Bailey Award Address

This Fatty Acid Business

R. H. POTTS, Armour and Company, Chicago, Illinois

MY PAPER must first start with the past for if there is any justification in your selection, it must lie with my past work. Secondly we should look at the present state of the industry and then, if time permits, make a few guesses as to what lies ahead for the decade just begun.

The use of fats for purposes other than food is very old, older in fact than the written history of mankind. Mixtures of palmitic acid and tripalmitin were found in Egyptian tombs dating back to the First Dynasty. It is also reported that olive oil was used as a lubricant for moving large stones, and mixtures of lime and fat were used for lubricating chariot axles as early as 1400 BC. The ancients depended upon the fats for light, and some of those old Egyptian night clubs must have been quite thick with acrolein formed by the decomposition of glycerol because it was not removed from the fat in those days.

Now I don't quite date back to the days of King Tut, but I do go back to rather primitive times when fatty acids were placed in cast-iron pots suspended over coal-fired furnaces. The distillate was collected in copper condensers, and its chief use was in soap, grease, and candle-making.

I slid into the fatty acid business with Armour and Company in 1923 on a bit of petroleum grease picked up during a short stay with the Sinclair Oil Company and look forward to skidding out in the not-too-distant future, not on such commonplace lubricants as those derived from petroleum but rather on the more exotic type, the type you men will prepare from animal and vegetable fats to answer the need for high temperature and high-load carrying service, such as an Arquad blessed bentone grease, the dioctyl sebacates, or some other compound yet to be developed. This is no idle dream because the best lubricants of the future will be man-made and more than likely will be based on fats.

I have spent many enjoyable years in splitting fats, separating the constituent fatty acids, and making them into various chemicals. Most jobs are interesting, and ofttimes quite easy to solve if the need exists and the goal is important and lucrative enough to make the solution worthwhile. I was fortunate to start in this business when new products and improved processes were badly needed. Fatty acid plants were usually associated with soap plants; the few exceptions were those making stearic acid for candles and red oil for textile purposes. They had been installed during periods when fats were in short supply for the purpose of converting waste greases into distilled acids for soap-making purposes. These acids were known under names indicating the source, *i.e.*, distilled cottonseed fatty acid, animal fatty acids, etc. Because fatty acids lacked individual identity, they merely substituted for the original oils in times of shortage, and consequently the very existence of a fatty acid plant was directly dependent upon the fat market. In periods of fat shortage, new fatty acid stills were built only to be shut down and dismantled after the shortage had passed.

