OIL EXTRACTION IN THEORY AND PRACTICE

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The following paper was presented before the seventy-first meeting of the American Chemical Society. Because of its importance to the Oil and Fat Industries, permission has been obtained to print the paper concurrently with Industrial and Engineering Chemistry. Mr. Whiton makes this the introduction to a more detailed treatment of his topic, which will be published exclusively in the Journal of Oil & Fat Industries of July and August.—*The Editor.*

The United States has been singularly behind in the development of the use of solvent extraction for the manufacture of oil from oleaginous-bearing seeds. No doubt this has been due to the fact that in the early days, before a very extended use had been found for vegetable oils, there were considerably larger quantities of oil available in the seed than could be sold. Hydraulic pressing which recovered a relatively small proportion of the oil was therefore the logical line of development.

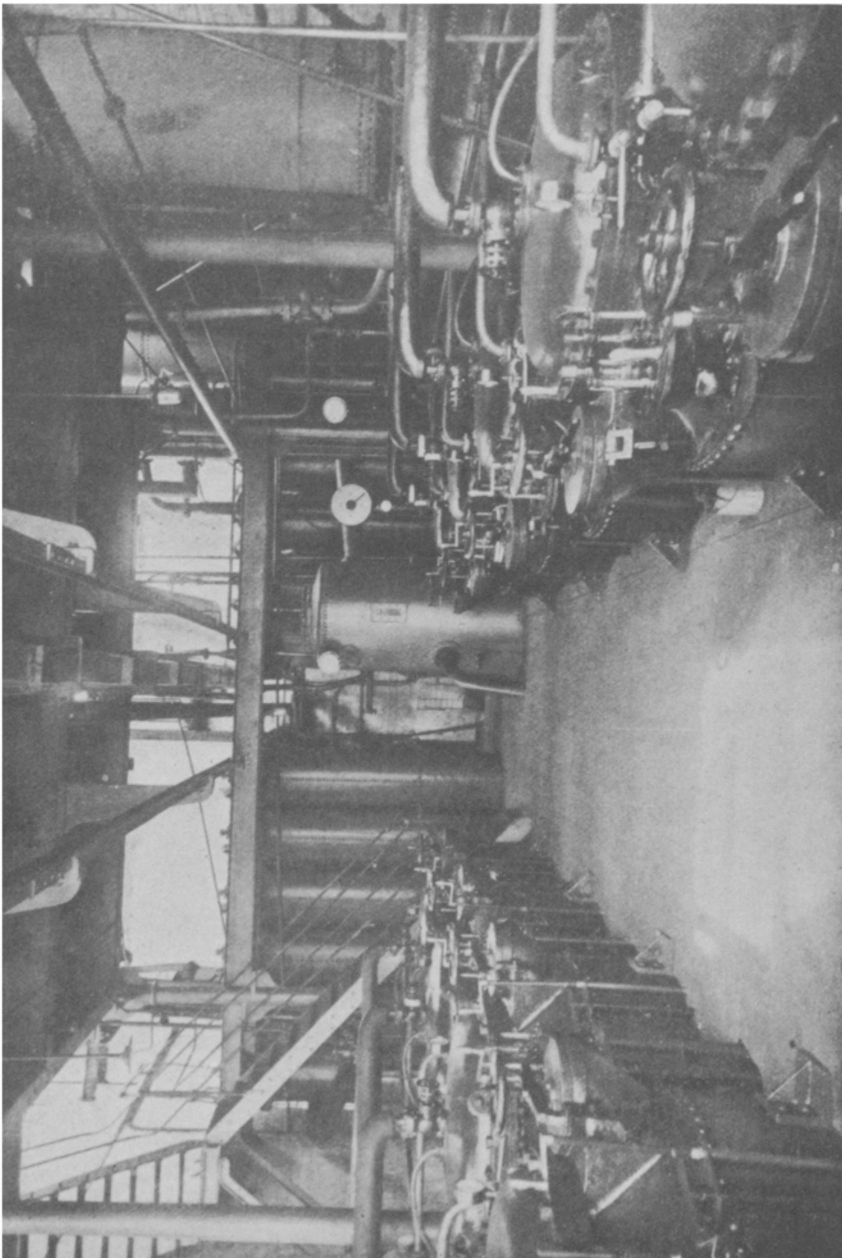
In Europe the same story could be told; but since 1900 the demand for vegetable oils has considerably increased and the conservation of this supply was forced upon the owners of the hydraulic press plants who had been wasting valuable product and selling it in the meal at about one-fourth of its real value as oil. Many of them turned to solvent extraction and it is now a highly developed industry abroad, particularly in the Mediterranean countries.

As is well known, there has been somewhat of an upheaval in the vegetable oil industry in the United States in the last five years. Changed labor conditions due to the war may have had something to do with it, but the fact remains that the stage in the development of this industry has been reached when it has become unprofitable and shortsighted to give away 100 to 150 lbs. of an oil worth about 10c. a pound, per ton of meal which is worth about 2½c. a pound. The discussion will be left to others as to the value of this fat as animal food—that is somewhat beside the question—the important point is that the oil can be used to a considerably greater advantage elsewhere and sold for four times more than if it is used as cattle feed.

