acids, infrared determination of *trans* isomers, periodate determination of monoglycerides, dilatometric estimation of soild fats, spectrometric determination of color, chromatographic determination of total neutral oil, analysis for refining loss by centrifugal methods, detection of crystal structure by x-ray techniques, and the most recent and perhaps one of the most significant developments, the analysis for fatty acid composition by vapor phase chromatography. Certainly one must not overlook the development of the "Official Methods of the American Oil Chemists' Society" which have contributed so greatly to the improvement and standardization of all of our methods of analysis.

IMPORTANT PROGRESS in our technology of both shortenings and margarines has resulted from fundamental information developed from the x-ray techniques. We have learned to classify our various products according to their inherent crystal type and have been able to associate this fundamental information with specific desirable or undesirable functional properties. Two important applications of this knowledge come immediately to mind. The first of these is the formulation of margarine to prevent the development of graininess during storage. After it was recognized that this graininess is associated with the formation of the *beta* type of crystals, formulation control was relatively simple. The other example is the development of lard having a modified crystal structure. As we all know, lard in its natural state tends to result in waxy or grainy crystals. This has been associated with the *beta*-forming tendencies of the solid glycerides of lard. However, when lard is properly treated with an interesterification catalyst, the proportion of these *beta*-forming crystals apparently is sufficiently reduced so that the modified lard becomes stable in the *beta*-prime crystal structure. The first successful shortenings based on crystal-modified lard were marketed in early 1950 and made lard for the first time fully competitive with the hydrogenated vegetable shortenings for cake baking.

You can see from the above summary of our technological advances that we have arrived at 1959 with better engineered, more economical processes for making a wide variety of products with improved functional properties. Our shortenings and margarines are better than ever from the point of view of odor, flavor, appearance, and performance in baking, frying, creaming, etc. But how are they as food? We must never lose sight of the fact that the end-objective in all of this processing is to produce a food product. So the question is properly asked, are the edible fats we are manufacturing today more or less nutritious than those of 50 years ago?

In our opinion, the trend has been in the direction of improved quality as a food. First, of course, palatability is an extremely important factor in a food product, and the modern shortening and margarines not only are better in odor, flavor, texture, and getaway when freshly prepared but retain these qualities longer than ever before. There have been great strides made in the area of sanitation, with much less exposure of the products of today to the atmosphere and to human handling. Our technology has made it possible for us to maintain an adequate supply of food fats. For example, how could we possibly produce sufficient margarine and shortening of suitable quality if we had not learned how to use soybean oil successfully? The increased consumption of vegetable oils in our food fat supply has increased our consumption of vitamin E. They have also helped us increase our total consumption of linoleic acid.

In summation, then, our technology has made it possible to provide our nation with an adequate supply of palatable, nutritious, high-quality shortenings and margarines at by far the lowest cost per calorie of any food on the market today.

Fifty Years of Progress in the Utilization of Inedible Fats and Oils

FRANCIS SCOFIELD, National Paint, Varnish, and Lacquer Association, Washington, District of Columbia

IN SPITE OF all that we hear or read, vegetable oils are extremely important to the paint industry and will continue to be. If, as seems probable, the types of vehicles used by the paint industry change even more in the next few years, we can be sure that vegetable oils, in one form or another, will continue to appear in most protective and decorative coatings.

Looking back 50 years, we see that 1909 was an important period for inedible vegetable oils since it may be regarded as either the end of the old era or the first stage of the new. In the utilization of oils we were just breaking the ground for the most tremendous changes, not only in uses as such but in the thinking which motivated the industry. It is not mere coincidence that the American Oil Chemists' Society was founded then. Much of the change in the past fifty years has been brought about by the members of this Society, acting either as individuals or as a group.

Since our very useful Journal was not in existence in 1909, we must look at two of the publications in which technical articles on the chemical industry appeared. These are Industrial and Engineering Chemistry, which started with Volume I in that year and, like our Society, is celebrating its Fiftieth Anniversary. The other is the Annual Proceedings of the American Society for Testing Materials. In 1909 the Proceedings of the Twelfth Annual Meeting were published, in a volume of some 698 pages.

In the former we find an article by Charles H.

Herty, F. B. Stem, and M. Orr on "Rapid Determination of Oil in Cottonseed Products" and one by L. M. Tolman on "A Study of the Fatty Acids of Fish Oils." In the Proceedings of the A.S.T.M. some 66 pages are devoted to the presentation of the report of Committee E, on Preservative Coatings for Structural Materials. A large part of this report describes the efforts to obtain representative values for the constants of linseed oil. Anyone accustomed to our present acceptance of samples furnished by a manufacturer as authentic will find the reading of this report edifying. Most of the rest of the report deals with reports on panel tests on practical paints. Undoubtedly similar articles could be found in the other available technical literature of the time, but, in general, they would bear out the same theme. The scientific and technical efforts in the field of inedible oils were being directed to measurement and analysis of natural products.

