Mixtures of Soap and a Commercial Alkyl Aryl Sulfonate[1]

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MIXTURES of soap and synthetic detergents are now being sold in the form of pastes, flakes, and bars. Where suitable ready-made mixtures are not available, many industrial users have learned to make their own combinations by charging both soap and synthetics to their processes. Experience has shown that the synthetic detergents may contribute their valuable properties to soap and likewise that soap may contribute its valuable properties to synthetic detergents.

Research on the mixtures has not been particularly active in spite of their commercial success. Research workers in both the soap and synthetic field have tended to specialize and avoided the study of mixtures. Where research has been carried on with the mixtures, it has often been disappointing. Research workers who have failed to find an unexpected synergistic action have often overlooked the possibility of obtaining a mixture which would have the valuable properties of both the soaps and synthetics.

Most of the commercial advances in the field of soap and synthetic mixtures have been made by the soap manufacturers. Mixtures are nothing new to the soap maker who mixes perfumes, antioxidants, glycerine, naphtha, antiseptics, lanolin, alkaline builders, color, and a great many other substances with the salts of the fatty acids.

In studying the special value of the mixtures of synthetic detergents and soaps, first consideration should be given to the properties possessed by soap which the synthetic detergent manufacturer often needs and the properties possessed by synthetic detergents which can be useful to the soap manufacturer. The faults of one component are frequently the virtues of the other. The research worker in the field will recognize this in the following comparison.

Complementary Properties

Soaps have a relatively slow rate of solubility compared to that of the synthetic detergents. A desirable improvement in the solubility can be obtained by the addition of the synthetics. Soaps are slow to dissolve and difficult to rinse out. The addition of synthetics really speeds up the rate of solution and the slow rinsing. Synthetic detergents on the other hand are much too soluble for many purposes. They can be pressed into cakes which could be convenient as hand soaps, but these cakes dissolve too quickly for a satisfactory hand soap, and they tend to disintegrate when left standing in the water which is inevitably present in a soap dish. Soap serves to give a desirable control to the over-soluble synthetic and makes possible the manufacture of a satisfactory hand cake. Such cakes account for a large share of the commercial market for mixtures of soaps and synthetic detergents.

Cold Water Soaps

Soaps are difficult and in many cases impossible to use in cold water. In contrast to this the synthetic detergent Nacconol NR,[2] the active part of which is a proprietary mixture of alkyl aryl sulfonates, washes about as well in cold water as it does in hot water. In many instances washing must be carried out with cold water as, for example, where the water is taken directly from a well. A mixture of soap and synthetic is an ideal hand soap for use in cold water. No farm washstand is complete without a cake of this versatile soap. This type of soap is particularly useful when greasy or particularly grimy hands are to be cleaned.

Slipperiness

Synthetics, like soaps, can be prepared in bar form. Most cakes made from synthetics have a harsh feel and a rough appearance after the first use whereas soap cakes are smooth and slippery throughout their use. People have become accustomed to the slippery "feel" of soap and like it. Soap contributes this valuable slipperiness to the synthetics. On the other hand, this slipperiness can become very undesirable. Soaps used to wash the floor can make it dangerously slippery. Furthermore, they rinse poorly from cold surfaces. The synthetic makes a real contribution because slipping is minimized and the removal of slippery soaps is accelerated.

Lubrication

Soaps serve to lubricate fabrics which are subjected to intense mechanical processing. The lubrication helps to avoid wear. Where the soap is used alone, it lubricates well but is difficult to rinse away. Synthetics have some lubrication in strong solution but lack the almost perfect lubrication of soap. If synthetics are used by themselves in protracted rubbing processes, there may be more wear than would be shown by soap in the same period of time. However, the synthetics wash and rinse out with great rapidity; the shorter processing cycle can compensate for the lack of lubrication. Where there is extreme mechanical action, it is advantageous to use mixtures which lubricate and which can be rinsed out in short periods of time.

Hard Water or Acid Waters

It has often been stated that the principal advantage of the synthetics is their behavior in hard and acid water. When soaps are used in acid water, fatty acids are precipitated and the action of the soap is destroyed. In hard water calcium and magnesium salts form gummy precipitates with the soap which coagulate and fasten themselves to surfaces. These are the insoluble soaps which form the "ring around the bathtub" and which cause the undyed, white spots on freshly dyed textiles. "Nacconol," used with soap, corrects this soiling problem by emulsifying or dispersing precipitated fatty acids and lime soaps.

