Mechanical Oil Extraction

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ABSTRACT

Competitive pieces of equipment for full-pressing and prepressing oilseeds are described. "Enhanser" machines to treat seeds before solvent extraction considerably increase the capacity of the solvent extraction system.

Over the centuries, four basic methods of extracting vegetable oil from the various seeds, nuts and fruits have evolved. The first was the basic wet rendering process in which the oil-bearing material was boiled in water leading to a partial separation of oil, which was skimmed off the top of the vessel. The second was the cage-type press in which pressure was put on a stationary mass by levers, screw jacks or hydraulic cylinders and the vegetable oil flowed from the compressed mass to collecting rings below. Both these methods are more or less obsolete.

The third method is the mechanical screw press and the fourth is solvent extraction. In our World Conference in Amsterdam in 1976, Joe Ward (1) of Simon-Rosedowns and Les Tindale (2) of Davy Ashmore, in cooperation with Mr. Hill-Haas of South Africa, very ably described many of the engineering considerations in the design of screw presses, as well as a detailed description of the machines available. It is not the purpose of this paper to go over the ground covered in the two previously mentioned papers, but to review the status of screw presses in 1982. I sincerely recommend to those of you who are seriously interested in screw pressing, to read the aforementioned papers.

Since 1976, several prominent companies have declined or passed from the scene and several new techniques have begun to market specialized versions of a screw press. But the predominant movement since 1976 has been the worldwide competition between the three largest full line (screw presses and solvent plants) extraction process companies. The basic screw presses of these three companies , so well documented in 1976, have been refined, made more sophisticated, improved, utilized on more and more seeds, and in case you have not looked lately, are well exposed in many advertisements in such trade magazines as *JAOCS*. In makin this statement, I do not mean to infer that some of the other screw presses being offered are not worth considering. But it is extremely obvious to me that time after time, in Africa, in America, in Asia, and in Europe, in responding to tenders of customers and/or engineering companies, the three almost always being considered are Krupp, Simon-Rosedowns or French Oil. Each of these companies has made innumerable installations of full-press and prepress plants.

In 1976, French Oil offered a 150-200 HP, D-88, 7-in. screw press and a 250-300 HP, C3300, 10¼-in. diameter press for full-pressing. These machines are still finding favor in developing countries and to an increasing extent in developed countries. This is because of increased cost of petroleum solvents and increased restrictions being put on hydrocarbon emissions in heavily populated urban countries. The D-88 has been improved by increasing the diameter of the feed section and the first 25% of the high pressure cage from 7 in. to 8½ in., leaving the last 75% of the cage at 7-in. inside diameter. The cages have been modified to eliminate the often difficult to remove cage bolts with simple, quick to remove clamps. These machines are able to process 50 ton/day of most seeds to a residual oil content of 3.5-4.5%. Recent production rates on the C3300 are 97 ton/day on full-pressing flaxseed and 83 ton/day on full-pressing soybeans.

Simon-Rosedowns has come out with a Mark 5 full-press machine which is quite similar to its G-type prepress. The press has a 99-in. long cage and 11-in. long feed section similar to the G and is equipped with either a 150 or 200 HP motor. The Mark 5 will full-press 70 ton/day or more of seed, according to one of their sales representatives. The press can readily be modified to prepress configuration.

Needless to say, thousands of oil mill factories exist throughout the world, employing screw presses. While there is no accurate data as to the exact tonnage processed worldwide, it is obvious that screw presssing will be with us for a long time, and we can look for additional developments in this method of extraction.

Many of the participants in this conference are from North America and Western Europe, where solvent extraction represents the majority of the oilseed processing facilities. Many seeds, such as soybeans, are direct extracted as a matter of common practice. Of course, many of the higher oil content seeds are prepressed prior to solvent extraction to enable solvent extracting to proceed efficiently and trouble-free. It is in the area of prepress development that the most activity has occurred since the last 1976 world conference.

