Continuous One-Step Refining-Water Washing of Crude Coconut Oil[1]

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Abstract

The Duozon-Hydrazon combination soapstock separating and water washing machine has been demonstrated as a versatile, efficient, continuous coconut oil refining machine in commercial installations, with refining factors of 1.0 and less.

THE PODBIELNIAK Duozon and Hydrazon centrifugal vegetable oil refining machines were introduced in 1956 (1). Commercial installations have demonstrated good performance of these machines in continuous processes for degumming, alkali refining, and water

1—JAOCS, 6169 T-104 Mss. 816 ve

washing of a variety of oils (2,3).

Most recently, a combination (4,5,6) machine has been developed for single-step refining and water washing of oils.

This paper describes a new and highly efficient process for the continuous refining and simultaneous water washing of crude coconut oil, and presents operating data from two commercial installations.

The Duozon-Hydrazon Machine

Figure 1 shows the essential features of the machine used for single-step refining-water washing operations.

It consists of a totally enclosed spinning rotor mounted horizontally. Within the rotor housing is provided a series of perforated concentric cylindrical elements through which two liquid phases of different densities, such as water and oil, can be passed countercurrently.

The Duozon-Hydrazon machines used for coconut oil refining have two feed connections as shown in the figure: one for the soap-oil mixture, and one for the countercurrent wash water; and two discharge connections, one for the neutral washed oil and one for the soapstock.

In operation, the mixture of soapstock and oil is introduced at a point within the rotor close to the periphery. The centrifugal force imposed on each phase by the spinning rotor causes the heavier soapstock to flow toward the periphery, thereby displacing oil and causing it to flow toward the center. At another point within the rotor closer to the center, process water is introduced. This water likewise flows under centrifugal force toward the periphery of the rotor, thus coming into countercurrent contact with the oil. The action of the perforated contacting elements within the rotor is to alternately mix and separate the oil and water phases in multistage fashion. Calming zones near the center and at the periphery provide clarification of both heavy and light phases before they are discharged.

Liquids flow into and out of the rotor through passageways provided in the central rotating shaft. It should be noted that the centrifugal energy of the heavy separated phase is thereby recovered by the machine. This feature substantially reduces the electric power required for operation.

Specially designed, balanced, mechanical seals located at the two ends of the central shaft keep apart the heavy and light phases and permit connection of the stationary supply and discharge pipelines.

The machines used commercially for processing of vegetable oils are 36 inches in diameter and have been built for capacities of up to 30,000 lb/hr. Variable speed drives are used to permit rotational speeds in the range of 1000 to 2500 rpm, depending upon the specific application, equivalent to centrifugal forces in the range of 500 to 3100 *g*.

By suitable adjustment of the back pressure in the light-liquid-out stream, the relative volumes, and interface positions of the heavy and light phases in the rotor can be controlled, independently of flow ratios.

In actual practice, the differential pressure between the oil into and out of the machine is automatically controlled. This differential pressure counterbalances frictional and hydraulic forces of the liquids within the machine and maintains a stable interface position between light and heavy phases.

The inlet pressure must be high enough to overcome frictional forces within the machine and provide for the proper discharge of the heavy soapstock. As back pressure is increased, thereby decreasing the differential pressure, the interface between light and heavy phases is moved towards the periphery of the rotor. Decreasing the back pressure allows the interface position to move towards the center of the rotor.

Proper positioning of the interface insures optimum separation of the light and heavy phases. A fixed back pressure control on the light-liquid-out would result in an unbalanced interface since such control could not adjust for variations in the viscosity of the soapstock. Differential pressure control, however, provides a stable interface since it automatically adjusts to such pressure fluctuations.

Operation of these machines is simply controlled, therefore, by proper settings of rotational speed and differential pressure to achieve optimum separation efficiencies.

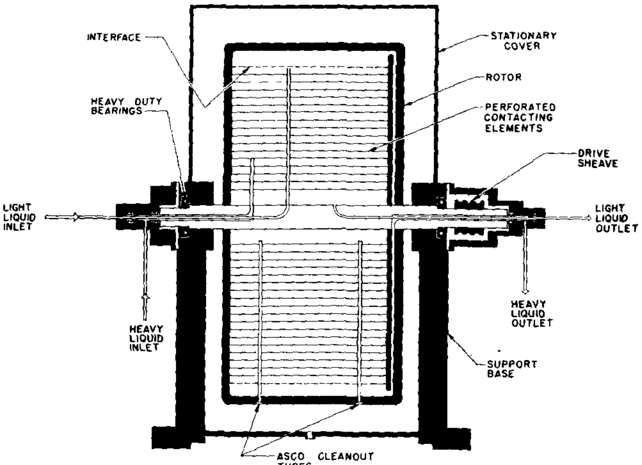

FIG. 1. Diagram illustrating design of 9700 series extractor.

