Modern Methods of Extraction by Means of Solvents

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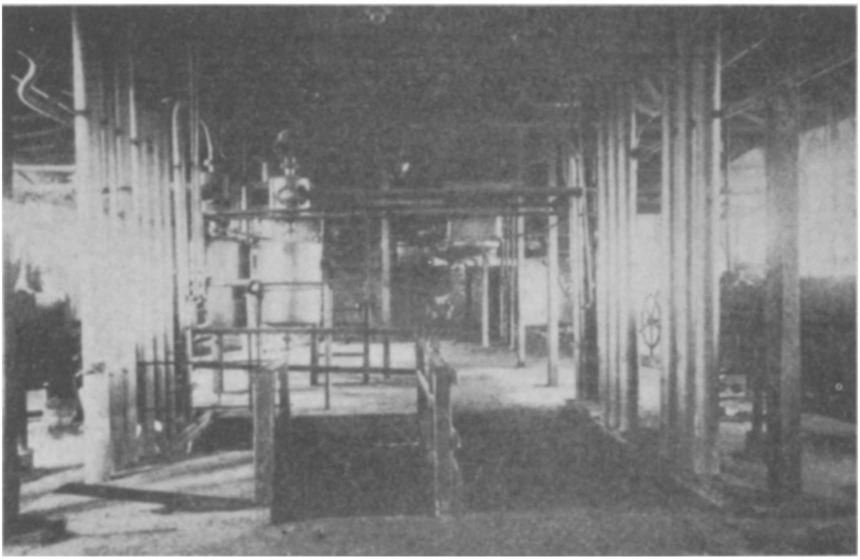


Illustrating the recuperation system

UNDOUBTEDLY the greatest proportion of the output of vegetable oils in America is still being produced by means of the hydraulic press. The chief reason for this is that until very recently no better method had been developed as the various extraction methods which had been offered were not by any means entirely satisfactory. Again, there is the natural conservatism exhibited by the oil manufacturer in changing from an old and well tried system to a new method, coupled with certain advantages which the Hydraulic Press System possesses. First, the production of press cakes containing a certain percentage of oil coupled with the fact that the press cakes may be shipped without any special bagging or packing. Local conditions are another factor entering into consideration as in places where water is scarce it is not so important in the case of the hydraulic press as in the Solvent Extraction System.

But, on the other hand, the hydraulic press method has many serious disadvantages when compared with the modern solvent extraction system. For instance, one must take into account the much higher cost of equipment coupled with the greater weight of pumps, presses, accumulators, "cookers"; the constant and expensive repairs, the continual cost of press cloths and most important the much greater amount of labor and higher wages.

Then there is the deficient yield of Oil by the hydraulic press method, when compared with the modern extraction system. This of course varies with the type of hydraulic press, the skill and care exercised in their operation, and with the technical knowledge of "cooking" on the part of the employees. The oil content in the press cake varies from 5 per cent to 15 per cent, occasionally more (the average being 8 per cent to 10 per cent).

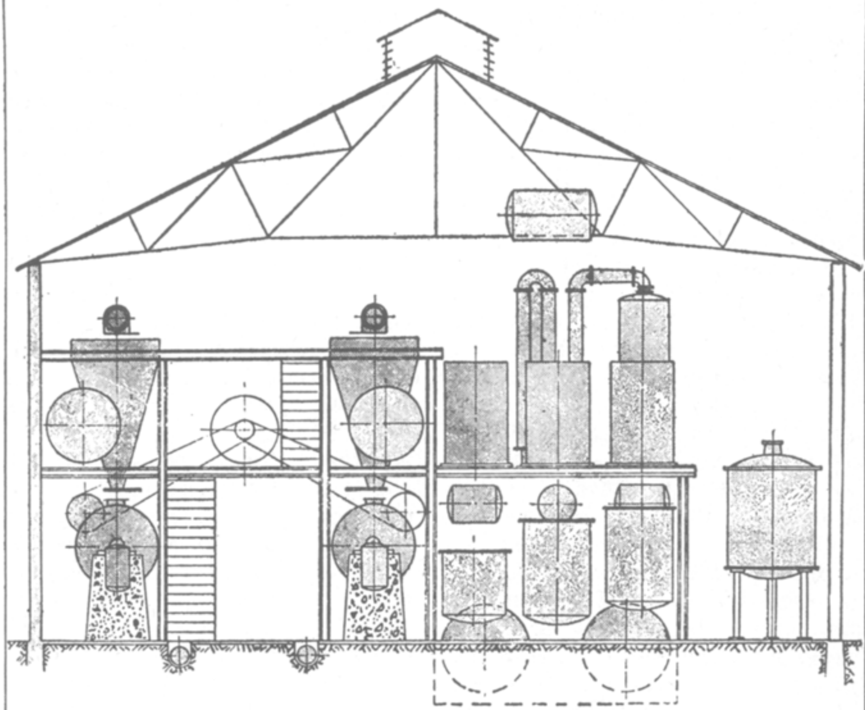
It is admitted that a small percentage of oil for feeding purposes is desirable in the press cakes or meal; but excessive amounts pass through the animal undigested, as has been proven, and it signifies a great economic loss. Feeding authorities in Europe state that not more than 1 per cent fat in feeds can be utilized; more than that is detrimental to the assimilation of that essential in foods, protein.

