SOLVENT EXTRACTION
—PAST AND FUTURE—

By DR. M. BONOTTO
PRESIDENT OF EXTRACTOL PROCESS, LTD.
New York, N. Y.

Abstract

In these modern times, with the amazing progress of science, manufacturing processes are constantly changing and improving. In the production of vegetable oils, however, a system dating back to Biblical times is still being used. Will solvent extraction be able to supplant the press system?

"IN the United States, during the year 1936, a gift of more than nineteen and one-half million dollars was donated to cattle." That is my answer to any one who still asks me why the trend of the oil industry points decidedly toward solvent extraction. In fact, enough cottonseed oil, peanut oil, cocoanut oil, corn oil, soybean oil, and linseed oil to total the amount of 123,000 tons was sold at one-seventh of its true value. In my calculation I have assumed that only 4 per cent of oil was left in the cake by the various press systems—but all of us know that that per cent is quite optimistic. Evidently, cattle do not appreciate the gift because only a fraction of the oil present in feed is utilized in their digestive tract, according to authorities.

The question as to the superiority of solvent extraction over pressing of oil arose when the former was first proposed, possibly forty years ago, to supplant press methods and even now, although to a less extent, the question is still alive. The successful adoption of solvent extraction methods during the past ten or twenty years in Europe indicates that oil processors there have answered the question. The abnormal condition created by the World War was a primary reason for that. The shortage of fats and the imperative need for them at that time, both for edible use and for the manufacture of explosives, outweighed any theoretical objections they might have had, and the necessity of obtaining the maximum amount of oil from oil-bearing materials overcame natural resistance to new methods.

As a result of intensive study of solvents and apparatus there were many improvements in solvent processes and, consequently, at the close of the war the European oil industry found at its disposition a new and more rational way to extract oils. Solvent extraction methods continued to be further improved to meet demands of the normal market for, as we all know, peace-time requirements are quite different from those during a war. Of course, the question of the superiority of the two methods came up often, but usually it was brought up by interested press manufacturers or by those crushers who were not willing to junk their old equipment. Also, at the same time, the advocates of solvent extraction were hindered, due to imperfect machinery, which often caused accidents, and, too, because of solvents not suitable for the purpose. In other words, the machinery came under discussion—not solvent methods.

Importance of a Proper Solvent

The word "solvent" itself was a serious set-back inasmuch as it created confusion in the minds of crushers, and that confusion was cleverly developed by those opposed to solvent extraction. Those opponents tried to discredit the whole process because often products, inferior as a result of the use of improper solvent, were placed on the market. Published results of works done on solvent extracted oil left the impression that all the oil so obtained was inferior in color to pressed oil. Really, the authors had not used the proper solvent.

I had occasion, myself, to check the results of one of those works where the findings demonstrated that the red color of solvent-extracted cottonseed oil compared very unfavorably with pressed cottonseed oil. That report may have led interested people to generalize, to conclude that solvent extraction invariably yields oil of inferior quality. On the contrary, my work showed that the solvent extracted oil was lighter in red color than pressed oil. The true fact of the case was that this experimenter had used the wrong kind of solvent. He had used Benzol and had experimented at high temperatures. Benzol has a tendency to extract some of the resinous and coloring matter from the hulls of cottonseed and the objectionable characteristic in the above case was not surprising. In my test I used a light gasoline and a temperature of 90° F., with the result that only the fatty material was present in the extracted oil.

Numerous mistakes such as that were made by various authorities working on both extracted oil and meal, leading oil processors to reach the conclusion that all solvent-extracted oil was inferior to pressed oil.

Much work was done testing the possibilities of chlorinated hydrocarbons as a solvent. In many cases too enthusiastic processors put on the market meal and oil which had been treated with impure trichlorethylene. Fifteen years ago it was impossible to obtain trichlorethylene having the same degree of purity as that obtainable today and, consequently, traces of impurities were left in meal when it was used as solvent. The opposition took advantage of and generalized that fact, propagating the impression that it was impossible to have solvent-extracted meal absolutely free from solvent and warning that to feed such meal would be dangerous to the health of cattle.

Another objection advanced by those opposed to solvent extraction was the necessity of subjecting the extracted meal to heat for a relatively long period of time in order to completely eliminate the solvent, which operation would greatly impair the quality of the meal. They admitted that in the press method the meal is heated or "cooked" before pressing and, in addition, is scorched in expellers, but that the length of time was not so long as that required to eliminate solvent from a charge of an extractor of the capacity of, shall we say, 6,000 pounds. Unfortunately, that was true and in reaction a tendency developed toward the use of smaller extractors, some using vacuum.

