water-thinned paints would completely displace oil-bearing paints from this field. However the new standards of performance set by the latex paints presented a challenge to the oil-based paints, which was met by the development of alkyd flats which gave properties essentially equivalent to those of latex paints in many respects. The result has been that the latexes have not taken over the entire field of flat wall paints and do not show any immediate prospects of doing so.

More recently, coatings based on latex have been developed for enamels, for exterior wood, and, in a few cases, for industrial products finishes. While none of these has yet reached the point of displacing large amounts of oil-containing materials, each shows considerable promise. It is not difficult to forecast that, in the near future, oil-containing coatings will disappear from these fields, but in the light of past history this does not seem to me to be a wise forecast. Certainly water-thinned materials will be developed which will be equal in performance to our present materials and will also be free of the hazards of fire which are associated with organic solvents. Yet the oil-containing coatings retain certain inherent advantages, and it is my guess that research and development will result in products which use substantial amounts of oil or, more likely, oil-based derivatives, which will be competitive with the petroleum-derived latexes. Exactly what form these products will take is anyone's guess, but I am sure that, in one form or another, they will appear.

The history of the use of oils in the coatings industry is repeated, with only slight modifications, in most of the other industries which have been large consumers of inedible vegetable oils. Originally the oils which were known and were readily available were often used for jobs for which they were not too well adapted. Other materials were developed which did certain jobs better and displaced the oils. As a result of this, the oil-producing and processing industries initiated research programs which resulted in the production of new oil-based derivatives which recaptured part of the market lost and, by setting higher standards of performance, resulted in the use of the newer material in fields where oil-based derivatives had never been used before. This, in essence, is the story of the last 50 years and, in my opinion, will be the story of the next 50.

Fifty Years of Progress in the Production of Soap and Soap Products

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THE PROBLEMS of soap-making must have been relatively simple 50 years ago for there were about four main types of soap. There were milled toilet soaps, white floating soaps, white laundry bars, and yellow laundry bars, but definitely, soap came in bars! Some of the bars were really long strips, from which the grocer could slice the quantity needed by the customer. When the housewife needed a soap solution to do the family wash or for other purposes, the standard procedure was to slice bars into bits and pieces so that much of the soap that was purchased as bars was actually used as sliced soap.

The improvements made since that time fall into two general classifications, namely, changes in the type of products produced to make them more convenient and more satisfactory to use, and changes in the methods and processes used for making soap. The processes will be discussed first.

The center of operation in the soap plant of 50 years ago was the kettle house where the fats were saponified, the glycerine was separated, and the soap was "fitted" for further use. In this fitting or finishing operation the soap was purified and standardized by adjustments in the ratios of soap, water, and electrolyte so that desirable phase-separations were achieved. Only skilled soap boilers with long years of apprenticeship and training could carry out these operations successfully, and they could operate with consistent results only by following certain routine procedures. Even then seemingly minor variations would sometimes spoil the soap. Chemists had not been found to be particularly helpful in such cases because phase diagrams had not been worked out, and chemists, in general, were not skilled in the art of soap-making. By the early 30's however many of these deficiencies had been corrected. Phase diagrams had been worked out for all the more important kettle-soap formulas, the operations had been standardized, and many physical plant improvements made. In fact, the better kettle houses had been improved, both in appearance and operation, to such an extent that they were hardly recognizable as the counterpart of the earlier kettle houses (Figures 1, 2, and 3).

After these refinements had been made however and after skilled soap boilers had contributed their best efforts, it was still very difficult to make soap that was regularly, consistently, and uniformly high in quality. Still more discouraging was the fact that the better the requirements of soap-making were understood, the plainer it became that the basic difficulty was caused by inadequate mixing in the kettles. In other words, the difficulties were inherent in the combination of the process and equipment that was accepted as standard. During the preceding half century successful soap plants had repeatedly increased their capacities, and in most cases this had been done, in part at least, by making the soap kettles larger. Generally there was pressure to get a given kettle of soap finished as quickly as possible

FIG. 1. A kettle-house representative of 1909.

and another started so the time allotted for mixing and settling was limited. In order to get the best results most efficiently, it was obvious that the saponification operation, the glycerine washing, and the finishing of the soap all required that the contents of the kettles be intimately and thoroughly mixed, not just once for each of these three operations but perhaps six or seven times for one kettle of soap. With the very large kettles commonly used, holding perhaps 300 to 400 thousand pounds of water weight, the problem of thoroughly mixing all the contents in the allotted time was very difficult, and all the evidence indicated that it was not being done on a consistent and adequate basis. The problem was made

FIG. 2. An improved kettle house built in 1931.

more difficult, of course, by the fact that the materials to be mixed were generally in at least two phases and they always differed appreciably in density. To get good mixing with a high efficiency, it is well known that small volumes are needed, and, to get a high capacity through a small-volume mixer, the through-put must be high. Obviously a high-speed continuous process was needed. It took several years to work out all of the techniques and to prove them by pilot-plant operation. It took still more years to get the new units built and in operation, but continuous soap-making became effective in the late 30's, and this process has now replaced kettles for soap-making in many places where large productions are needed and low costs are necessary (Figure 4).