The French Oil B2100 200-250 HP prepress, the Simon-Rosedowns G-type 150-250 HP prepress, and the Krupp SVP 200 HP prepress have had greatly increased usage on considerably larger numbers of seeds. Much of the development on these machines has been in the area of specific shaft arrangements and the proper conditioning for the seed being processed so that today most processors can expect successful performance from the start. There are wide ranges of capacities appearing in advertisements for various machines to condition the seed before pressing. But, one must keep in mind the preparation variables at various oil mills and the desired residual oil in prepress cake. Some theories of solvent extraction want low oil content cake and some high. A similar size, high-capacity press, might prepress 100 ton/day at one plant for its particular requirement, and the same machine might prepress 200 ton/day at another plant for its particular needs. The French Oil B2100 has been improved since 1976 with an available force feeder and provisions for ease of maintenance but, except for a much larger number being utilized by the oilseed industry, it is the same machine.

An offshoot of our B2100 is the B3100 prepress, which essentially has a high pressure cage some 25 in. longer than the B-2100, and some refinements to the shaft and gear box. Three wet process corn germ millers have successfully incorporated these presses into their prepress requirements demonstrating its ability to prepress 100 ton/day of corn germ to the 15-18% residual oil range, and producing an ideally extractable cake. This equipment can be equipped with a force feeder and, so equipped, will prepress in excess of 200 ton/day of canola and rapeseed to a residual oil content in the 18% range.

In the usages to which these presses are being put, it is essential to remember that proper cleaning and conditioning of the seed must be done prior to pressing. Adequate runaround systems must be designed for each installation and an efficient system of cleaning the fines or "foots" from the oil is essential.

It is interesting to realize that since the late 1940s flaxseed has been prepressed whole, and at or near ambient temperatures in the United States. I believe that when I was superintendent of Cargill Inc.'s flaxseed processing plant at Savage, Minnesota, from 1945 to 1950 that this method was begun and refined and to the best of my knowledge all the prepress/solvent plants on flaxseed in the USA have employed this method.

When French Oil first began to develop the large machines for prepressing, the French patented notched worm was incorporated into shaft arrangements to aid in masticating the seed and a restrictive orifice was located in the midpoint of the press (3,4). The French Oil H2-6600 has demonstrated its ability to prepress 325 ton/day of ambient temperature whole flax or sunflower seed to a satisfactory extractable cake. One interesting development is that in the dead of winter when the outside temperature gets down to -40 C in Minnesota, it has proved beneficial to have a conditioner to adjust the temperature of the seed up to ca. +40 C to have uniform results, summer and winter. The B3100 presses incorporate notched worms as do some B2100s.

Krupp has offered a feature laded screw press called "VPEX process" that incorporates many of the discoveries made with the French Oil H2-6600. Stein of Krupp delivered an excellent paper at the Toronto AOCS meeting (5) in which he reviewed the technical aspects of the VPEX oil extraction process. Krupp claims the VPEX press, with a maximum 350 kW motor, will prepress from 150 to 200 ton/day of uncrushed cold oilseeds to 18-22% residual oil.

Since 1976, it is apparent that Simon-Rosedowns has further refined its G-type prepress and has expanded its utilization in the oilseed industry.

There are two screw presses, the Allocco of Argentina and the Masiero of Brazil, that are being used in some installations with success, but their distribution has largely been regional due to the very high import duties to import such equipment into those countries.

A relatively recent development has been the development of extraction enhancing machines which we at French Oil call the "Enhanser" (Fig. 1). This machine is used to treat seeds such as soybeans before solvent extraction as well as cottonseed meats.

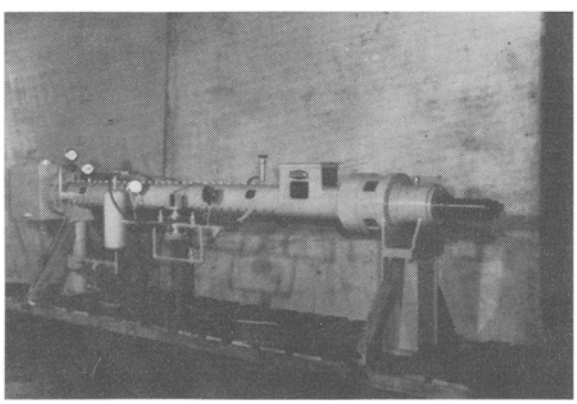

FIG. 1. "Enhanser".