In the process of recovering solvent by the use of old batch distil-

ling apparatus, the color of the oil was somewhat darkened. The miscella was periodically fed into a container and heated to 220° F. by indirect steam, then direct steam was used to strip off the last traces of the solvent from the oil. According to the capacity of the apparatus, the oil was thus subjected for a period of from forty to sixty minutes to the action of heat, with the result that the finished oil was darkened. This was another fact which helped to keep undecided the question as to the superiority of the two methods.

When finally, during the past few years, an extracted meal which overcame all the objections was obtained, the question of palatability was presented. I think that that is their last stand. According to those opposed to solvent extraction, such meal is tasteless and cattle prefer the taste of pressed meal.

It Will Happen Here, Too

In the United States the average oil processor was aware of what was going on in Europe on the above subject, but was not sufficiently interested to make an effort to discover the truth. For some time scientists have attempted, without success, to call the attention of American processors to the new trend of the oil industry and I have heard a number of reasons for their singular lack of interest. One of those reasons was—the favorable economic condition of the oil industry in this country in the past. If that was a real reason, I think it is about time now that solvent extraction in all its possibilities be considered because, undoubtedly, that reason for their indifference is gone.

Chemical engineering has developed continuous solvent extraction methods to a very high degree of efficiency and safety and the European industry is now adopting it as an improvement and logical development of batch extraction methods. The United States oil industry will be in a particularly fortunate position when it decides to change its present method of obtaining oil because the American crusher's task of modernizing his plant has been greatly facilitated by experience in Europe. The European crusher who now is operating a continuous extraction plant has had to junk two kinds of equipment, namely, the press and the batch solvent extractor. The American crusher will need only to junk the press.

That may sound a little hard, but that is what is going to happen in the United States just as soon as continuous solvent extraction has the chance to demonstrate how near it is to meeting all requirements of the American oil industry. Such change started to take place in Europe ten years ago and continues at a speed increased by each new development.

In the United States the adoption of continuous solvent extraction will be limited only by the size of the oil mill. That is to say, the small crusher of twenty tons per day will continue to operate with the old equipment or eventually will install some small batch solvent system, but the economic factor will force those crushing fifty tons per day or more to adopt continuous solvent extraction methods.

The organization of the petroleum industry in America makes it possible to furnish the "cut" of paraffin hydro-carbons suitable for the extraction of each kind of oil at very attractive prices. The perfection of fractionating plants enables it to furnish those "cuts" with very narrow boiling ranges and without "light" or "heavy" ends, thus reducing loss of solvent in its recovery from the oil and facilitating the elimination of solvent from extracted meal without severe heat treatment.

The American processor, by proper selection of solvent, proper temperature, and by the use of proper metals in the construction of apparatus, will be able not only to match the quality of pressed oil but to produce oil superior in every way. With the use of continuous distillers, high-speed flash distillation and two-phase continuous stripping columns, solvent may be recovered from the miscella at atmospheric pressure without the necessity of heating the oil for more than a few minutes. Less albuminous matter, gums and resins, mechanically removed with the oil from the seed in press methods, will be present in the finished oil extracted with properly selected solvent. If for some reason long cooking of meal is not acceptable to feed mixers, continuous solvent methods eliminate that objection. In some continuous solvent extraction systems the meal stays in contact with solvent only from fifteen to twenty minutes instead of a period of seven or eight hours which was the main disadvantage of batch systems. In eliminating solvent from meal, ingenious apparatus has been developed in connection with continuous solvent extraction to meet the requirements of the feed market. Thus it will be possible to deliver "palatable" meal to please even the most sophisticated cow.

The enormous facilities and the skill of chemical engineers in the United States will soon give us American developed extraction systems and American manufactured apparatus. Thus, all the objections which have kept the question as to the superiority of the two methods alive for many years will have been overcome and the question finally settled. However, I do not expect to see that come about in a short space of time.

As is the case with all machinery which has a big output, a continuous solvent extractor has its minimum economic capacity. That must be kept in mind when consideration is given the economic side of the new trend. If, suppose, a twenty ton per day continuous solvent extraction plant cannot compare favorably with a press plant of the same capacity, the conclusion is not that press plants are more economical than solvent plants. From my experience, I think that the profit derived from a twenty ton per day continuous extraction plant would be so small that it would be an uninteresting investment. In addition to that, the operating costs would not permit the employment of specialized operators. But, from a fifty ton per day capacity on, the economic factors in favor of the solvent plant are so striking that no one could be left indifferent. The wide margin of profit would permit the employment of highly specialized operators, which, in my opinion, is essential for the safe and profitable operation of a solvent extraction plant. However, it is not my purpose to discuss that matter at this time.

The trend of the market now is exceedingly favorable to the introduction of new ways in the oil industry. The unsettled condition of Europe, the peculiar situation in Asia, and the increased demand for glycerine for war purposes, lead us to believe that a future shortage of fat will affect the market—and a gift of 123,000 tons of oil to cattle will be rather expensive.