The Inferior Quality of the Oil is a point of great importance. On account of the direct steam used in the "cookers," mucilaginous substances are liberated which under pressure enter the oil. These impurities must be removed either by settling or filtration or other means of clarification, which adds expense.

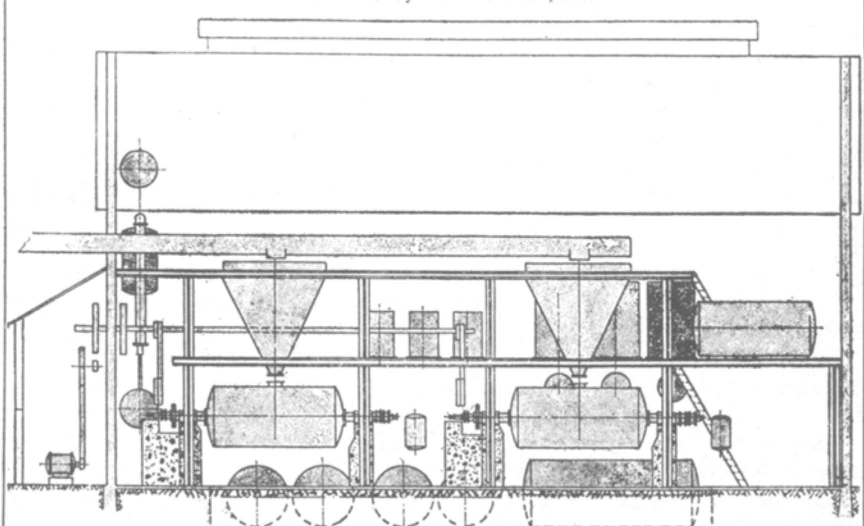
Again in the cooking process previous to hydraulic pressing, steam is introduced into the oil seeds in the cookers; heat plus moisture induces hydrolysis deteriorating the quality of the oil: its influence on color and increase of the free fatty acid is well known.

Since 1843 when Fisher of Birmingham (England) introduced extraction, many endeavors have been made to use the extraction method, as it was realized to be more simple and economical in operation. It is interesting to follow the early types of extraction apparatus—English, French, German and American. All were more or less unsuccessful in reaching the ideals of the process, which can be said to secure the complete removal of the oil or as much of it as it is desired to recover in one stage and should leave the residue of the seed in a dry state. Many extraction plants fall short of this ideal, inasmuch as the meal after extraction has to be separately dried. The methods in the past were also more or less unsuccessful, owing to the fact that it was almost impossible to obtain oils and meals free from taste and odor of the solvent employed and of as good color as by hydraulic pressing and last the greatest obstacle to its use—the constant danger of explosion. These serious disadvantages were due in the most part to faulty design and mechanical construction. For instance, the use of vertical or horizontal stationary extractors, in which direct steam was blown through the extracted mass in order to eliminate the last traces of the solvent, was found to be not only objectionable in regard to quality of meal but a very dangerous practice as well (reference is made to this later).

In the old fashion extraction system, in which direct steam was blown through the extracted meal, not only was the color of the meal influenced unfavorably, but the proteins (the essential food principle) were coagulated, losing much of their digestibility because they were no longer water soluble and consequently were not so readily



End view of extraction plant



Side view of extraction plant

assimilated when fed to the animal.

