New Technology in Centrifugal Processing of Fats and Oils

K. KLEIN and L.S. CRAUER, De Laval Separator Co.,
Poughkeepsie, New York 12602

ABSTRACT

The mechanical features of the SRPX-317 hermetic high capacity, self-cleaning separator are described. The operation of this centrifuge in degumming and refining systems is given, noting throughput capacities, yields, product quality, and the advantages of automation.

INTRODUCTION

The increased world-wide demand for all types of crude oils has and will continue to produce many new significant product and process developments. To meet the vegetable oil industry requirements, a new high capacity SRPX-317 hermetic self-cleaning separator is now available (Fig. 1).

This SRPX-317 centrifuge is compact in design, occupying only 4 x 5 ft floor space. The 50 horsepower motor drives a 30 in. diameter bowl, hermetically sealed to operate at pressure to 125 psig. Throughput capacity, dependent upon type of feed product, is in the range of 25,000-50,000 pph. Of self-cleaning design, any accumulated solids in the bowl may be discharged efficiently while operating, eliminating any need for manual cleaning and costly labor. The unit can be automated for processing control and cleaning-in-place. It can be adapted readily to a totally automated system, including computer control.

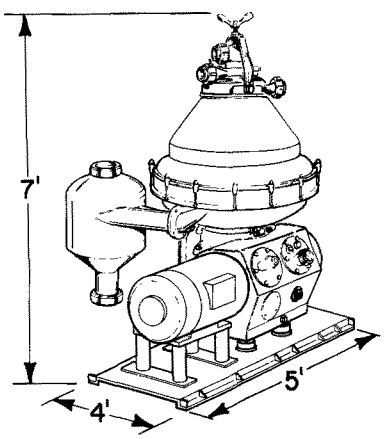

FIG. 1. SRPX-317 self-cleaning separator.

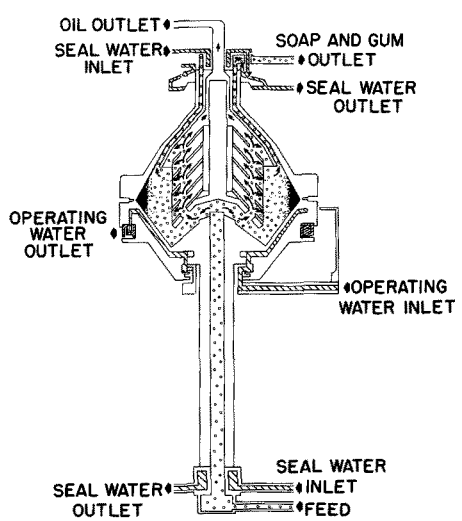

FIG. 2. Schematic of SRPX-317 centrifuge operation.

DESCRIPTION OF CENTRIFUGE (FIG. 2)

The bowl shell of the SRPX-317 is of type 329 stainless steel construction. All liquid contact parts, including the bowl, discs, inlet and outlet parts, are of type 316 stainless steel. This centrifuge offers the advantages of thin strata liquid separation in a disc bowl, operation under positive pressure, large sludge space for solids accumulation, and the self-opening feature for efficient solids removal and cleaning.

The unit may be used for either degumming or refining. In either mode, the feed product enters the bowl at the bottom of a hollow driving spindle with a sealing device. The flow moves upward through the rotating spindle into the separator bowl. The light oil, the heavy immiscible liquid and any solids are separated, with both the light and the heavy phases discharging under operating pressure at the top of bowl through separate mechanical seals. The solids, such as meal fines, are accumulated on the inside of the bowl in the sludge space and are discharged intermittently through a series of slots in the bowl wall. When it is necessary to discharge, the sliding bowl bottom is forced downward by the liquid hydraulic pressure, the discharge slots are exposed, and the accumulated solids or sludge are discharged quickly.