THE ENTIRE FIELD of industrial oils is so complex, most of my remarks will be directed to the utilization of industrial oils in paints and related protective and decorative coatings, partly because this is the field with which I have the greatest familiarity and partly because it is representative of the trends that have occurred in printing inks, linoleum, soaps, core oils, and the hundreds of other areas in which industrial oils are utilized. Fifty years ago industrial oils, either as obtained or with such slight modifications as heat-bodying, blowing, or reacting with resins or metallic oxides, were used as the principal ingredient in a number of materials. The selection of one over another was an empirical matter, based on long experience or trial and error. If slightly different properties were required, they were obtained by going to another oil. There was great interest in a wide variety of natural oil sources. Many technologists devoted much time to studying oils from exotic sources in the hope of finding slightly different properties which might be of industrial concern.

Today industrial oils are, essentially, raw materials of the chemical industry, and with a few exceptions the desired properties are obtained by modifying the oil or reacting it with one of the hundreds of available materials to give the exact material needed to deal with the immediate problem.

By coincidence, the first volume of Industrial and Engineering Chemistry contains an article by L. H. Baekeland, entitled "The Synthesis, Constitution, and Uses of Bakelite." The products he describes do not involve oils in any way. The oil-soluble phenolics are still in the future. Further, although he suggests the use of these products as coatings, this is only in passing and to a limited degree. Nevertheless, from the standpoint of our present-day knowledge, he foreshadows the chemical revolution in the coatings industry and the tremendous changes which have come about in the uses of inedible oils.

Several other developments, in later years, affected the picture of oil consumption in similar ways. After World War I the availability of low-cost solvents for nitrocellulose resulted in the commercial development of lacquers. The extremely fast dry, high gloss with a minimum of rubbing, and good exterior durability which could be obtained with these products led a number of authorities to prophesy that the day of oils in coatings had passed, except possibly for the use of small amounts as plasticizers. However the standards set by these products stimulated the inventiveness of others, and within a few years Kienle and others had developed alkyd resins to the point where most of the properties of lacquers could be matched or exceeded and products with certain advantages of their own could be developed.

Since alkyds could be tailored, by the use of the proper fatty acids and other ingredients, to the end-use intended, they might be regarded as the first step in the use of oils as the chemical raw materials for the coatings industry. With an alkyd the properties of the vehicle are no longer determined solely by the oil used. If some change in the property is called for, it may be obtained by one of numerous changes in the ratio of fatty acid to glyceryl phthalate, by the use of other polyols or dibasic acids, or by changing the fatty acids used. More or less simultaneously the development of essentially pure fatty acids, which the alkyd manufacturer could blend as he wished, freed him from dependence on a wide variety of oils. Linoleic and linolenic acids are the same regardless of the oil from which they are derived, and the question is reduced to an economic one. They are obtained from the source which will deliver the cheapest acids of the purity desired.

We still rely on natural oils for acids of unusual structure, such as eleostearic and ricinoleic, since plants can synthesize these much more cheaply than we can, but our interest in perilla, sunflower, walnut, and poppyseed oils has declined almost to the vanishing point. Twenty years ago the National Paint, Varnish, and Lacquer Association was spending substantial amounts of time and money in attempting to establish the culture of perilla oil in this country. There was active interest in this oil and in any other oils which had properties slightly different from those standard oils of commerce. Today all interest in most of these oils has vanished unless some one can show that there is an economic justification for their development.

THE HISTORY of castor oil is a good example of the trend of the times. Fifty years ago about 15 million pounds of castor oil was used annually in this country, nearly all of it in the form of raw or refined castor oil in medicine, in cosmetics, and in lubrication. While these uses have decreased to some extent, they still account for around 2% of the present consumption of 150 million pounds a year. Nearly all the remaining 98% is processed to some degree, ranging from hydrogenation, blowing, or similar modifications to the use of castor oil as a raw material for the production of sebacic acid. The discovery of the dehydration reaction, by Scheiber, made possible the production of a drying oil from castor oil, an oil more similar in its properties to tung oil than to the original castor oil. Thanks to this and related developments, about 45% of the castor oil consumed in the United States today goes into the protective coatings industry in one form or another.

With the end of World War II the large capacity for the production of synthetic rubber brought about a revolution in the paint industry. Styrene-butadiene and later polyvinyl acetate and acrylic latex produced water-thinned paints, the performance characteristics of which equalled or exceeded, in many respects, those of the currently available oil-based materials. The first impact was felt in the field of interior flat wall paints, and at first it was widely believed that these 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

R. A. DUNCAN, Procter and Gamble Company, Cincinnati, Ohio

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