Some Improvements in Design in Solvent-Extraction Plants[1]

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THIS PAPER is a summary of part of the progress made in the last several years in solvent-extraction processing with emphasis on mechanical or the machinery design involved in this progress. The writer has pointed out before to this same group the advantage to the oil milling industry of the intense competitive situation that exists in this industry, which is one of the finest examples of free competitive enterprise. In almost any industry you think of costs have doubled or more in the last 10 or 15 years. Automobiles are an example. My new Oldsmobile cost $970 in 1942. The new improved model for 1955 costs over $3,000. But new, improved solvent-extraction plants can be bought today for almost the same price as 10 or more years ago. That is a remarkable achievement, redounding to the benefit of the oilseed processor and to the consumer. It is our contribution to the general well-being and improved standard of living of the general public.

Many developments by many different men have contributed to this record. This paper will be concerned with only some of the improvements, details of which are known to the writer. I would like to acknowledge the individual contributions of the scores of processing engineers, superintendents, and operators in the industry but find that such a list, once started, cannot be ended. It should also be understood that this paper is concerned with small or medium-sized plants with 50 to 300 tons capacity. Some of the described economies are not readily adapted to the very large plants. A number of good descriptions of the mechanical features and operation of basket extractors are available and will not be repeated (1, 2, 3).

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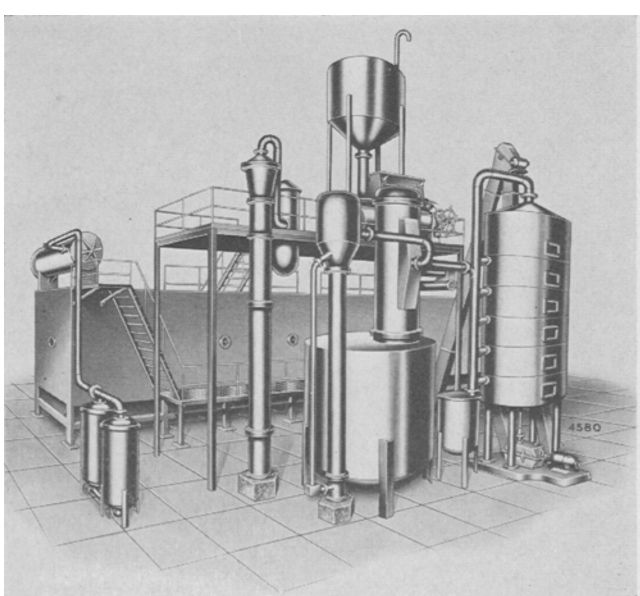

FIG. 1. Streamlined horizontal basket extractor installation.

Figure 1 shows a horizontal basket extractor installation now being installed for the extraction of cottonseed at two different plants in Mississippi. The equipment improvements are best described in terms of five unit operations of extraction, filtration, desolventizing and toasting, distillation, and solvent recovery. (Note: Plants now are operating.)

THE BASKET extractors have been improved internally in many ways to increase process efficiency and mechanical excellence as well as to cut the cost. Only three developments will be described.

1. Continuous filling has been accomplished with a unit shown in Figure 2, consisting of a feeder conveyor and an inclined slurry conveyor. The continuous feeder is a housed screw conveyor with variable speed drive. The plug seal is in the

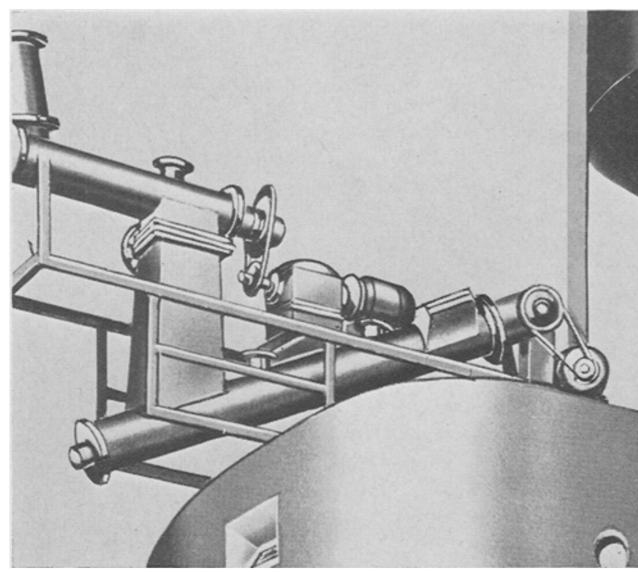

FIG. 2. Continuous filling of vertical basket extractor.

feeder and varies in length from 1⅓ to 2½ times the conveyor pitch, depending on the type and condition of material being handled. Miscella is added in the inclined screw so that the feed is slurried into the basket. The flakes are packed into the baskets more densely by this means, extending the extraction time with a fixed tonnage and extractor. Only soybean flakes and flakes from prepressed cake have been processed at full plant scale by this equipment to date.

Continuous filling has turned out to have unexpected advantages. It was originally developed to cut costs compared to the hydraulic-operated two-compartment system. Successful in this, it also provides a positive seal against solvent loss by means of a plug of flakes, and increases efficiency by improving extraction, or increasing capacity, whichever is desired. Almost perfect basket filling has resulted.