As CAN BE SEEN from the flow chart, continuous soap-making is a stepwise process. Fat and water are proportioned, heated, and pumped into the column in countercurrent fashion. The hydrolyzer is filled with fat, which slowly rises through the column while droplets of water fall countercurrent through the fat and finally collect at the bottom. The glycerine sweet-water is released from the bottom of the column and concentrated to a crude by means of its own sensible heat. The fatty acids are released from the top of the column and flash-dried before going to the continuous still. On their way into the still the crude

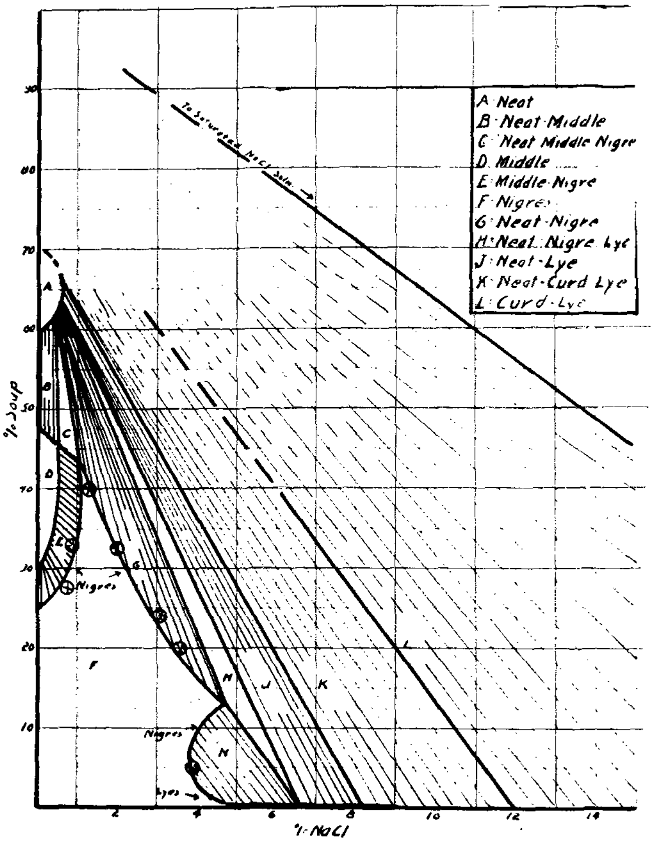

FIG. 3. Phase diagram for tallow soap.

fatty acids pass at high speed through a heat exchanger so that there is no static film of fatty acid in contact with a source of heat. The still itself contains no coils or other heated surfaces. The fatty acid distillate is cooled and proportioned into a mixer with caustic and electrolyte so as to give a continuous flow of neat soap. The composition of soap made in this way is much more uniform than kettle soap was wont to be, the time in process is reduced from a week or more to two or three hours, and incidentally the cost is lower (Figure 5).

Meanwhile other soap-processing steps were in need of attention. Floating soap was well known before the start of our 50-year period, but it was made in a slow and laborious fashion, and there was always trouble in the control of its density. The soap was air-crutched in open crutchers, but the rate and degree of air-crutching was influenced greatly by the temperature for a difference of even one degree would affect the density. Furthermore the crutched soap

CONTINUOUS SOAP SYSTEM

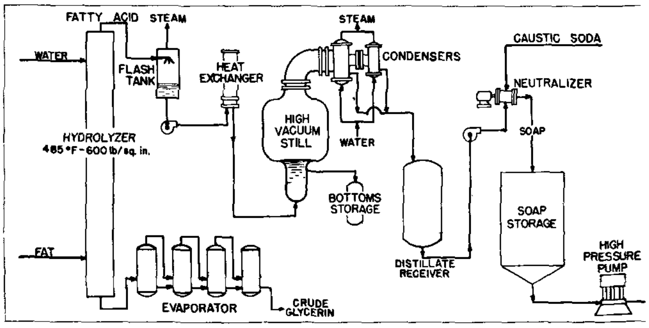

FIG. 4. Flow chart for continuous soap process.

was stored in frames to cool, where it remained a week, but the soap from the bottom of the frame was always more dense than that from the top of the same frame. This was the result of a greater degree of compression of the air bubbles near the bottom than on those higher in the frame so that no remedy was possible so long as the framing procedure was used (Figure 6).