Again with oil seeds having a large mucilaginous content; such as Linseed, for example, when steam was blown through the extracted meal, caking took place, forming balls of the extracted meal. These, when dried, were hard on outside and soaked with solvent inside. When these balls were ground, explosions often took place. In fact, the great explosion at the plant of J. Bibby & Co., Liverpool, was traced to this cause. Also, the steam blown through condenses and it will be found that often there is a moisture content in the meal running as high as 35 per cent and therefore a severe after-drying must be resorted to.

The necessity for increasing the production of oils and fats during the Great War stimulated invention and in Europe, particularly Germany, great advances were made. Finally a System of solvent extraction was devised that has entirely overcome the objections that existed formerly and that carries out the process to perfection.*

This introduces a new era in the history of extraction, the ideals are fully met and by the introduction of special apparatus the fire hazard and danger of explosion that existed heretofore is entirely eliminated.

The Extraction Plant consists of:

1. The Extractors proper with built-in Heatable Filter Tubes
2. The Distillation System
3. The Recuperation System

The Extractors are horizontal, jacketed, rotary with inserted heatable filters and operate in vacuo. They are constructed in two sizes, viz. 1.8 meters (6 ft.) and 2 meters (6 ft. 6 in) in diameter and 4 meters long (13 ft.), capacity varying from 5 to 7.5 long tons in 24 hours.

Loss of Solvent during operation. The loss of solvent is guaranteed not to exceed 1 per cent based on the weight of the material to be extracted. However, practical experience has shown the loss to be very considerably less.

Consumption of Steam. This amounts in the case of oil bearing seeds to about one pound of steam to one pound of the weight of the raw material although if care be exercised considerable savings are still possible.

Consumption of Power. The rotation of the extractors require very little power. For instance, a plant having a capacity of 5 to 6 tons per day 20-30 Kwh. is used, 10-12 tons 40-60 kwh., 20-25 tons 100-120 kwh. It is evident that the cost of power is negligible.

Consumption of Water. The consumption of water is about 12 times the consumption of steam, therefore, a 5 to 6 ton plant will require about 60 cubic meters (14,500 gals.)

Labor. The amount of labor required is two to three men per shift on plants up to 20 to 25 tons per day providing conveying assistance is supplied to and from the plant.

Yield. With the extraction process it is possible to obtain the entire oil content of the raw material, but, commercially leaving 1 per cent or fractions thereof in the residual meal are sufficient. On the other hand should a higher oil content or absolute removal be desired, it is entirely within the will of the technical manager.

Quality of Extracted Oil and Meal. The extraction method removes only the fats and oils. Proteins and mucilaginous materials are not sol-

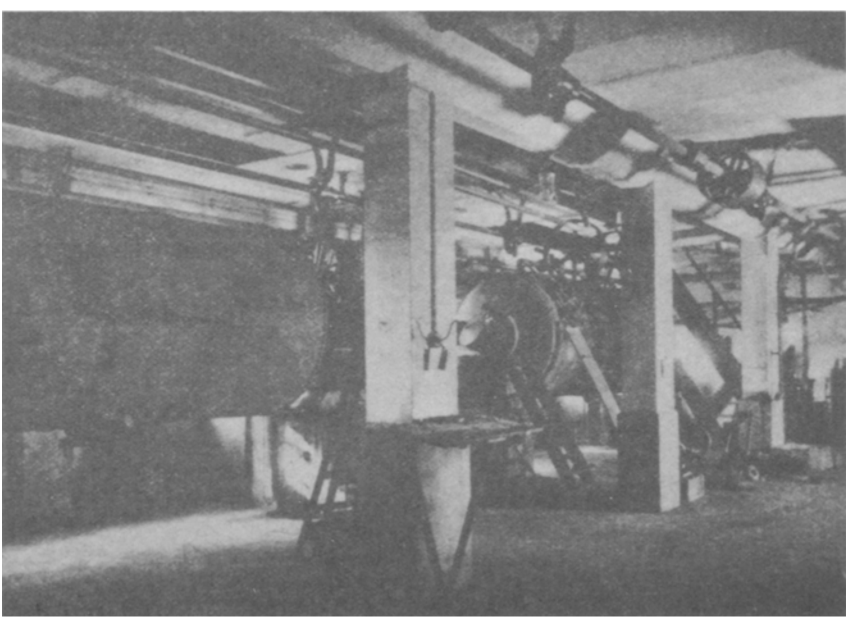
* Reference is made to the Rotary Vacuum Extractor—Karl Friedrich Wilhelm patents.

uble in the solvent. The quality of the oil obtained is exactly the same as that contained in the raw material—it is not deteriorated as is the case in the hydraulic pressing process. The oil is free from "foots." The oil extracted meals are generally white and flaky and in any event much lighter in color than hydraulic press cakes. The proteins contained are water soluble and therefore fully digestible.