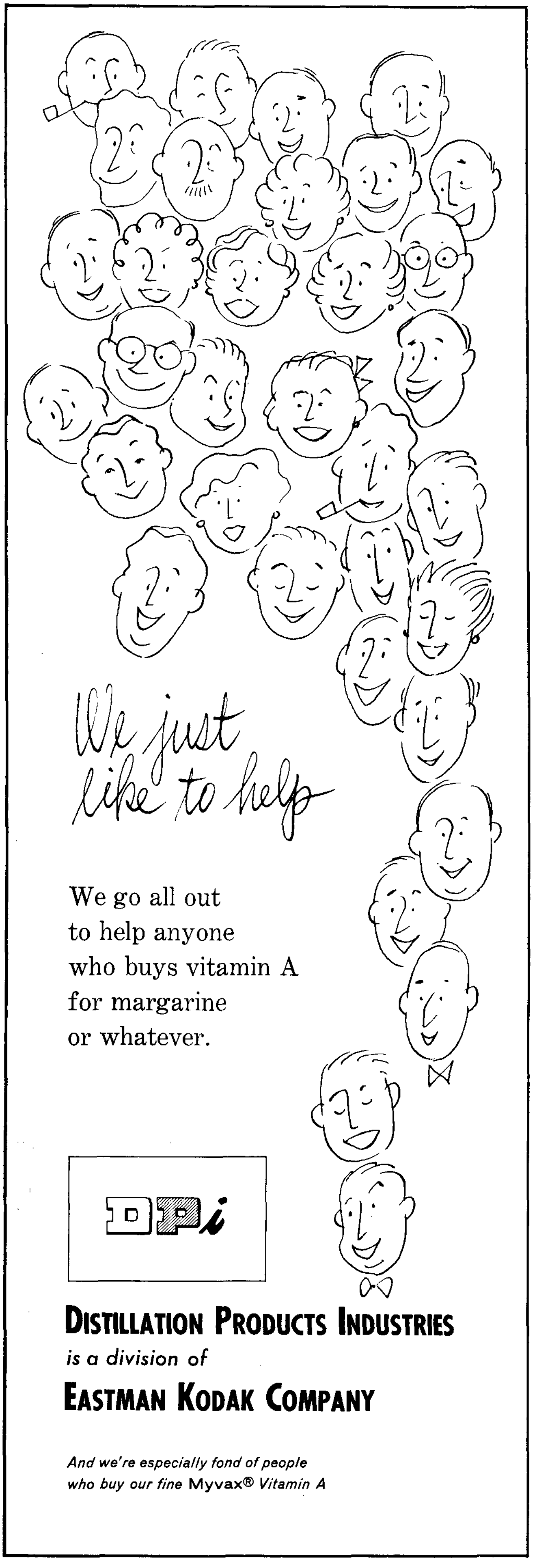
JOBS were difficult to get in 1922; and even one at $25 per week, the going rate for chemical engineers, was worthwhile holding onto, so we in the fatty acid business thought something should be done to put it on a more permanent basis. It was obvious that if the concentration of the saturated acids of cottonseed foots or of garbage grease could be accomplished, larger amounts could be used in making soap by substituting for high-priced tallow. In observing the operation of our batch fatty acid stills, we decided that higher melting stock could be obtained by fractional distillation because the initial fractions had a higher melting-point than the bulk distillate.

To prove our idea a small still was built in 1925, not by research funds but by a few petty-repair orders issued to an understanding and sympathetic machine-shop foreman under the guise of pump repairs. The fractionating column was a piece of 4-in. brass pipe about 4 ft. long, capped at both ends and filled with broken milk bottles for tower packing. The bottom of the column was suspended in a brick-lined fire-box, heated by a gas burner. Separate coils of copper tubing were placed in the fire-box to preheat the feed stock and the steam. Another pump-repair order furnished the reflux condenser, and the unit was connected to the plant vacuum system, which, when running perfectly, maintained the magnificent vacuum of 24-in. Hg. referred to the 30-in. barometer. This little still did not work too well, but the titer of the overhead fraction, when obtained, could not help but be higher because the palmitic acid just would not stay with the bottom fraction.

No help or funds were available to continue our experiment so the idea was abandoned until about 1930 when we had just about used up our World War I supply of stills. Our six cast-iron stills had been disintegrating one by one, and we were faced with the choice of spending money for replacements or getting out of the fatty acid business. This was the opportunity we were waiting for, and even though several producers gave up about that time, we at Armour decided this was the time to try out our ideas by replacing the old stills with one of an entirely different design, one that would fractionate. I was fortunate in having a boss who not only loved the fatty acid business as much as I, but knew more about it, D. M. Flick. He had grown up with it, working for Wm. Garrigue and Sons, builders of most of the fatty acid stills in existence at that time, and to him should go the credit for keeping Armour in the fatty acid business and enabling us to develop fractional distillation and, in fact, our fat chemical division.

The road was not easy. We had no pilot plant and only a minimum of laboratory work to help us with the design. In spite of insufficient data we designed and built a still with a feed capacity of about 3,000 lbs. per hour, starting operations on January 1, 1934. The still showed some indications of working as we expected, but before we could make enough runs to prove its worth, all of its internals (bubble caps, trays, etc.) corroded away. Laboratory corrosion tests had failed to indicate that ordinary stainless steel did not resist the attack of fatty acid at operating temperatures. It was a bit tedious, to say the least, to induce management to give us a second appropriation for a yet-to-be-proven process, but we did it and the original Type 304 stainless internals were replaced with the Type 316, and the still went back into fractionating service early in 1935. It was soon apparent that fractionation provided fatty acids better fitted for specific uses, and users no longer found it necessary to "make do" with naturally-occurring mixtures.