The operating water which controls the opening and closing of the sliding bowl bottom is supplied from an outside separate water source through a pressure reducing valve. By regulating the water supply pressure, the size of the shot or discharge and time interval is controlled at the desired range. Due to the tremendous hydraulic force exerted downward by the liquid in the bowl, this discharge is rapid when the bowl is opened. This operation of opening, cleaning, and closing takes only 3-4 sec. In the meantime, the centrifuge is still rotating at normal speed. None of this operating water ever comes in contact with the product. It enters, controls, and leaves the centrifuge in a separate, independent system. The operation of the bowl at a timed sequence is monitored through its own automatic control system. This program can be as simple or complex as desired, dependent upon the degree of sophistication dictated by the installation.

The neutral zone diameter, i.e. the zone between the two phases, depends primarily upon the gravity difference between the two phases and the diameter of the heavy phase outlet. The change of this zone in a hermetic separator, such as the SRPX-317, is accomplished easily by varying the pressure on a control valve in the oil outlet. An increase in the back pressure on the outgoing oil moves the zone outward toward the periphery of the bowl and will

TABLE I

Degumming in SRPX-317

Oil discharge psig	Gums (dry basis) AI[a]	Gums (dry basis) Oil	Degummed oil heat break (F)
45	72	28	485
50	69	31	510+
54	65	35	510+

[a]AI = acetone insolubles or phosphatides.

give a cleaner oil phase. It will contain lower soap or gums content. This adjustment in pressure can be made while the separator is operating. By tracking the differential pressure between the inlet and oil discharge pressure, the bowl can be self-monitoring, discharging the accumulated sludge as required to maintain optimal operating efficiency.

DEGUMMING PROCESS

In the degumming operation, this hermetic self-opening separator has performed efficiently at 25,000-35,000 pph on crude nondegummed soya (Table I). With proper hydration conditions for crude soya degumming, the SRPX-317 will produce 65-72% acetone insolubles (AI) in the gums (dry basis), while yielding a degummed oil of 485 F minimum heat break. This range of AI or phosphatide content is regulated by the pressure control valve on the discharging oil phase, which, in turn, governs the neutral zone area in the bowl. As illustrated in Table I, the lowest back pressure 45 psi will yield the highest AI content, or 72% in the gums phase. The degummed oil will have a 485 F heat break. As the zone is moved outward by increasing oil discharge pressure, to 54 psig, the degummed oil quality improves. However, the gums phase contains higher oil content and lower AI.

During the degumming operation, any impurities, such as meal and scale, present in the incoming feed accumulate as sludge in the dirt-holding space. These solids are discharged in a partial shot (3-4 sec) every 4 hr. By interrupting the feed and completely discharging the bowl once a day, this separator can operate for weeks with disassembly only for preventive maintenance purposes.

CRUDE NONDEGUMMED OILS REFINING

Crude nondegummed oils, such as soya, corn, and cotton, which are refined in a hermetic system, may be efficiently separated in this centrifuge at throughputs of 36,000 pph. Typical data for crude soya refining are given in Figure 3. This crude soya analyzed 0.6% free fatty acid (FFA), 2.5% phosphatides, with theoretical loss of 3.1%. When refined with a treat in range of 0.15% excess as 16°Bé caustic with proper mixing and separation conditions, the refined oil analyzed 200-400 ppm soap and 0.03% FFA content. There was 3.9% refining loss. If this plant yield is compared to the theoretical yield, the refining efficiency is 99.2%. (Refining efficiency = [100-3.9]/[100-3.1] x 100 or 99.2%). This value represents efficient refining of this quality crude nondegummed soya.

DEGUMMED SOYA REFINING

When a degummed soya is refined in this same hermetic system and separated in the SRPX-317 at 36,000 pph, the refining loss is low, less than 0.3% over the theoretical value (Fig. 2). This particular crude soya analyzed 0.4% FFA with theoretical loss of 0.77%. When it was treated with ca. 0.08% excess over theoretical requirement as 22°Bé caustic, followed by proper mixing and heating conditions, the refining loss at this unit was less than 1%.