Manner of Operation

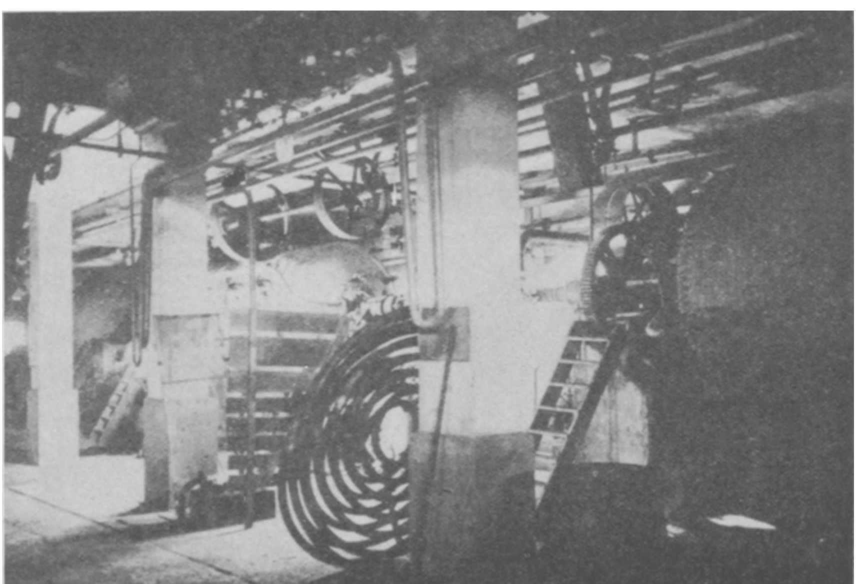
The previously cleaned oil bearing seeds are placed on suitable crushing machines in order to be rolled out in the form of flakes. This is done in the manner that the roughly ground seeds are fed to a pair of smooth rollers. The leaf-like material goes into a hopper arranged above the extractor. The latter measures the quantity required for the filling of the extraction apparatus. The extractor is jacketed horizontal, cylindrical and rotatable. The filling is effected by means of a manhole the cover of which can be placed on and removed within a few minutes. After the closing of manhole the necessary quantity of solvent is introduced into the apparatus and the extractor is rotated, while simultaneously steam is introduced into the jacket. The extractor is rotated but a few times so that every particle of the material comes in contact with the solvent, in this way being thoroughly saturated. Then, the apparatus remains at rest for a few minutes in order to give the material an opportunity to settle; i.e. to separate from the miscella or mixture.

The Miscella (i.e., mixture of fat



Showing the arrangement of the extractors and solvent) is then drawn off by vacuum through filters, built radially in the extractor, into a storage tank for re-use in a second extractor if the fat content of the material to be extracted is small or if it be large, into a still where the solvent is distilled off under vacuum. In a similar manner the material in the extractor is subjected to a second, third and perhaps fourth washing until the fat content of the material to be extracted is found to contain not over 1 per cent of fat, the mixtures in each case being stored for re-use in other extractors before going to the still. After sufficient washings have been made the extractor is again rotated. Steam is applied in the jacket and the solvent remaining in the now extracted meal is recovered by means of vacuum. The residual meal can now be discharged bone-dry and ready for disposition. If it be desired, steam may be fed into the extractor to moisten the meal slightly so as to bring it up to the humidity of the atmosphere. In the stills the solvent is driven off under vacuum at a very low temperature, recovered by condensation. Both oil and meal are devoid of odor or taint of solvent.

While the majority of extraction plants are used in the vegetable oil industry, many are employed for the purpose of obtaining oils, fats and greases from all kinds of fat-bearing materials such as bones, slaughter-house waste, butcher's trimmings or shop fat, "cracklings," fish and fish cuttings, hydraulic press cake and parings, Fuller's earth, bleaching earth, spent catalysts, and fatty substances of mineral origin, such as Montan wax from lignite.



Another view of the extractors showing the rotating mechanism