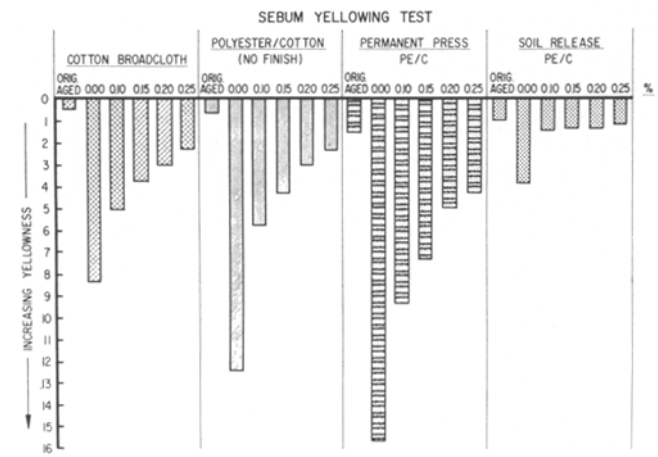

FIG. 6. The effect of model detergent concentration on fabric performance, Sebum Yellowing Test.

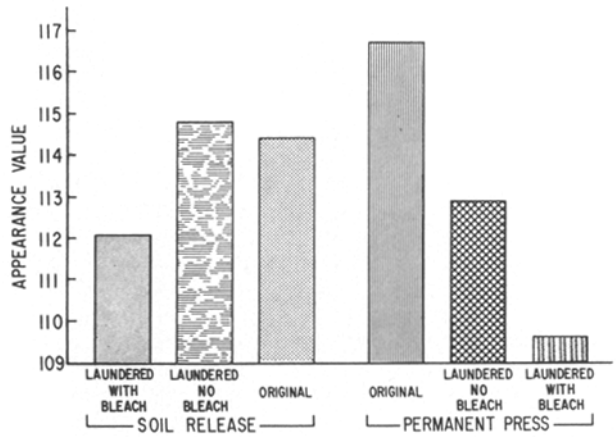

FIG. 7. Appearance changes on permanent press, regular and soil release fabrics, L + 3a − 3b values—original vs laundered (10X).

to builder changes. Cotton and polyester-cotton showed no linear response to changes in TPP/NTA weight ratios. Considering the entire picture, however, it appears that some benefits in cleaning modern fabrics can be achieved through the use of NTA as at least part of the builder system.

Concentration Changes. Earlier work has shown that the more hydrophobic fibers are difficult to clean with normal or less-than-normal concentrations of LAS-based built systems. This factor was explored in the current study as shown in Figure 6. It was found that progressing from cotton to polyester-cotton to permanent press polyester-cotton emphasizes the need for higher than normal (>0.15%) amounts of detergent. The soil release fabric appears to alleviate the need for the high concentrations.

Practical Laundry Evaluation. The results of some redeposition testing with a series of soil release finishes are shown in Figure 7. The changes in appearance are given according to the Hunter equation, L + 3a − 3B = A, since this work was done cooperatively with a textile manufacturer who used that scale. The data indicate that, although it starts off with a slightly lower appearance number, soil release maintains a good appearance through 10 washes. In this regard, and in its response to bleach, soil release is better than the permanent press fabric from which it has been derived. This Practical Laundry finding was included to reinforce various laboratory studies which indicated that soil release finishes offer a bright prospect in the laundering of modern synthetic fabrics.

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