An 8 in. × 12 ft long extruder, with a 100 HP motor, will process 200 ton/day of soybeans. The soybeans must be conditioned to 60 C, flaked similar to normal processing. In the "enhanser", sparge steam is added to increase the moisture content to ca. 18%. The thoroughly masticated soybean is extruded through a die plate, discharging like so many strands of endless sausage (Fig. 2) at a temperature of 85 C and moisture of 18%. The strands of soybean must be dried to 10% and cooled to 60 C before entering an extractor. The process densifies the soybean and increases its porosity. A given solvent extraction plant can be increased in capacity from 50 to 100% because of the increased density and its rapid draining characteristics.

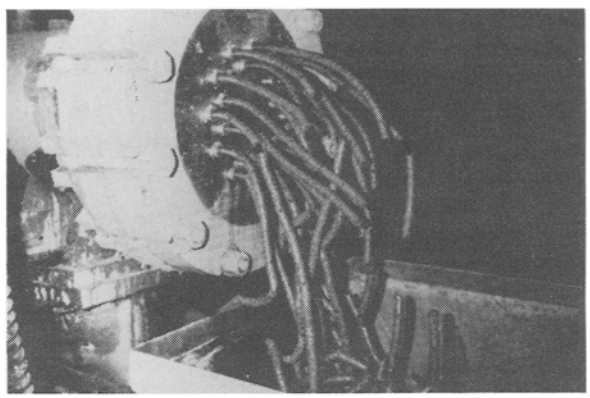

FIG. 2. Extruded soybeans.

In a cottonseed operation, the meats from 260 tons of white seed can be "enhansed" with the same machine so that the broken pellet type cottonseed containing 37% oil can be direct extracted. Not nearly as much moisture is required with cottonseed as with soybeans, but it too must be dried and cooled. An extractor that had been using 1.1 of solvent to 1 of prepress cottonseed cake permitted the ratio to be cut to .9 and 1 of the enhanced pellets. The usual direct extraction is 1.8 solvent to 1 of seed. The miscella concentration was 30-35% oil compared to a normal 18-25%. The capacity was the same but the retained solvent in meal to DT was less. The free gossypol was in the .01 to .02 range.

The economics of this, plus the advantages and disadvantages, have yet to be fully developed, but an exciting year or two is ahead of us. We have many installations out on trial for the coming season and will know a great deal more about it a year from now. It is apparent that screw presses, whether they are full-press, prepress, or "enhansers" will be an essential part of oil milling in the years ahead.

Oilseed screw presses begat wood pulp screw presses for the paper industry. The synthetic rubber and cane sugar industry required screw presses which we developed. When high capacity prepresses were required the larger rubber presses pointed the way for the large oilseed prepresses. An 18 in.-2000 HP rubber press is shown in Figure 3. A 42 in.-4000 HP sugar cane (bagasse) press is shown in Figure 4. Might some versions of these presses be in the oil mill of the future?

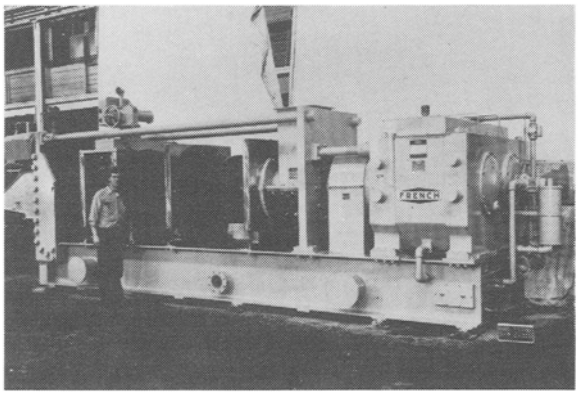

FIG. 3. 2000 HP rubber press.

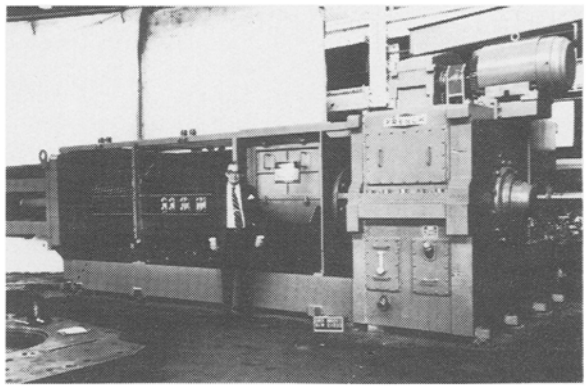

FIG. 4. 4000 HP bagasse press.

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