Lathering and Suds

Soaps vary widely in their ability to lather. Raw

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[2] Trademark "Nacconol" registered in U. S. Patent Office by Allied Chemical & Dye Corporation.

materials for soap manufacture are selected carefully to provide the degree of lathering that will be suitable to the consumer for the job at hand. In similar fashion the lathering ability of synthetic detergents varies quite widely from one type of product to another. When soaps are combined with synthetic detergents, certain lathering incompatibilities will be found where the mixture provides less foam than either of its components. Proper selection of these components is necessary, and they must be used in the correct proportion. Under hard water conditions the soap-synthetic detergent mixtures lather by virtue of the presence of the synthetic.

Deodorant Action

Although soap has limited effectiveness as a deodorant, it is convenient and easy to apply, but its deodorant action is very short-lived. The deodorant properties of "Nacconol" have been described in an article entitled "Synthetic Detergents and Odors" (Flett, Toone, and Booth, Am. Perfumer, June, 1947). This deodorant action is quite persistent. "Nacconol," however, is inconvenient to apply as a deodorant. The mixture of soap and "Nacconol" gives ease of application combined with effective deodorant action.

Early Tests on Mixtures

The mixtures of soap and synthetic detergents have been studied in our laboratories since the synthetic detergent was first introduced into this country. The first studies were directed to an improvement of the sudsing of soap, by the use of the alkyl sulfates, a study which was abandoned when it was found that the mixtures then being studied would lose practically all suds in hard water.

Later on studies were made of the addition of the alkyl aryl sulfonate type of synthetic to soap as a means of avoiding the lime soap precipitation on the sides of the bathtub and wash basin. The results obtained, although not perfect, were really very good.

Satisfactory milled bars of good appearance were produced at that time in standard soap milling equipment which showed a superiority of performance in hard water over the usual milled toilet soaps. These soap milling tests were subsequently extended to include the use of larger proportions of synthetic detergent. We were able to produce, in 1938, milled soaps containing up to 40% of active synthetic detergent. A significant fact about these soaps with a high synthetic organic content was noted at that time, viz., that they lathered freely on the hands, cleansed well, and rinsed easily in sea water.

Salt Water Soap

When the war with Japan started, it quickly became obvious that the shortage of coconut oil would make it impossible for the Navy to obtain further supplies of its traditional salt water soap made wholly from coconut oil. With the background already established from past experience, the authors developed a satisfactory, framed salt water soap by mixing "Nacconol" with tallow kettle soap. Tallow soap served as a very desirable binder and even though it was completely precipitated by the sea water, the composition containing it washed whiter than the straight synthetic. One very important feature of this soap-synthetic blend was that it could be produced quickly and in large quantity by any soap company with the simplest equipment for framed soap manufacture. This information was immediately turned over to the Navy and adopted by them. The subsequent large scale manufacture of this "Nacconol"-soap mixture here at Chicago was the first substantial production of a detergent-soap mixture.

Deodorant Soap

"Nacconol" NRSF is of interest as the effective component of a deodorant toilet soap by virtue of its capacity for absorbing or suppressing odors. The most successful soaps of this type contain approximately equal proportions of "Nacconol" NRSF and pure soap. Milled soap with a large proportion of a high organic synthetic detergent like "Nacconol" NRSF can readily be obtained if 5 to 10% of starch is added (USP 2,438,169).

A framed soap containing 40% "Nacconol" NRSF can be made either by blending the "Nacconol" NRSF with kettle soap in a crutcher or, with much more ease and speed, by starting with fatty acids and conducting the entire soap making process in the crutcher. A soap having excellent lathering, cleansing, and deodorant properties can be produced by the following formula:

Coconut fatty acids	362
"Nacconol" NRSF	400
Water	50
42° Caustic Soda Lye (37.7%)	188
	1,000

Weigh the melted fatty acids into the crutcher. Apply heat until the fatty acids reach a temperature of about 120-130°F. Add the "Nacconol" NRSF, followed by the water and mix with a downward motion of the crutcher screw. A thin slurry of "Nacconol" NRSF-fatty acids will result. Reverse the operation of the crutcher and add the caustic soda lye gradually, adjusting the addition so that the rapid saponification will not get out of control. Continue crutching for 5-10 minutes after addition of all of the lye. Add perfume or color as desired and drop into a frame.

The moisture content of this framed soap made with coconut fatty acids should be held about 20-22% as made. With less than 20% moisture the soap may become too stiff for proper handling in the crutcher and above 25% moisture the soap may be too soft on cooling. Stearic acid or tallow fatty acids may be substituted for part of the coconut fatty acids, if desired, with proper adjustment, of course, of the amount of lye required.

Hard Water Domestic Soap

Soap companies catering to the household trade in hard water areas have developed built soap powders containing 20 to 40% of "Nacconol" NR. These products have been well received by consumers who find that the combination of synthetic detergent with soap achieves satisfactory cleansing and promotes better rinsing and removal of finely dispersed lime soap.