Crude degummed oil can be refined successfully in this centrifuge without use of bowl flush water. This greatly reduces the water requirements in refining of degummed oil, as well as the volume of soapstock to be handled. If there is three phasing, as a result of the strength of treat, the heavy lye phase accumulates in the sludge space and can be discharged periodically by monitoring the pressure differential across the bowl. With proper refining conditions, there can be little lye phase, even at 36,000 pph. Frequency of shot may be only every 45 min-1 hr.

LAURIC OILS REFINING

Crude coconut and palm kernel oils are difficult to refine continuously in any system which is not pressurized. Since their principal impurities are fines and FFA, the reaction with caustic is rapid. In the presence of excess caustic, water, air, or too much mixing or turbulence, these oils readily emulsify and saponify and will produce stable emulsions and hard soaps.

In a properly designed hermetic system and centrifuge, lauric oils can be refined efficiently. By treating with a low excess of 11-12°Bé caustic, crude cocnut and palm kernel oils are refined and separated at 40,000 pph throughput in the SRPX-317 separator.

Typical data for refining of crude coconut oil of 5.7% FFA content at 43,000 pph is given in Figure 4 which shows a plant refining loss of only 5.9%. The refining factor is 1.04, when comparing the plant loss/FFA of crude oils as oleic. Actual throughput to this separator during this day's operation was in range of 48,000-50,000 pph.

Typical refined lauric oils contain only 100-200 ppm soap.

PALM OIL REFINING

A crude palm oil of 4.8% FFA content was refined in a hermetic system with this SRPX-317 unit at ca. 36,000 pph crude oil feed rate. As shown in Figure 4, refining loss was 7.6%, while producing a refined oil of 180 ppm soap content. The refining factor was 1.58. Normally, at this particular plant facility, any refining factor value under 1.8 is rated as good refining efficiency, due to the poor quality of crude palm oils available.

SLUDGE DISCHARGE

When this SRPX centrifuge has been in continuous re-

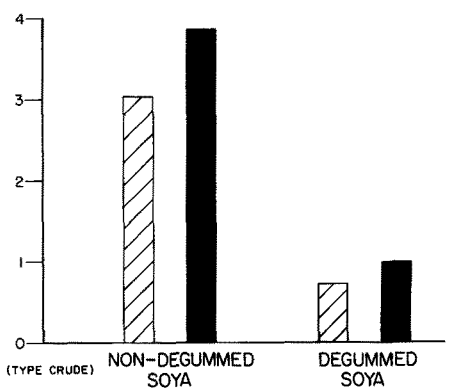

FIG. 3. Refining soya in SRPX-317. ▨ = Theoretical loss, and ■ = plant refining loss.

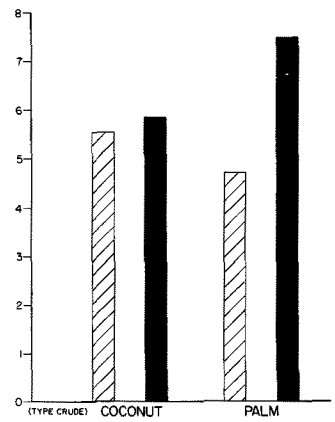

FIG. 4. Refining lauric oils in SRPX-317. ■ = Plant refining loss, and ▨ = free fatty acid (FFA) crude as oleic.

fining or degumming operation, the sludge phase has been collected during the self-cleaning cycle to determine if there is any appreciable neutral oil loss. The material, which is discharged during the shot cycle, is the heavy solids accumulation against the bowl wall and the soap or gums from the heavy phase. Analysis of the solids at the time of the discharge indicated only 200-300 ppm of neutral oil is lost.

The volume of shot was 3 gal over a period of 3 sec.

ADVANTAGES

The use of this SRPX-317 centrifuge in a degumming or refining system has the following advantages. The hermetic feature of the SRPX-317 will eliminate possible oxidation and ensure production of high quality oils. The thin strata disc and bowl design will provide high efficiency. The high capacity of the machine will reduce floor space requirements and minimize installation cost. The fact that this machine is self-cleaning and can be automated completely will reduce plant operating cost. Manual labor is virtually eliminated, and maintenance and spare parts expenses are kept at a minimum.

[Received April 22, 1974]