There were other troubles too for the soap as packed contained about 28–30% moisture, and, when stored during warm weather, it would "sweat" and the whole stack would become wet and unsightly. If this happened in the plant warehouse, the lot could be rejected for shipment, with extra costs of course, but if it happened in the warehouses of middlemen the

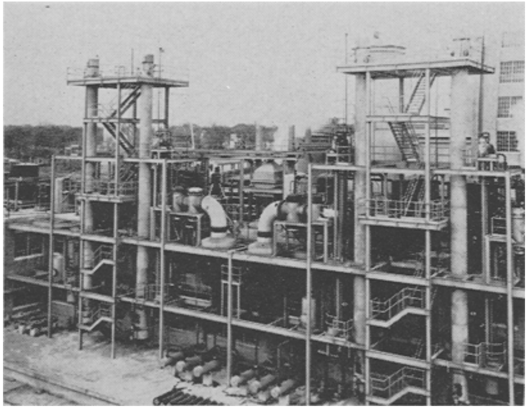

FIG. 5. A multiple unit, continuous soap plant.

soap was likely to reach the customer in a poor and unsightly condition. Even when the sweating difficulties were avoided, the soap dried out very slowly but generally reached the customer at about the 15–20% moisture level. With this loss in moisture there was also a shrinkage in volume, which meant that by the time the soap had reached the customer the bar had shrunk in size by 10–15% and was loose in the wrapper. In addition to this, its shape was generally twisted and somewhat warped as a result of the shrinkage.

The solution of these problems was achieved by pumping the neat soap containing about 30% moisture through heat exchangers and flash-drying it to about 20% moisture while keeping the temperature high enough so that the partially dried soap was still pumpable. It was then pumped through an agitated freezing chamber with enough air proportioned in to give the desired density. By the time soap treated in this manner reaches the package, the moisture level is sufficiently low that sweating, shrinkage, and warping are all avoided. Fortunately the rate of solution is also improved by this processing so that the soap performs very much better in use (Figure 7).

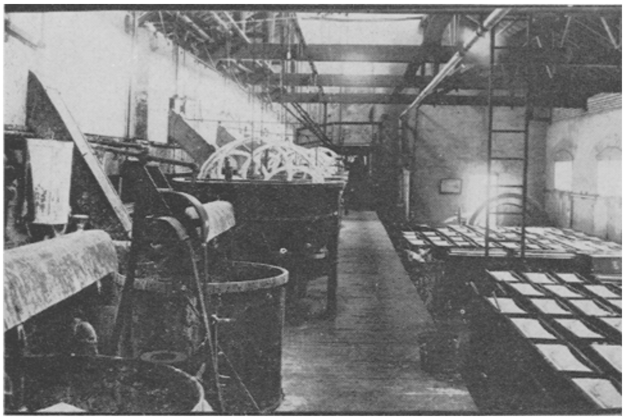

FIG. 6. Floating soap crutchers in use in 1909.

THE CHARGES we have been discussing are primarily those of processing, but corresponding improvements were made in the packaging and handling operations. To appreciate the changes involved and their importance to the consumer, it should be kept in mind that in 1909 much hand-work was required and a high proportion of it was heavy and laborious. Mechanical equipment and automation have eliminated most of this drudgery and have made it possible to provide consumers with packaged products of a quality far better than was possible 50 years ago and to do this at very moderate costs. The economic importance of this can be appreciated when we realize that the consumption of soap products in the U.S.A. now amounts to perhaps 40 separate packages per year for each person.

While working on problems such as the above, soap producers recognized other challenging needs. One was the need for a soap that would be as satisfactory in hard water as it was in soft water. Many people

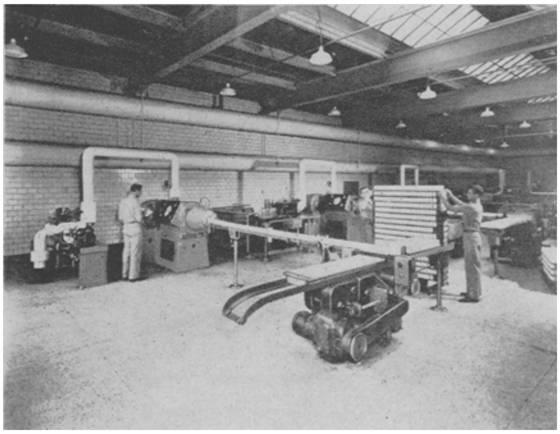

FIG. 7. Continuous unit for making floating soap.

appreciated this need, but it was not until the early 30's when the first synthetics were produced that this goal seemed attainable. Even then it required many years of work to produce synthetic products that could successfully compete with soap products, but it was finally accomplished (Figure 8).