In order that the solvent extraction plant be a success in replacing the hydraulic press, it is necessary for it to fulfill the following requirements:

1. It must produce absolutely solvent-free oil and meal so that the former may be used for the refinery and the latter as cattle food.
2. It must be as free from complications as possible so that expensive technical supervision is not required.
3. The machinery must be of such a nature that small plants of the size of the average cotton oil plant in the South can be run at a profit for a short season.

To anyone who has ever had the occasion to review the patents on solvent extraction, he has found it to be one of the favorite playthings of



Early form of Bataille Extractors Installed in England in 1892 the theorist; but contrary to many types of machinery, solvent extraction almost resolves itself to the crude formula: the fewer the refinements, the better the extractor. In other words, the laboratory Soxhlet on a commercial scale is almost the ideal. Below are mentioned some of the complications which seem reasonable to the best engineers until they have had experience in the solvent extraction field.

Freeing Oil of Solvent

It seems more reasonable to collect the oil bearing solvent from a number of extractors and to distill this from a large still. This appears to require less labor and a less costly installation. From a practical standpoint it heats the oil too long a time, thus producing an inferior quality of oil, and requires intensive steaming and heating at the end to eliminate traces of solvent from a large quantity of residual oil. It is far better to use small stills connected with each extractor and to have each still finish off the oil from a single extraction. The oil will thus be less violently treated and of a better quality. Since a still requires no labor to speak of, there is no disadvantage from that standpoint. The idea that oil cannot be freed of solvent is illogical when one realizes that products much more difficult to remove are eliminated in a refinery deodorizer and that the oil still operates upon the same principle; that is, it must separate an oil, boiling at a high temperature, from a low boiling solvent which, needless to say, should be properly rectified beforehand.

Freeing Meal of Solvent

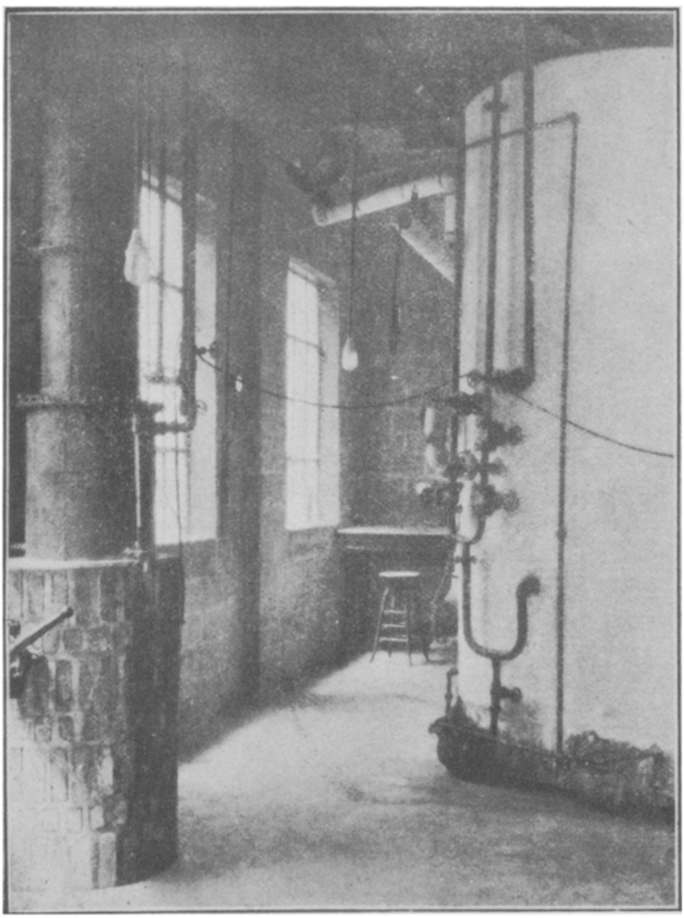
The elimination of the solvent from the meal is also accomplished by steaming. A natural conclusion is that this solvent can be more easily volatilized if the material is stirred. This is partially true. Nevertheless consider the mechanical difficulties of stirring several tons of solid particles of meal which is not surrounded by liquid. It requires a fair amount of power, offers possible leaks at stuffing boxes and is a movable part which it is wise to dispense with if possible. The only successful method of avoiding the agitator is one used by one of the manufacturers of extractors and which consists in draining the meal thoroughly of solvent and then introducing solvent vapors so that there will be a large quantity of vaporous material to steam rather than liquid which first must be vaporized.

Discharging the Extractor

Discharging the extractor by a mechanical agitator theoretically appears to be worthwhile. An extractor of the proper size of 5,000 lbs. capacity can be discharged about as rapidly by hand. The danger of the agitator at this point is considerable. If the meal is improperly deodorized, the solvent mixed with the air which enters when the discharging door is open, becomes an explosion hazard, since the agitator might strike a spark against a stray stone.