2. Another extractor improvement involves the elimination of flake overflow in supplying the extractor. Basket extractors had always been overfed to the two compartment filling hoppers, and overflow was considered necessary to insure uniform basket filling. Like many other developments the result was obtained simply, once the long held mental block that overflow is necessary was discarded. Tonnage control is transferred to the flaking roll feeders in the preparation area with electrical interlocks provided for all conveyors between the extractor and the flaking rolls. Any interruption to processing in the extrac-

tion area automatically shuts down the cross-yard conveyors and the flaking roll feeders, preventing any choke up.

3. The third extractor improvement involves the elimination of flake spillage. For many years this was considered a necessary disadvantage of basket extractors. But the complete elimination of the problem now seems obvious. Several variations in mechanism have been used successfully (4). The simplest method involves hopper bottoms with open impeller pumps which pump any spilled flakes along with the miscella back into the baskets. With continuous filling the miscella is pumped into the inclined slurry loader. The elimination of flake spillage or rather of flake build-up in the base of the extractor is easiest when combined with continuous filling.

THE SECOND unit process presenting a problem was filtration. The perfect solution was some time in coming but has now been achieved, by eliminating the filters. Since the major job of filtration was always done inside the basket extractor and the filters were only safety, or polishing units, the complete elimination of filters has turned out to be a most beneficial development. There is a substantial saving, not only in the equipment cost but also in piping. The miscella is filtered and re-filtered through the individual beds of flakes during the extraction cycle. It is necessary only to provide a full miscella take-off separate from the miscella recirculation suction lines with provision to prevent any accidental spillage of flakes into this full miscella take-off. In actual practice completely polished full miscella is obtained directly from the extractor.

Continuous filling, elimination of flake spillage, and elimination of filters have been three companion developments that have been worked out simultaneously.

The third unit process, of desolventizing extracted flakes, has been improved most drastically in the last 10 years. Ten years ago all solvent plants used steam-jacketed tubes called "sneckens" for removing solvent from extracted flakes. The most successful of several improvements are the superheated vapor desolventizer (5) and the vertical cooker desolventizer, which is now universally called the DT (6). The DT, shown in Figure 1, uses sparging steam in varying quantities to supplement indirect heat to desolventize flakes and follow with such additional heat treatment or toasting as is desired. This development alone cut 25% from previous solvent extraction plant costs. Results from processor plants show solvent losses cut by 50% and even up to 75% of previous losses.

Distillation equipment has also shown marked improvement from a cost standpoint (Figure 3). Old plants had three-stage distillation, replaced now in almost all extraction plants with two-stage systems. The cost of present equipment is only half the present-day cost of the old three-stage system. This comparison is necessarily an estimate since no one would buy the old system even if it were cheaper.

A secondary development concerning distillation equipment has been the streamlining to make each unit self-supporting to allow the elimination of structural supports. The most recent design almost completely eliminates supporting structures (7). Condensers and vapor-scrubbers and the high-safety water tank are supported by placing them on top the

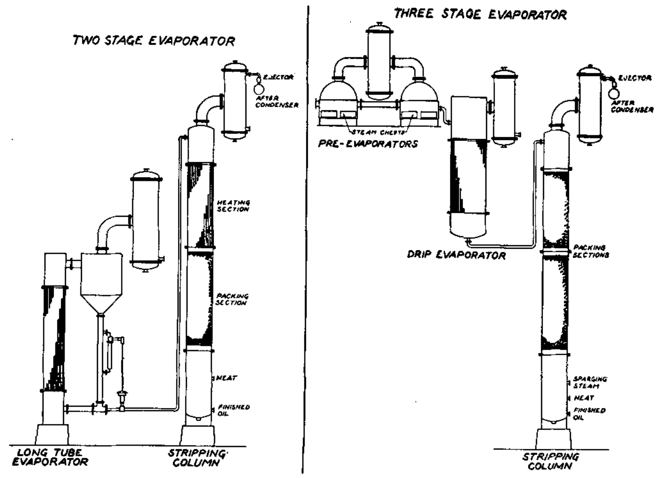

FIG. 3. Two-stage evaporator and three-stage evaporator.

extractor and on the solvent-work tank or water-separation tank.

Solvent recovery equipment has been drastically consolidated and improved with great savings in both equipment and installation costs. As many as seven condensers have been consolidated into one primary unit, which is supported on top of the separation tank and connected directly to it (8). The saving in equipment is only a small part of the total, involving elimination of vapor lines, cooling water lines, solvent return lines, and vent lines with valves and fittings. The labor cost of commercial installations had been getting alarmingly high. This trend has been reversed, at least temporarily, by engineering efficiencies and streamlined design. The material and labor cost of the installed pipe system in a solvent plant has been cut to at least 50% of the previous cost by such streamlining of design. Many small consolidations have entered into the whole picture. One pump has been made to do the work of two, or even three or four. Heat exchangers have been consolidated or sometimes eliminated, with resulting savings without loss in efficiency.

It has been possible to discuss only a small part of the total story of achievement in the oil milling industry. It is a remarkable story, and one that should be an inspiration to young chemists and engineers starting in this industry, and an example to other industries. The driving force has been competition, both between machinery builders for customers, and between processors for more profitable operation.

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