In terms of economic impact on the soap industry, of stimulating effects on scientific investigation, and in the increased satisfaction consumers have found in using the products, the development of satisfactory synthetic detergents is the outstanding accomplishment of the soap industry during the past half century. The reaction of the customers is shown by the fact that three-quarters of the sales of soap plus detergents are now synthetic. Furthermore the proportion is still growing, and there is strenuous competition to find better and/or cheaper new synthetic materials from which to make better products.

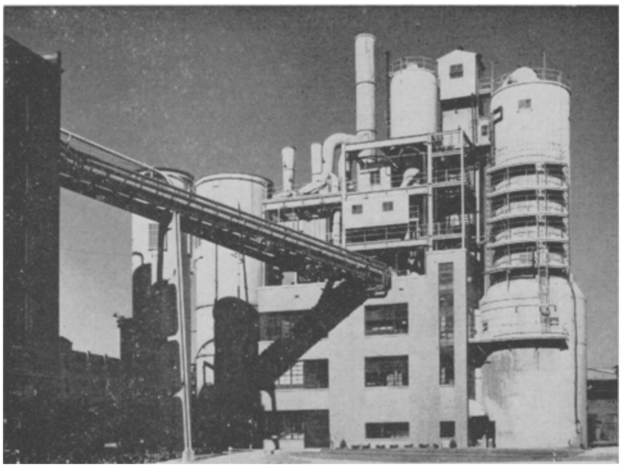

Fig. 8. A single unit, synthetic granules tower.

While the above changes in processing and facilities for producing soap and synthetics were in progress, the form and character of the finished products marketed were radically changed, not just once but several times. The soap bars in use in the beginning were largely replaced by soap flakes, which were replaced by spray-dried soap granules and these in turn were replaced by synthetic granules. In each case the old equipment became obsolete, and new processes were developed and new equipment was built.

And now synthetic liquids are having their fling. Just how far they can go and what the next candidate for the housewife's favor will be is the sixty-four—or perhaps I should say the million-dollar question.

As can be seen from this very condensed version, the past half century has been a turbulent period for soap-makers. Most of the procedures and equipment used have been discarded and rebuilt at least once and in some cases several times as better ideas were developed. Within the last 40 years there have been three drastic charges in the type of soap products produced and each change has cost many millions of dollars in obsolescence and new development costs. Very little about the products sold or the methods used in their production is the same now as it was 50 years ago. Soap-makers have had to run hard to keep even, but for the customers it has been a wonderful era. The products are not only better now, but they are much more convenient to use; on a properly adjusted basis, they cost much less to buy than they did 50 years ago.

Many interesting developments of the past half century have been omitted in the above account of the progress made, but we believe that the examples given show that in the processing and production of soap and soap products great strides have been taken to catch up and to hold even with the best technology of our times. The rate at which new processes and products are being developed seems to be increasing, particularly in the soap products field, and it seems very probable that the gratifying progress made during the past half century will be exceeded in the not-too-distant future.

Fifty Years of Progress in Castor Oil

D. S. BOLLEY, The Baker Castor Oil Company, Bayonne, New Jersey

Fifty years ago about 15 million pounds of castor oil were used annually in this country. Twenty-five years later the use had risen to 45 million pounds. The demand has continued to increase, with some fluctuation, to the present current consumption of about 130 million pounds annually. This is about one-fourth of the world's total annual consumption.

Castor oil was first produced from seed grown in the Midwest. However about the time our Society was founded, it was found more economical to import the beans from Brazil and India and domestic production ceased. During World War II some castor was grown in this country, and again during the Korean conflict high price and government support permitted an appreciable quantity of castor to be profitably grown here. However when "normal" conditions were re-established, the domestic crop was not quite ready to compete with foreign imports and declined. In 1956 the agronomic research that had been going on for the past decade began to pay off and gave improved castor-plant varieties and more efficient harvesters. The greatly improved yield changed the picture and has resulted in increased domestic production. Thus 1,800,000 lbs. of castor oil were obtained from domestic seed grown in 1956 and 10,000,000 in 1957; 22,000,000 will be produced from seed grown this past year. While this is still only 15% of our current con-