CONCURRENTLY with the efforts of the 31st Street group to develop fractional distillation, the packing plant was faced with diminishing returns on lard, and a research program for the purpose of increasing its value was started by Victor Conquest and A. W. Ralston in the Central Research laboratories at the Stock Yards. Lard hit the bottom at around 2½¢ per lb., and the slogan of the research group was to make "lard worth a dollar a pound." This goal was never attained because lard is still selling for practically the same price if we take into account the devalued dollar, but we did however learn to make fat chemicals, some of which have been sold for a dollar per pound. Of the many chemicals prepared in the laboratory by "Doc" Ralston and his group, those prepared by reacting fatty acids with ammonia showed great promise, especially the amine salts which, due to their cationic property, frothed in hard water and in acid solutions and were quite selective for upgrading phosphate rock by removal of the silicious impurities in flotation circuits.



John P. Harris (1917), president of the American Oil Chemists' Society in 1933 and treasurer 1945-47, has been selected to receive the Fuller Award for 1960 by the Illinois Section of the American Water Works Association. The honor is given "for his help and advice to water plant operators on methods of producing a better product, and for his continued efforts toward the advancement of knowledge among Illinois Water Works men through his active association with such groups as the Illinois Operators Short Course, the Northern Illinois Water Works Works Institute, the Illinois Operators Conference, the West Shore Water Producers Association, and the Illinois Section of the A.W.W.A., of which he was chairman in 1946." The award will be presented in Miami, Fla., this spring.

but at that time the price of coco oil was only 1½¢ higher than tallow and there was little incentive to carry on the research program. I wish we had continued to work on the problem because the difference in price now is about 13¢, and it would be nice to knock off 2 to 6 carbon atoms from stearic acid to satisfy our lauric, myristic, and palmitic acid requirements.

PASSING on to new products, we should see new series of fat chemicals develop, say those based on phosphorous or silicon, in the same manner as the nitrogen derivatives. Peroxides, aldehydes, ketones, and a host of others will find utility.

We must remember however that a substantial portion of our chemicals can be produced or replaced by other chemistry from other starting materials. This is a greater threat in the next decade than in the past. We have Ziegler chemistry whereby CH_2 groups can be strung together by first putting them on tri-alkyl aluminum, then by hydrolyzing to the corresponding alcohol. A plant is being built to make a reported 50,000,000 lbs. per year of medium-chain length alcohol, principally lauryl alcohol. The "oxy" process, alkylation techniques, etc., are constantly being perfected, and many compounds, even though they differ from fat chemicals in that the carbon chains are usually branched, are being produced in ever-increasing numbers. Many of these chemicals perform the same functions as our straight-chain variety now, and competition from them will become even more intense in the future.

Actually the possibility of the petro-chemical boys running us out of business is rather remote. As they go farther afield and drill deeper wells for their raw material, all we need to do for ours is eat more sirloin steaks. Supplies of vegetable and animal fats should be ample in the foreseeable future, and it is reasonable to assume that, as long as this condition exists, prices will remain moderate. It is not logical for anyone to go to the trouble of hooking up 16 or 18 C atoms in a straight chain and wind up with a 3 or 4¢ crude fatty acid. We have an excellent, cheap, and pure raw material, and the possibilities for making useful chemicals are many.

As I prepared the outline for this paper, I could not help recalling a similar talk with the same title which I gave about 20 years ago at a spring meeting of the American Oil Chemists' Society in New Orleans. It was during that meeting that Ed Bailey and I became very well acquainted. We both allowed that while nature synthesized fats superbly for her purpose, they just were not right for ours, and we both vowed that we intended to do something about it. We have, I believe, come part of the way toward reaching our goal, and I am sorry Ed is not with us now to share in our achievements. If he were here, I am sure he would join me in saying, "Good, but now let's get back into our respective laboratories and plants tomorrow and get some more work done."