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Process Requirements

Figure 2 shows the schematic arrangement of the equipment used for the continuous refining and water washing of crude coconut oils.

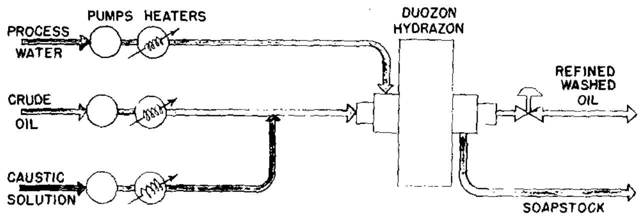

FIG. 2. One-step continuous coconut oil refining-water washing.

Crude oil and caustic solution of required strength are pumped under proportional control, heated to 160–180F, and then blended continuously in a short section of pipeline before entering the machine. The vigorous mixing which is customary in the refining of most other oils is avoided here because of the tendency of coconut oil-soap mixtures to form stable emulsions which make subsequent separation difficult.

The soap-oil mixture is then introduced into the rotor of the machine at a point near the periphery where the heavier soapstock phase is separated. Hot wash water (10–15%) pumped into the rotor flows countercurrent to the flow of the separated oil and combines with the soapstock phase to be discharged as a single stream. The interface position of the heavy and light phases, within the rotor, is automatically controlled, as previously described, by the back pressure valve in the discharge oil line.

Oil and caustic flow ratios are simply controlled. A rotary positive displacement pump with a variable speed drive is used to pump crude oil at the desired flow rate. Caustic is introduced with a positive displacement piston pump provided with manual stroke adjustment. A sample of the mixture is withdrawn and checked for total alkalinity and, if necessary, the caustic flow is reset to provide the proper ratio. Accuracy of total alkalinity in the mix has been maintained to within ±2% with this arrangement.

The tendency of soap-oil mixtures to form stable emulsions made it necessary to modify existing machine designs to minimize any internal turbulence which would affect the degree and efficiency of the separation.

Such factors as free fatty acid content of the crude oil, concentration of caustic solution, temperature of operation, size, position and orientation of mix inlet tubes within the rotor, spacing and perforation patterns of the contacting elements, and speed of rotation and throughput capacity were studied extensively before a successful machine could be developed to insure optimum separation efficiencies.

First Plant Built in Panama

Industrias Panama Boston, S. A., Panama City, R. P., was the first to refine coconut oils continuously with the Duozon-Hydrazon machine. This plant has been operating since June, 1959, producing cooking and salad oils of high quality.

Crude oil is extracted from copra at the plant site. The oils are filtered and stored for periods of up to two days before being processed. After refining and water washing residual color and soap are removed from the oil by vacuum bleaching with 0.1 to 0.2% by weight of fuller's earth. Bleaching is followed by high vacuum deodorization to produce oils light in color, with practically zero soap content, and with smoke points of over 400F. The finished oils are then given a final polishing filtration before being bottled for domestic sale.

Overall plant losses, including refining, bleaching, and deodorizing, for processing crude oils with free fatty acids varying over a range of 3–9% are reported as 1.2 times the F.F.A. of the crude. Losses for the refining and water washing step are reported to be 0.85–1.0 times the F.F.A. (calculated as oleic acid) of the crude.

This operation is considered highly efficient as compared to the usual kettle refining methods that most processors of coconut oil are using. Typical kettle losses have been reported in the range of 1.3 to 1.6 times the F.F.A. of the crude. The savings made possible by this process, therefore, have quickly paid-off the somewhat higher investment for the continuous process equipment at the Panama Boston plant.

Table I summarizes data obtained from the Panama plant and from an installation of a commercial packaged plant at Podbielniak's Hillside operations, utilizing the Duozon-Hydrazon machine for continuous coconut oil refining and water washing.

Acknowledgments

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TABLE I

Caustic Refining-Water Washing Crude Coconut Oils
Typical Plant Scale Results

Crude Oil		Caustic		Soapstock		Refined Oil		Refining loss, %	Refining factor [c]
% F.F.A. as lauric	% F.F.A. as oleic	Bé	% [a]	% H_2O	% NaOH	% H_2O	ppm Soap [b]		
3.2	4.5	10°	0.58	88.2	1.69	0.43	225	3.8	0.85
4.2	5.9	10°	0.84	80.2	2.81	0.46	200	5.7	0.97
6.2	8.7	12°	1.30	77.2	3.83	0.30	350	8.3	0.96

[a] % NaOH dry basis on weight of crude oil.
[b] Determined as sodium oleate.
[c] $\text{Refining factor} = \frac{\text{\% Refining loss}}{\text{\% F.F.A. as oleic}}$
Losses determined by sodium balance.