Power Laundry Soaps

During the period when commercial laundry soaps were not freely available, an extensive series of tests was run in one of the larger laundries in which "Nacconol" NR was used to replace one-fourth of the pure high grade soap flakes used by this particular laundry for the washing of white shirts. No other change was made in the supplies; the same builders, and in the same amount, were used throughout the tests without any deviation in the washroom cycle.

A test bundle consisting of white T shirts and white dress shirts was used. Whiteness of the test pieces was measured by the Hunter Reflectometer at the start of the tests and after 20, 40, 60, and 80 complete wash cycles. The average values for the reflectances are shown in the following table:

	Dress Shirts		T Shirts	
	100% Pure Soap Flakes	75% Pure Soap Flakes 25% "Nacconol" NR	100% Pure Soap Flakes	75% Pure Soap Flakes 25% "Nacconol" NR
Start	81.3	81.3	83.5	83.5
20 Washings	84.4	83.8	82.6	79.3
40 Washings	83.9	83.4	78.3	80.3
60 Washings	82.8	82.3	78.2	78.1
80 Washings	84.3	83.3	78.2	77.7

Examination of the 80 loads run with soap and with the soap-"Nacconol" NR mixture was made by the usual laundry procedure. Laundry inspectors with many years' experience reported that there was no difference in the quality of the work produced.

Diaper Washing

Considerable evidence has been accumulated to show that the manner in which infant garments are washed has a very definite bearing on the infant dermatitis, commonly referred to as "diaper rash." Clinical data obtained by pediatricians show that when diapers and infant garments generally are washed with a synthetic organic detergent such as "Nacconol" NR, either alone or in combination with soap, the dermatitis clears up in almost 100% of the cases. The irritation is believed to be caused by lime soap residues.

Pediatricians now instruct the mothers of young children to wash the infant garments with a synthetic detergent if moderately soiled. If the garments are heavily soiled, it is recommended that they be washed with a combination of ¼ to ⅓ synthetic detergent and ⅔ to ¾ soap, followed by three or more rinses, of which the second rinse can advantageously be made by adding a small amount (about 0.05%) of synthetic detergent to facilitate removal of traces of lime soap.

Fulling Soaps

In the finishing of fine woolen fabrics the fulling process, as the name implies, serves to provide additional body to the fabric. This is done by shrinking the fabric in both length and width through the use of strenuous mechanical action in the presence of a lubricating solution. Although alkaline soap solutions are perfect lubricants for this purpose, the subsequent rinsing processes to remove these soaps are very lengthy and expensive. Alkaline solutions of synthetic detergents do not provide sufficient lubrication to be good fulling agents by themselves. It is now recognized that when 25-50% of the usual fulling soap is replaced by "Nacconol" NR the fulling will proceed normally in all respects. When this is done the fulling soap may be rinsed out of the fabric in 25-40% less time which is very important from a production standpoint.

A typical formula for a 6-ounce per gallon fulling soap is as follows:

TYPICAL FULLING SOAP COMPOSITION CONTAINING SYNTHETIC DETERGENT

Palm Oil Soap	300 lb.
"Nacconol" NR	100 lb.
Soda Ash	225 lb.
Pine Oil	132 lb.
Water to make 1,000 gal.	

In a 1,500-yard run of 8-ounce suiting materials using the above formula, spot samples were taken across the width of every third piece processed in a continuous scouring machine and their residual grease content determined by Soxhlet extraction with carbon tetrachloride. The residual grease values were low and very uniform, averaging 0.22%. It will be recognized that this is an excellent performance since a grease content of 0.50% or slightly higher is usually acceptable.

Summary

This middle ground between the soaps and synthetics has not been actively exploited in spite of the intense current interest in the straight products. It has been a no man's land where the manufacturers of synthetic detergents have carefully avoided soap, which they regard as outside of their field, while many manufacturers of soap have been indifferent to the effect of the synthetic detergents.

In spite of this general indifference work has been done on both sides of the fence with a continually increasing use of the mixtures. Where mixtures have been ready-made, the soap manufacturers have been largely responsible for their manufacture.

Commercial mixtures of soaps and synthetics have been sold where synthetic detergents have been found to improve soap for specific uses. This trend is certain to expand. The present success should encourage further research and development commensurate with the increasing commercial importance of the products.

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Correction

An error in the paper entitled "Nomographs for Calculating the Fatty Acid Compositions of Oils and Fats from Iodine and Thiocyanogen Values" by S. A. Hussain and F. G. Dollear in the June 1950 issue of the Journal should be corrected so that the figures are transposed for the calculated and nomograph percentages of olein and linolein for soybean oil in Table VI, page 209. The transposed figures should read % linolein (calc.) 55.9, nom. 55.8; % olein (calc.) 24.5, nom. 24.6.