Size Units

Theoretically it should not be much more difficult to extract 50,000 lbs. at a batch than 5,000 lbs. It probably is not more difficult, but it is practically an impossibility to deodorize the residual meal. A large extraction plant for flaxseed was built in the United States some years ago which attempted to extract immense quantities in each charge. It was impossible to properly deodorize the meal and this unfortunate experience has probably hindered considerably the development of solvent extraction in the United States. Both the Bataille and the Scott extrac-

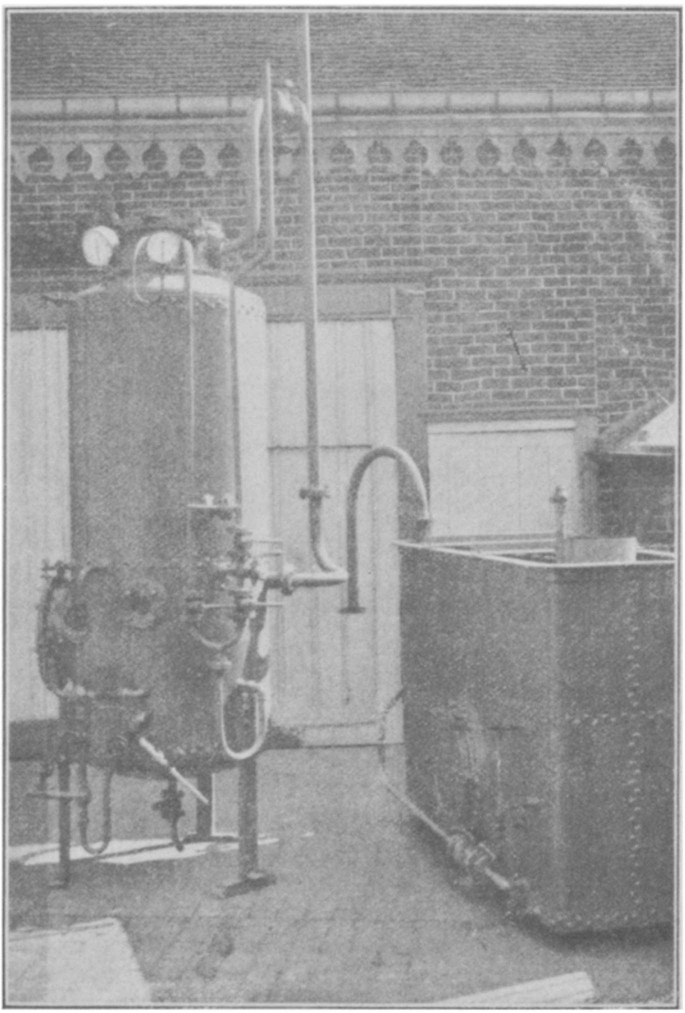


Modern form of Bataille Extractor without agitators, series flow of solvent or circulating pumps

tors are small. This is because the European experience upon which their designs are based has indicated that 5,000 lbs. or 6,000 lbs. capacity is the maximum size of which an extractor should be built.

Continuous and Series Extractors

The writer knows of only one installation of continuous extraction in this country. Since this plant is no longer in operation, he is under the impression that continuous extraction has not yet been fully developed.



Small extractor unit for Fuller's Earth. (Left) Combined Extractor and Still. (Right) Combined condenser and solvent reservoir. which is located above extractor when apparatus is assembled

It is doubtful whether it is feasible because the capacity per dollar invested is probably not as great as the intermittent extractor plant and the complications are manifold.

The semi-continuous or series extractor is an arrangement of 4 to 6 in a row with the solvent passing from one extractor to the next. Theoretically, this should save steam by producing a more concentrated oil solution. Practically, it is inadvisable because it means a complicated series of piping and circulating pumps handling hot solvent, both of which increase the solvent loss, which rapidly nullifies any steam saving. The greatest difficulty is the necessity of charging and dicharging all of the extractors in the series at the same time. This is evidently uneconomical and the practical result is that certain extractors are out of service part of the time awaiting their turn. In addition if difficulty is experienced with one extractor it holds up the rest of the family. Individual unit extractors, independent one from the other will be found to turn out a greater amount at the end of the year and operate more economically than the above arrangement.

Extraction Period

The extraction period is comparatively simple provided the extractor is kept filled with solvent and the proper arrangement of filters are used. The solvent that is generally employed in Europe is a cut of gasoline boiling at 60° C. with neither light nor heavy ends and which is available almost anywhere on the Continent. Trichlorethylene is also in general use because it is not inflammable. Benzol is excellent except that it frequently produces a darker oil. Carbon tetrachloride is not used because it is too easily hydrolized and attacks the metal container. Ethylene dichloride is similar to trichlorethylene except that the manufacturers claim that it hydrolizes less. It has the disadvantage of being slightly inflammable (about one-sixth as much as gasoline), and costs about the same price per pound as trichlorethylene.

In conclusion, the extractor which has no movable part, no pumps or agitators, which is of a proper size and independent in operation from any other extractor is the most practical type. It certainly is the type that most appeals to the oil plant operator who wishes to avoid the use of expensive technical supervision and undoubtedly in the next ten years many of the cotton oil plants will have adopted such an extractor and thereby recover sufficient oil to pay for the actual operation of their plants.

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